REVIEW

Omega-3 Fatty Acids for Cardioprotection

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The most compelling evidence for the cardiovascular benefit provided by omega-3 fatty acids comes from 3 large controlled trials of 32,000 participants randomized to receive omega-3 fatty acid supplements containing docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) or to act as controls. These trials showed reductions in cardiovascular events of 19% to 45%. These findings suggest that intake of omega-3 fatty acids, whether from dietary sources or fish oil supplements, should be increased, especially in those with or at risk for coronary artery disease. Patients should consume both DHA and EPA. The target DHA and EPA consumption levels are about 1 g/d for those with known coronary artery disease and at least 500 mg/d for those without disease. Patients with hypertriglyceridemia benefit from treatment with 3 to 4 g/d of DHA and EPA, a dosage that lowers triglyceride levels by 20% to 50%. Although 2 meals of oily fish per week can provide 400 to 500 mg/d of DHA and EPA, secondary prevention patients and those with hypertriglyceridemia must use fish oil supplements if they are to reach 1 g/d and 3 to 4 g/d of DHA and EPA, respectively. Combination therapy with omega-3 fatty acids and a statin is a safe and effective way to improve lipid levels and cardiovascular prognosis beyond the benefits provided by statin therapy alone. Blood DHA and EPA levels could one day be used to identify patients with deficient levels and to individualize therapeutic recommendations.

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AA = arachidonic acid; AHA = American Heart Association; ALA = α-linolenic acid; CAD = coronary artery disease; CV = cardiovascular; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid; FDA = Food and Drug Administration; GISSI = Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico; HDL = high-density lipoprotein; JELIS = Japan EPA Lipid Intervention Study; LDL = low-density lipoprotein; MI = myocardial infarction; SCD = sudden cardiac death

The American Heart Association (AHA) has endorsed the use of omega-3 fatty acids for secondary prevention of cardiovascular (CV) events in people with documented coronary artery disease (CAD). The recommendation calls for approximately 1 g/d of a mixture of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Although the AHA statement identifies oily fish as the ideal source, fish oil (in capsules or liquid form) is also an acceptable option.[1] This is the first time that the AHA has recommended a nutritional supplement for CAD prevention. The omega-3 fatty acid recommendation is based on an extensive and growing body of evidence supporting the CV benefits and triglyceride-lowering effects of omega-3 oils.

The Food and Drug Administration (FDA) has approved an omega-3 fatty acid ethyl ester formulation, at a dosage of 4.0 g/d, for the treatment of very high triglyceride levels. Nevertheless, many physicians and patients are confused about the appropriate form, indications, and dosing of omega-3 fatty acids. This review briefly summarizes current scientific data on omega-3 fatty acids and CV health, specifically focusing on indications for use and recommended guidelines for administration and dosing. Throughout, the term *omega-3 fatty acids* is used to indicate DHA and EPA only; as discussed later, the evidence for a CV benefit from α-linolenic acid (ALA), a plant omega-3 fatty acid, is much weaker than it is for DHA and EPA.

EFFECTS ON CV HEALTH

BACKGROUND

During the past 3 decades, thousands of epidemiologic, observational, experimental, and randomized controlled studies have been published on the CV effects of omega-3 fatty acids. In the aggregate, these studies document clear CV protective effects.[2] The 2 specific omega-3 fatty acids that have been associated with CV benefit and triglyceride lowering are those from fish oils, DHA and EPA. In contrast, ALA, which is found in abundance in flaxseed and to a lesser extent in walnuts and other tree nuts, as well as in trace amounts in green leafy vegetables, is inadequate as the sole dietary source of omega-3 fatty acids because humans convert less than 5% of ALA to EPA (and less to DHA).[3] In some but not all epidemiologic studies,[2] ALA intake has been inversely associated with CV events; however, because of the absence of convincing randomized trials with clinically relevant end

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TABLE 1. **Association Between Tissue Fatty Acids and Risk of CAD Events, Estimated by Effect Sizes in 25 Studies**[a]

	All studies			
Fatty acid	*g*[b]	*P* value	95% CI	No. of studies
EPA-DHA	–0.19	<.01	–0.06 to –0.33	19
DHA	–0.34	<.01	–0.12 to –0.59	19
EPA	–0.10	.08	0.01 to –0.21	15
ALA	–0.21	.03	–0.02 to –0.39	16

[a] ALA =α-linolenic acid; CAD = coronary artery disease; CI = confidence interval; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid.

