Determinants of the Cost-Effectiveness of Statins

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ABSTRACT

OBJECTIVE: To examine the cost-effectiveness of statins in relation to different measures of effectiveness, differences in efficacy among individual statins, and the risk of coronary heart disease. Efficacy is defined here as the magnitude of the effect produced by a given amount of drug, as demonstrated in placebo-control trials; i.e., the effectiveness per unit dose.

DATA SYNTHESIS: Treatment guidelines categorize patients by their risk of coronary events and set lower target cholesterol levels for patients at higher risk. Statins vary in their efficacy. If effectiveness is expressed as percent lowering in low-density lipoprotein cholesterol (LDL-C) and relatively little cholesterol lowering is required—as in low-risk patients—even statins of low efficacy provide adequate cholesterol lowering, and drug price is the determining factor of cost-effectiveness. For patients at high risk—the primary target group, which has been expanded in recent guidelines—high-efficacy statins are required to meet the more aggressive cholesterol goals, and efficacy is the important determinant of cost-effectiveness. When effectiveness is expressed in terms of life-years saved, the cost-effectiveness of statins as a class for treatment of high-risk patients compares favorably with the cost-effectiveness of generally accepted medical treatments.

CONCLUSION: In order to optimize cost-effectiveness, the level of effectiveness required to treat the specific patient or patient group must be considered. Statin efficacy is the major determinant of cost-effectiveness when greater cholesterol lowering is required, i.e., for high-risk patients, who make up the primary target group. Statin price is the more important factor if only limited cholesterol lowering (e.g., 35% or less reduction in LDL) is required.

KEYWORDS: Hydroxymethylglutaryl-CoA reductase inhibitors, Cost-effectiveness analysis, Drug therapy, Economics, Coronary disease

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High blood cholesterol is a major modifiable risk factor for coronary heart disease (CHD), the primary cause of illness-related death in the United States.^{1,2} Every 10% reduction in total cholesterol decreases the risk of coronary death by 15%.³ Hence, cholesterol-lowering treatments, including statins (inhibitors of hydroxymethylglutaryl-CoA reductase), have been recommended in national guidelines for an ever-widening section of the population.

The guidelines issued by the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III placed patients in 3 risk categories: (1) those with established CHD and those with a 10-year risk of coronary events equivalent to that of CHD, (2) those with hypercholesterolemia and 2 or more risk factors, and (3) those with hypercholesterolemia and less than 2 risk factors. The guidelines set low-density lipoprotein cholesterol (LDL-C) treatment goals of <100 mg/dL, <130 mg/dL, and <160 mg/dL, respectively, for patients in these 3 groups (Table 1).⁴

These categories and LDL-C treatment goals are similar to those in the ATP II guidelines published in 1993 except that in the earlier guidelines, only patients with established CHD were included in the first risk category.⁵ The broadened indications for treatment in the ATP III guidelines increased the number of people in the United States who require cholesterol-lowering drugs to about 36 million, up from about 12.7 million in the ATP II guidelines.⁶

Outcomes studies have revealed a considerable gap between NCEP recommendations and clinical practice in the United States.⁷⁻⁹ Sixty-two percent of patients receiving lipid-lowering therapy in the L-TAP study, a study of 4,888 patients in 5 regions of the United States, did not meet their LDL-C goal.⁷ Similarly, in a retrospective study of 7,619 patients treated with statins at 27 managed care plans, 37% did not reach their LDL-C goal.⁸ Consistently in these and other studies, the percent of patients achieving their ATP treatment goals was lowest in the highest-risk groups—i.e., those patients most in need of effective treatment.⁷⁻¹⁰

Statins are established as first-line cholesterol-lowering drugs and are the pharmacologic treatment of choice because of their effectiveness and safety.^{10,11} The expanded indications for treatment in the ATP III guidelines and evidence of widespread undertreatment increase the need for statin therapy and will increase demand (Table 1). For managed care, this raises questions about the costs and cost-effectiveness of statins. In particular: What determines the cost-effectiveness of statins? Are there differences among the statins in cost-effectiveness? Are statins as a class “cost effective”? For which patients are statins most cost effective? In order to address these questions, we

reviewed the statin pharmacoeconomic literature and examined the factors that determine the cost-effectiveness of statin treatment.