[b] *g*: Hedges *g* (effect size), in which the case-control difference is expressed as a fraction of the pooled SD; negative values indicate that fatty acid values were lower in cases relative to controls.

Adapted from *Atherosclerosis*,[4] with permission from Elsevier.

points, its role in cardioprotection is less clear than that of DHA and EPA.

Clinical Trials on Coronary Artery Disease

Harris et al[4] reviewed 25 trials that evaluated risk of CAD events as a function of in vivo omega-3 fatty acid levels. The quantity of DHA in plasma and cellular phospholipids, which closely correlates with the quantity of DHA in the myocardium, was inversely related to the risk of events.[4,5] Reduced risk appears to be more clearly linked to increased tissue levels of DHA than EPA (Table 1); however, it is difficult to separate completely the effects of these 2 omega-3 fatty acids that are almost always consumed together.

In a randomized trial performed almost 2 decades ago, omega-3 fatty acids, either in the form of oily fish or fish oil capsules, reduced 2-year all-cause mortality by 29% in post–myocardial infarction (MI) patients.[6] More recently, 2 major randomized controlled trials examined the effects of supplemental omega-3 fatty acids on CAD risk. The Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico (GISSI)-Prevenzione study randomized 11,323 patients who had experienced an MI to omega-3 acid ethyl esters (1 capsule per day, providing 850 mg of DHA and EPA) or usual care. Treatment significantly reduced risk of death from any cause by 28%; after 4 months, risk of sudden cardiac death (SCD) was decreased by 45% (Figure 1).[7] In another megatrial, the Japan EPA Lipid Intervention Study (JELIS),[8] 18,645 patients with hypercholesterolemia (70% women; mean age, 61 years) were randomly assigned to either statin alone or statin and pure EPA (1.8 g/d). During the 5-year study, EPA reduced major adverse CV events by 19% (Figure 2). Omega-3 fatty acid supplementation lowered CV risk in both the GISSI-Prevenzione study and JELIS, despite aggressive therapy with standard pharmacotherapy (eg, statins, aspirin, β-blockers and angiotensin-converting enzyme inhibitors). Additionally, the JELIS trial established the safety and efficacy of combination therapy with EPA and a statin vs statin therapy alone for improving CV prognosis.[8]

MECHANISMS OF ACTION

Omega-3 fatty acids appear to confer CV benefits largely through DHA and EPA enrichment of membrane phospholipids.[9] Via this mechanism, omega-3 fatty acids can ultimately increase arrhythmic thresholds,[10] reduce blood pressure,[11,12] improve arterial and endothelial function,[13] reduce platelet aggregation,[14] and favorably affect autonomic tone[11,15] (Table 2). In a meta–regression analysis of 22