Incremental Cost-Effectiveness

The cost-effectiveness ratio usually referred to in pharmacoeconomics is the *incremental cost-effectiveness ratio*, which compares the costs and effects of one treatment (here, statins) with those of another (typically patients' usual care). The incremental cost-effectiveness ratio is defined as the difference in the cost of the 2 treatments (statin and usual care) divided by the difference in their effectiveness:

$$\text{Cost/Effectiveness} = \frac{\text{Cost (statin)} - \text{Cost (usual care)}}{\text{Effectiveness (statin)} - \text{Effectiveness (usual care)}}$$

Alternative treatments typically vary both in their cost and in their effectiveness. The goal is to find the treatment with the least cost for the greatest effectiveness, i.e., the treatment with the smallest (most favorable) cost-effectiveness ratio. It is evident from the above equation that the cost-effectiveness ratio can be minimized by decreasing the cost or increasing the effectiveness. The equation does not, however, specify how costs and effectiveness are to be defined. The cost is expressed in currency, but effectiveness can be expressed in a number of ways. The measures of effectiveness we shall consider are the average percent reduction in LDL-C per patient, the proportion of patients reaching their LDL-C goal, and number of life-years saved (LYS). These different measures imply different time horizons and corresponding differences in the costs that must be considered.

Differences Among Statins in Efficacy and Price

Six statins—atorvastatin, fluvastatin, lovastatin, pravastatin, rosuvastatin, and simvastatin—are currently marketed in the United States. These statins vary considerably in price and efficacy. *Efficacy* is defined here as the magnitude of the effect—or effectiveness—produced by a given amount of drug. It can be understood as the inverse of potency, which is the amount of drug required to produce a given effect.

Table 2 lists prices and effectiveness, expressed as percent reduction in LDL-C, for different statin dosages. The effectiveness of statins increases with dosage, but efficacy is a fixed property for each statin. There are 2 ways of increasing the effectiveness: (a) increasing the dose of a given statin or (b) using the same dose of another statin with greater efficacy. There are limits, however, to the extent to which the effectiveness of statins with relatively low efficacy can be increased by raising the dose. As an example, the effectiveness of pravastatin 80 mg (measured as percent reduction in LDL-C) is 65% greater than that of pravastatin 10 mg but still less than that of rosuvastatin 5 mg and considerably less than that of higher dosages of statins with greater efficacy. Although it has been argued that the statins are clinically interchangeable,¹² the differences in efficacy and price have important consequences in the determination of cost-

TABLE 1 LDL-C Goals and Cut Points for Drug Therapy by Risk Category in the NCEP III Guidelines*

Description†	10-Year Risk of Coronary Events	LDL-C Goal (mg/dL)	LDL-C Level at Which to Consider Drug Therapy (mg/dL)
CHD and CHD risk equivalents	>20%	<100	≥130 (100-129, drug therapy optional)
≥2 Risk factors	≤20%	<130	≥130 if 10-year risk of events = 10%-20%; ≥160 if 10-year risk of events <10%
0-1 Risk factors	<10%‡	<160	≥190 (160-189, drug therapy optional)

ATP = Adult Treatment Panel.

CHD = coronary heart disease.

LDL-C = low-density lipoprotein cholesterol.

NCEP = National Cholesterol Education Program.

* ATP III is based on the earlier ATP II and has the same LDL-C goals for the 3 risk categories. The highest risk category in ATP III includes patients with a risk of major coronary events equivalent to that of established CHD (in ATP II, only patients with established CHD were in the highest risk category). CHD risk equivalents include other forms of atherosclerotic disease, diabetes, and combinations of multiple risk factors conferring a 10-year risk of CHD of >20%. By focusing more on the 10-year risk of coronary events rather than simply on risk factors and placing more patient groups in the higher risk categories, ATP III expands the indications for intensive cholesterol-lowering therapy.⁴

† Major risk factors (exclusive of LDL-C) that modify LDL-C goals include cigarette smoking, hypertension (blood pressure ≥140/90 mm Hg or use of an antihypertensive medication), low HDL-C (<40 mg/dL), family history of premature CHD, age (men ≥45 years; women ≥55 years). Diabetes is considered as a CHD risk equivalent.

‡ Almost all people with 0-1 risk factors have a 10-year risk <10%; 10-year risk assessment in these patients is not necessary.

effectiveness of statins, as demonstrated below.

Relationship Between Efficacy and Cost-Effectiveness

The relationship between the efficacy and cost-effectiveness of individual statins can be visualized in a scatter plot of the cost versus the effect. Figure 1 shows such a plot, where effectiveness is expressed as percent lowering of LDL-C and costs are expressed as annual drug costs, based on October 2003 prices from an online pharmacy. The line in Figure 1 describes the "efficient frontier," consisting of those points representing the lowest cost at any given level of effectiveness. Rosuvastatin and generic lovastatin lie on the efficient frontier at higher and lower levels, respectively, of effectiveness; fluvastatin 80 mg and atorvastatin 10 mg lie on the efficient frontier at intermediate levels of effectiveness. If, for example, the level of effectiveness is set at 45% reduction in LDL-C, rosuvastatin 10 mg has the lowest cost; in the absence of rosuvastatin, atorvastatin 40 mg would have the lowest cost at that level of effectiveness. At higher lev-

TABLE 2 Statin Dosages by Effectiveness
(Percent Reduction in LDL-C) and Price*

Statin	Daily dose				
	5 mg	10 mg	20 mg	40 mg	80 mg
Atorvastatin	-	39% / \$2.04	43% / \$3.07	50% / \$3.07	60% / \$3.07
Fluvastatin	-	-	22% / \$1.56	25% / \$1.56	35% / \$1.97
Lovastatin†	-	21% / \$0.96	27% / \$1.11	31% / \$1.97	-
Pravastatin	-	22% / \$2.50	32% / \$2.52	34% / \$3.70	37% / \$3.76
Rosuvastatin	45% / \$2.22	52% / \$2.22	55% / \$2.22	63% / \$2.22	-
Simvastatin	26% / \$1.63	30% / \$2.18	38% / \$3.72	41% / \$3.72	47% / \$3.73

* Data presented as percent lowering of LDL-C / price per unit. Price per tablet based on price of 90 tablets listed on drugstore.com on October 10, 2003. Values for the percent reduction in LDL-C are as cited in the Physicians' Desk Reference or at www.rxlist.com for patients with primary hypercholesterolemia.¹³

† Prices are shown for generic lovastatin. Brand lovastatin prices are \$1.28, \$2.20, and \$3.94 for 10, 20, and 40 mg, respectively.

FIGURE 1 Annual Statin Cost by
Percent Reduction in LDL-C

In this presentation of cost-effectiveness, drug acquisition costs are the only costs considered, and effectiveness is expressed as the percent reduction in LDL-C. The curve approximates the "efficient frontier," which tracks the lowest cost at any given level of effectiveness. Statin dosages that lie on the efficient frontier are labeled: L10, L20, and L40 generic, generic lovastatin 10 mg, 20 mg, and 40 mg; R5, R10, R20, and R40, rosuvastatin 5 mg, 10 mg, 20 mg, and 40 mg. Annual drug costs are based on prices for 90-pill packages, as listed on drugstore.com on October 10, 2003. Effectiveness data are from the Physician's Desk Reference or www.rxlist.com as indicated in the legend to Table 2.¹³

reduction in LDL-C) the lowest-priced statin has the lowest cost-effectiveness ratio; i.e., is the most cost-effective. The lowest-priced statin currently is generic lovastatin.

Essentially the same results have been obtained in several similar analyses set in the United States and Canada.¹⁴⁻¹⁶ The effectiveness data (average percent reduction in LDL-C per patient) for these analyses were gleaned from published sources, and the costs were annual drug costs, again expressed as average wholesale prices (AWPs) for the U.S. study¹⁴ or as average reimbursements for the 2 Canadian studies.^{15,16} In each of these studies, the efficient frontier was defined by the statin with the greatest efficacy then available—simvastatin in one study¹⁶ and atorvastatin in 2 later studies,^{14,15} and by the least expensive statin, then fluvastatin.