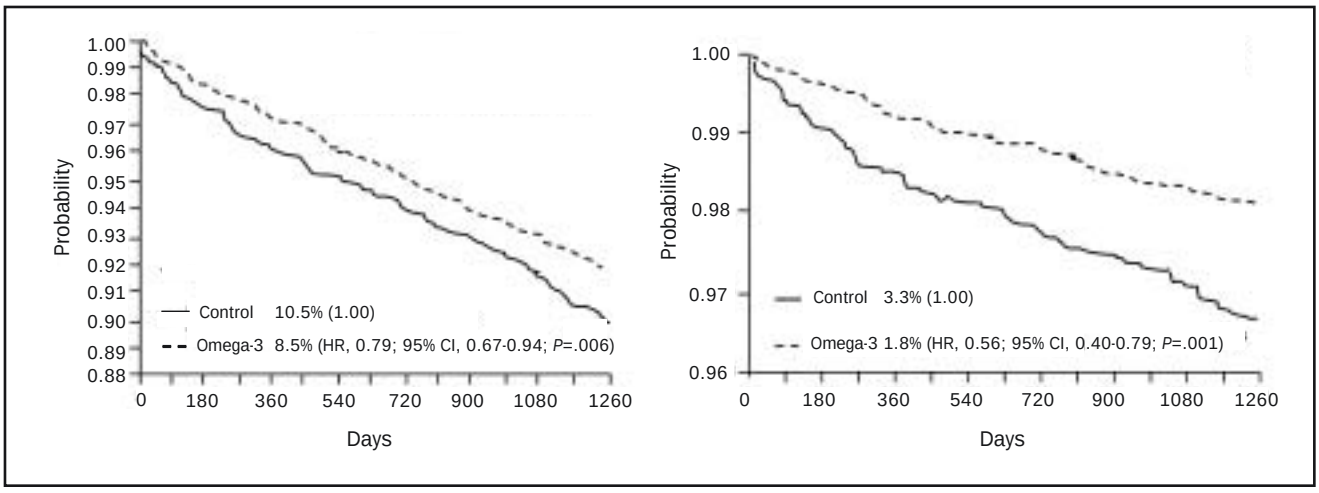

FIGURE 1. Time course of clinical events in the Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico (GISSI)-Prevenzione study. Treatment with 850 mg/d of omega-3 acid ethyl esters reduced total mortality (left) by 21% and sudden cardiac death (right) by 45% at 3.5 years. CI = confidence interval; HR = hazard ratio. Data from reference 7.

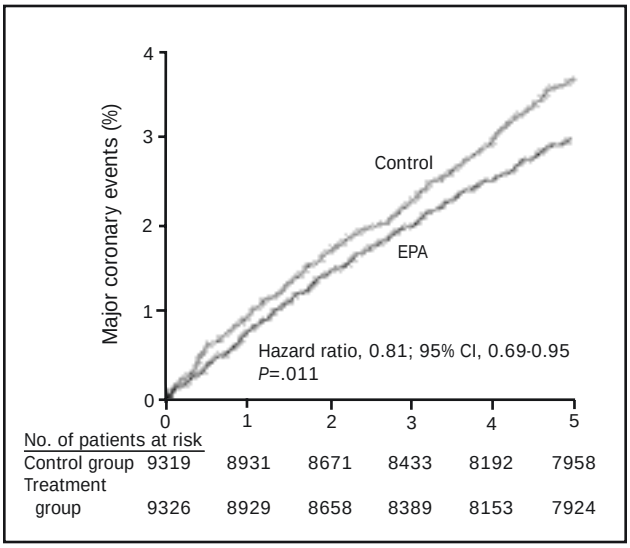

FIGURE 2. Eicosapentaenoic acid (EPA) (1.8 g/d) reduced the incidence of major adverse coronary events in the Japan EPA Lipid Intervention Study (JELIS) by 19%. CI = confidence interval. From *The Lancet*,[8] with permission from Elsevier.

double-blind studies, Geleijnse et al[16] reported that consumption of approximately 4.0 g/d of omega-3 fatty acid was associated with a significant 1.7- and 1.5-mm Hg reduction in systolic and diastolic blood pressures, respectively; these reductions were more pronounced in older patients and in those with higher blood pressures. Evidence suggests that lowering systolic blood pressure by as little as 2 mm Hg can yield reductions of 4% in mortality due to CAD.[17]