■ NCEP ATP III Risk Groups

When effectiveness is measured in terms of the proportion of patients reaching a target LDL-C threshold, effectiveness is dependent on patients' initial LDL-C level and on their target level. Since the LDL-C target levels recommended by the NCEP are lower for patients at higher risk of CHD, effectiveness (expressed as the percent of patients reaching their LDL-C goal) and, therefore, cost-effectiveness, are dependent on the risk of CHD. Figure 2 shows a scatter plot of annual statin cost versus percent of patients achieving their ATP III treatment goal for patients in the highest risk category (CHD and CHD-risk equivalents). The picture is similar to that in Figure 1 for the statins shown, which include the higher-efficacy statins (atorvastatin, rosuvastatin, and simvastatin) and pravastatin. Again, atorvastatin 10 mg and rosuvastatin 5 mg, 10 mg, 20 mg, and 40 mg lie on the efficient frontier. The lower-efficacy statins, including pravastatin, are not effective in the high-risk patient group.

For patients in the lower ATP III risk groups, the data points and the efficient frontier seen in Figure 2 are shifted to the right. Table 3 shows the percent patients reaching their LDL-C goal for each of the 3 ATP III risk categories. For patients in the lowest risk group (fewer than 2 CHD risk factors), even low-efficacy statins such as pravastatin can bring most patients to their treatment goal (Table 3); under these circumstances, it is drug price rather than efficacy that is the more important determinant of cost-effectiveness.

Table 3 illustrates the concept that, as CHD risk decreases, statin efficacy is relatively less important. There are, however, some caveats to the interpretation of these results. First, the relationship between CHD risk and effectiveness seen in Figure 2 is a consequence of the method of expressing effectiveness and the fact that the NCEP target LDL-C levels are set lower for higher-risk groups. Second, it is generally not the case that all low-risk patients reach their LDL-C treatment goal.

els of effectiveness, the statin with the greatest efficacy (rosuvastatin) has the lowest cost-effectiveness ratio; i.e., is most cost effective. At low levels of effectiveness (e.g., less than 30%

Outcomes studies have shown that many patients in the low-risk category do not reach their LDL-C goal.⁷⁻¹⁰ The failure to reach LDL-C goal may be due, in part, to low adherence,¹⁷ but inadequate treatment, due to failure to titrate and low-efficacy therapies, also contributes to failure to reach LDL-C goal.^{7,9,10} Third, the use of the percent of patients reaching their LDL-C treatment goal as a measure of effectiveness ignores any potential benefit of reducing LDL-C levels to below recommended thresholds.

Preliminary data from the Heart Protection Study indicate that statin treatment reduces the risk of coronary events in some patient categories (those with a history of heart disease, stroke, other occlusive vascular disease, or diabetes) even when their cholesterol levels are normal.¹⁸ Furthermore, there appears to be no threshold cholesterol value below which statin therapy is not associated with a benefit, even among those with pretreatment cholesterol levels below current national recommended targets.

Titration to LDL-C Treatment Goal

The situation illustrated in Figures 1 and 2, in which patients continue with their initial statin dose, may, in fact, represent reality for many patients. Outcomes studies indicate that many patients—about half in some studies—do not receive LDL-C level monitoring or appropriate statin dose adjustment.^{8,9} In contrast, the NCEP guidelines recommend drug titration until patients reach their treatment goal (or the maximum dose) if the initial dose is inadequate.⁴ In this scenario, effectiveness is appropriately measured as the percent of patients reaching their LDL-C treatment goal.

The costs that must be considered are all those associated with measuring and remeasuring patients' cholesterol levels, including the costs of office visits and laboratory tests, as well as drug acquisition costs. This scenario was examined in a pharmacoeconomic analysis based on a 54-week, randomized, multicenter trial in the United States, in which starting doses of 4 statins were titrated upwards until patients with and without atherosclerosis reached the ATP II goal for LDL-C (or the maximum dose was reached).^{5,19} All related medical costs (drugs, office visits, laboratory tests) were considered from the perspective of insurers and managed care organizations and were based on national averages.¹⁹ The statin with the greatest efficacy—atorvastatin, in that study—was “dominant,” i.e., it was both more effective and less costly than dose titration with the other statins. Note, however, that once drug titration has been completed, the costs of long-term maintenance therapy are principally the direct drug-acquisition costs.²⁰

Cost per Life-Year Saved

Since hypercholesterolemia is clinically silent, survival is the ultimate measure of statin effectiveness, not cholesterol lowering. When effectiveness is measured in terms of survival as the number of LYS, the costs that must be considered include not

FIGURE 2 Annual Drug Cost per Patient by Percent of Patients Achieving LDL-C Treatment Goal for Patients in the Highest ATP III Risk Category

The highest ATP III risk category contains patients with CHD and CHD-risk equivalents. The line shows the efficient frontier, defined as in the caption to Figure 1. Statin dosages that lie on the efficient frontier are labeled: A10, atorvastatin 10 mg; R5, R10, R20, and R40, rosuvastatin 5 mg, 10 mg, 20 mg, and 40 mg. The source for drug costs is as in Figure 1. The sources of the effectiveness data are (except for rosuvastatin 5 mg) the STELLAR trial,⁴¹ and mean values from the comparative trials referenced as follows: rosuvastatin 10 mg,⁴¹⁻⁴⁵ atorvastatin 10 mg,^{41,42,45} simvastatin 20 mg,^{41,43,44} and pravastatin 20 mg.^{41,43,44}

TABLE 3 Percent of Patients Achieving LDL-C Treatment Goal by ATP III Risk Category for Selected Statin Dosages

Statin Dosage	Percent of Patients at ATP III Treatment Goal*		
	CHD and CHD Risk Equivalents	≥2 Risk Factors	0-1 Risk Factors
Pravastatin 20 mg	6	40	89
Simvastatin 20 mg	23	74	90
Atorvastatin 10 mg	25	79	92
Rosuvastatin 10 mg	62	89	98

*ATP III risk categories as defined in Table 1. Effectiveness data are mean values from the comparative trials referenced as follows: rosuvastatin 10 mg,⁴¹⁻⁴⁵ atorvastatin 10 mg,^{41,42,45} simvastatin 20 mg,^{41,43,44} and pravastatin 20 mg.^{41,43,44}

just statin therapy and dose titration but also medical treatments for CHD (which are reduced for patients treated with statins). More than 30 pharmacoeconomic analyses of the cost

TABLE 4 Cost Per Life-Year Saved for Patients With and Without Preexisting Coronary Heart Disease in the United States

Study	Statin	Cost per LYS (\$1,000s)*†
With Preexisting CHD		
Ashraf, et al. (1996) ³⁶	Pravastatin	7.1 – 12.7
Elliott 1999 ^{37,38} ‡	Various	2.3 – 30.9
Ganz 2000 ³⁹ §	Pravastatin	5.4 – 97.8
Goldman 1991 ²⁷	Lovastatin	<0 – 310
Grover 1999 ⁴⁰	Simvastatin	4.4 – 21.7
Huse 1998 ²⁹	Various	8.2 – 63.6
Johannesson 1997 ⁴¹	Simvastatin	3.8 – 27.4
Prosser 2000 ²⁶	Simvastatin	1.8 – 40.0
Without Preexisting CHD		
Goldman 1991 ²⁷	Lovastatin	13.0 – 1,500
Hay 1991 ²⁸	Lovastatin	6.0 – 297
Huse 1998 ²⁹	Various	4.3 – 468
Prosser 2000 ²⁶ †	Pravastatin	54.0 – 1,400

LYS = life-years saved.

* Range of values (lower and upper) for the highest- and lowest-risk patient groups, respectively (except where indicated).