The antiplatelet, anti-inflammatory, and triglyceride-lowering effects of omega-3 fatty acids require relatively higher doses of DHA and EPA (eg, 3.0-4.0 g/d), whereas the reduction in SCD risk can be achieved at lower intakes (0.5-1.0 g/d).[4,7] Omega-3 fatty acids have been shown to suppress production of proinflammatory cytokines such as interleukin 6, interleukin 1β, and tissue necrosis factor α.[18] Additionally, when administered to people who were obese, 1.8 g/d of EPA increased the level of adiponectin, which can reduce inflammation and improve insulin sensitivity.[19] Very high doses of omega-3 fatty acids (ie, 8.0 g/d) have been shown to have anti-inflammatory effects and to improve body composition in patients with heart failure.[20] However, omega-3 fatty acids have not been shown consistently to lower C-reactive protein levels.[21]

TABLE 2. **Possible Omega-3 Fatty Acid Benefits**

Antiarrhythmic effects[a]	Decreased blood pressure
Modulation of autonomic function[a]	Anti-inflammatory effects
Decreased platelet aggregation	Plaque stabilization
Vasodilation	Decreased triglycerides

[a] Conferred at lower doses of docosahexaenoic acid and eicosapentaenoic acid.

A "GISSI" dose of DHA and EPA (810 mg/d) given to stable CAD patients decreased resting heart rate, increased postexercise heart rate recovery, and increased beat-to-beat heart rate variability (in the high-frequency band).[11] These changes are consistent with augmented vagal tone, suggesting that omega-3 fatty acids could confer cardioprotection in part by improving autonomic sympathovagal balance.[11,15] However, other studies in patients undergoing heart transplant suggest that omega-3 fatty acids can reduce heart rate independently of vagal activation.[22]

To the extent that the omega-3 fatty acid cardioprotection is mediated by changes in cell membrane composition, the much higher levels of DHA than EPA in membrane phospholipids[5,14] suggest that DHA is the more important of the 2 omega-3 fatty acids. However, data from JELIS demonstrated the efficacy of EPA, which is integrally involved in the antiplatelet and anti-inflammatory activities of omega-3 fatty acids. Although EPA can compete with arachidonic acid (AA) as a substrate for the production of cyclooxygenase- and lipoxygenase-derived eicosanoids, it is a much poorer substrate than AA.[23] Given that membranes typically contain 10 times as much AA as EPA, the beneficial effects of omega-3 fatty acids are not likely due to EPA-derived eicosanoids. As discussed earlier, the presence of both DHA and EPA in cellular membranes can alter the activity of membrane-bound proteins (receptors, ion channels, etc), and both omega-3 fatty acids can work synergistically to alter metabolism via this mechanism.

Some of the cardioprotective effects of omega-3 fatty acids, particularly at higher doses, could result from their favorable effects on the lipid profile. Davidson et al[24] recently reported that 3.4 g/d of omega-3 acid ethyl esters, when added to baseline simvastatin therapy, produced additional reductions of 29.5% in triglyceride levels and 9.0% in non–high-density lipoprotein (HDL) cholesterol levels, with a small but significant increase in HDL levels (Figure 3). Omega-3 fatty acids induce variable effects on low-density lipoprotein (LDL), depending on the baseline lipid profile. In JELIS, EPA reduced LDL by approximately 10%; however, omega-3 fatty acids can increase LDL by up to 10% when used in high doses to treat moderately elevated triglyceride levels,[25] and by 32% (from 79 to 104 mg/dL [to convert to millimoles per liter, multiply by 0.0113]) in patients with very high baseline triglyceride levels.[26]

OPTIMAL OMEGA-3 FATTY ACID MIX: DHA VS EPA

Both DHA and EPA are present in all oily fish, although at variable ratios (Table 3).[27] Most commonly consumed fish,