† Costs are unadjusted for inflation and are expressed in \$U.S. for 1989,^{27,28} 1995,^{35,40} 1996,³⁹ 1997,^{26,29} 1998,³⁸ and 1999.³⁶

‡ The lower and upper limits represent the most favorable and least favorable model scenarios rather than patient risk groups.

§ Cost per quality-adjusted life-year reported.

TABLE 5 The Cost Per Life-Years Saved of Statin Treatment Decreases as the Risk Factors for Events Increase*

Risk Factors						Cost-Effectiveness (\$/LYS)
LDL-C (mg/dL)	Sex	HTN	Obese	Smoker	CHD	
≥300	F	-	-	-	-	130,000
250-299	M	-	-	-	-	93,000
≥300	M	-	-	-	-	58,000
≥300	M	+	-	-	-	28,000
≥300	M	+	+	-	-	17,000
≥300	M	+	+	+	-	15,000
<250	M				+	17,000
≥250	F				+	8,100
≥250	M				+	1,600

CHD = coronary heart disease.

HTN = hypertension.

LYS = life-years saved.

* Data of Goldman et al. for people 55 to 64 years of age treated with lovastatin 20 mg.²⁷ Definitions: hypertensive, diastolic blood pressure ≥105 mm Hg; normotensive, diastolic blood pressure <95 mm Hg; obese, ≥130% of ideal weight; nonobese, <110% of ideal weight.

of statins per LYS have been reported. In these analyses, the data for the incidence of CHD, risk factors, and coronary events in patient-lifetime projections typically comes from the Framingham Heart Study, while the data for the effects of statins

on coronary events comes from long-term clinical event trials with lovastatin, pravastatin, and simvastatin: the WOSCOPS (West of Scotland Coronary Prevention Study)²¹ and AFCAPS/TexCAPS (Air Force/Texas Coronary Atherosclerosis Prevention Study)²² primary prevention trials and the 4S (Scandinavian Simvastatin Survival Study),²³ CARE (Cholesterol and Recurrent Events),²⁴ and LIPID (Long-Term Intervention with Pravastatin in Ischaemic Disease)²⁵ secondary prevention trials. In some analyses, the cost per quality-adjusted life-year (QALY) was determined; this adjustment for quality of life increases cost-effectiveness ratios by about 10% to 20%.²⁶

In most analyses of patients with preexisting CHD,²⁶⁻²⁹ the ranges of lifetime incremental cost per LYS values lie in the range of \$1,800 to \$40,000 (Table 4). The upper limits of the ranges exceed \$50,000 in some studies, but only for patients in the lowest risk groups.^{27,29} For subjects without preexisting CHD, the lifetime cost-effectiveness ratios vary over an extremely wide range—more than 100-fold in some studies^{27,29}—from lower limits generally below \$15,000 to upper limits sometimes exceeding \$1 million per LYS (Table 4).^{26,27} The critical factor is the risk of CHD: the cost-effectiveness ratio tends to decrease as the risk of coronary events increases. This is illustrated in Table 5, which shows data of Goldman et al.²⁷ This relationship holds because the effectiveness measure—LYS—depends on the number of coronary events avoided, which is greater in a high-risk population.

The cost of statins per LYS for patients with preexisting CHD, and for those without CHD but with multiple risk factors, falls inside the threshold for an acceptable cost-effective ratio: the value of this threshold was about U.S. \$30,000 in the early 1990s and \$40,000 to \$50,000 more recently. The cost-effectiveness values for statins also generally fall within the range of values for other currently accepted treatments: \$7,700 to \$10,000 for single-vessel angioplasty in patients with severe angina; \$18,000 for annual screening for colorectal cancer with a fecal occult blood test; \$108,000 to \$112,000 for single-vessel angioplasty in patients with mild angina; \$15,000 to \$96,500 for treatment of hypertension in patients aged 35 to 64 years; and \$150,000 for annual mammography in women aged 55 to 65 years (cost-effectiveness ratios expressed as 1995 U.S.\$ per QALY).^{26,30}

Specific Risk Groups

In addition to patients with CHD, several at-risk patient groups have been subjected to cost-effectiveness analysis. Statin treatment of heterozygous familial hypercholesterolemia, which affects approximately 0.5 million people in the United States, is cost-saving for men and costs only \$300 per LYS for women, even without additional risk factors.³¹ Patients with type-2 diabetes have a risk of coronary events comparable to that of non-diabetic patients with a history of myocardial infarction.³² This suggests that the cost-effectiveness of statin treatment of these

2 populations should be equivalent; this has not, however, been demonstrated in the primary prevention cost-effectiveness literature, where diabetes has been treated as a risk factor for CHD comparable to smoking or hypertension.²⁹ Secondary prevention of coronary events in diabetic patients was studied in post hoc analyses of patient subgroups of the 4S trial.^{33,34} The cost per LYS of simvastatin treatment was substantially lower for diabetic than for nondiabetic patients with CHD.³³

Statin Pricing

In Figures 1 and 2, we presented cost-effectiveness data using current statin prices from an online pharmacy. We note that there have been changes in pricing policy by drug manufacturers over the past several years, such as a switch for some statins from higher prices for higher doses to flat pricing, as well as the introduction of new statins. Rosuvastatin has displaced atorvastatin at the upper end of the efficient frontier seen in Figure 1, just as atorvastatin previously displaced simvastatin. Lovastatin, which was the first statin to be marketed in the United States (in 1987), became available as a generic drug in 2002. Generic lovastatin has replaced fluvastatin at the lower end of the efficient frontier shown in Figure 1. However, generic lovastatin 40 mg is comparable in effectiveness to simvastatin 10 mg or pravastatin 20 mg, which bring less than 20% of high-risk patients to their LDL-C goal (Figure 2), so that generic lovastatin can only compete (on the basis of price) at lower levels of effectiveness. Outcomes studies indicate that the majority of patients currently being treated with statins are in the CHD or risk-equivalent category.⁷⁻⁹

Limitations

Managed care organizations typically contract for statin prices at discounts to the AWP. Discount prices for the statin drugs were obtained from an online pharmacy Web site to help account for the difference in AWP prices and the actual costs incurred by managed care organizations (MCOs), prior to member cost share. However, actual statin purchase costs will differ among MCOs, and this may change the cost-effectiveness rankings of statins at any given level of effectiveness. Nevertheless, in order to optimize cost-effectiveness, MCOs must consider the level of effectiveness that is required to treat individual patients or specific patient groups rather than simply the lowest purchase price.

Summary

In principle, the incremental cost-effectiveness ratio can be reduced by decreasing the cost or by increasing the effectiveness of the therapy. Both of these effects are evident in the comparisons of individual statins. When effectiveness is expressed as percent reduction in LDL-C and cost as statin price, increasing the efficacy (the effect per unit dose) decreases the cost-effectiveness ratio and, when greater LDL-C lowering is required

(as is the case with patients with CHD or CHD-equivalent risk), the statins with the greatest efficacy have the lowest (most favorable) cost-effectiveness ratios. If limited LDL-C lowering is required (as may be the case for some low-risk patients), drug price may be the more important factor.

The same relationships between the cost-effectiveness ratio and statin efficacy and price are also seen when effectiveness is expressed as the proportion of patients reaching LDL-C goal. The inverse relationship between statin efficacy and the cost-effectiveness ratio holds up under the circumstances of statin titration to treatment goal and the inclusion of all related treatment costs. When effectiveness is expressed in terms of LYS and all long-term medical costs are taken into account, the incremental cost-effectiveness ratio decreases as the risk of CHD increases. For patients with preexisting CHD or CHD-equivalent risk of coronary events, the cost-effectiveness ratio of statins as a class compares favorably with generally accepted medical treatments.

The results suggest 3 strategies for minimizing the cost-effectiveness ratio of statin therapy. First, preferentially treat patients with existing CHD or equivalent risk; second, use statins with the greatest efficacy for these patients and for patients at low risk but with high baseline LDL-C levels; and third, use a less-expensive statin when less LDL-C lowering is needed, as in low-risk patients with lower baseline LDL-C levels.

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