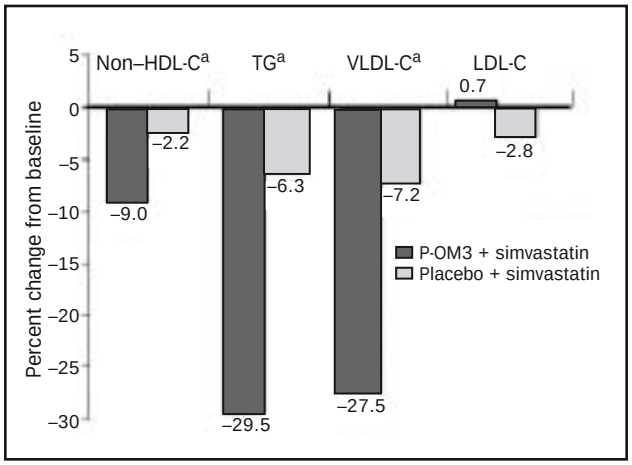

FIGURE 3. Effect of prescription omega–3 acid ethyl esters (P-OM3) (4.0 g/d) on lipid and lipoprotein levels in statin-treated patients with serum triglyceride (TG) levels of 200-499 mg/dL (2.26-5.64 mmol/L). Median percent changes are presented for non–high-density lipoprotein cholesterol (non–HDL-C), TGs, calculated very-low-density lipoprotein cholesterol (VLDL-C), and low-density lipoprotein cholesterol (LDL-C) from baseline to the end of treatment.
[a] P<.05.
From *Clin Ther*,[24] with permission from Excerpta Medica, Inc.

such as salmon, contain DHA and EPA in a ratio of approximately 2:1, whereas standard fish oil (usually derived from menhaden, an oily fish of the herring family) contains DHA and EPA in a 2:3 ratio. To a small extent, DHA can be retroconverted to EPA[28]; however, EPA supplementation does not increase tissue or blood levels of DHA.[29] In vitro studies have shown both fatty acids to alter ion channel function.[30]

A recent meta-analysis pooling the results of prospective clinical trials and epidemiologic studies suggests that most of the reduction in risk of CAD death is conferred with modest omega-3 fatty acid consumption (approximately 250-500 mg/d of DHA and EPA, corresponding to approximately 1-2 servings per week of oily fish) (Figure 4).[31] Thus, the antiarrhythmic effects[32] are apparent in studies in which the background intake of omega-3 fatty acids is already low and the risk of SCD is high. The reductions in SCD and fatal CAD in the GISSI-Prevenzione study appeared quickly, within weeks of initiating omega-3 fatty acid therapy. On the basis of the JELIS trial, the reduction in nonfatal CAD events could require higher doses (eg, 2000 mg/d of DHA and EPA) and a longer duration of treatment (3-5 years).

In a recent review of the cumulative data, Anand et al[10] showed significant benefits of DHA and EPA against atrial fibrillation,[33] as well as trends toward benefits in malignant ventricular arrhythmias.[10,34-36] In a randomized trial of 160 patients with CAD, omega-3 fatty acid supplementation (1700 mg/d of DHA and EPA) reduced the occurrence of atrial fibrillation after coronary artery bypass surgery by 54% vs placebo.[33] Although omega-3 fatty acids are effective at reducing SCD in patients with CAD and reduced

TABLE 3. **Fish Content of Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA)[a]**

Type	DHA (g/100 g)	EPA (g/100 g)	DHA and EPA (g/100 g)	Ratio DHA:EPA
Tuna				
Bluefin	1.141	0.363	1.504	3.1:1.0
Light, canned in water	0.223	0.047	0.270	4.8:1.0
Albacore, canned in water	0.629	0.233	0.862	2.7:1.0
Salmon				
Atlantic, farmed	1.457	0.690	2.147	2.1:1.0
Atlantic, wild	1.429	0.411	1.840	3.5:1.0
Chinook	0.727	1.010	1.737	1.0:1.4
Sockeye	0.700	0.530	1.230	1.3:1.0
Mackerel, Atlantic	0.699	0.504	1.203	1.4:1.0
Herring, Atlantic	1.105	0.909	2.014	1.2:1.0
Trout				
Rainbow, farmed	0.820	0.334	1.154	2.5:1.0
Rainbow, wild	0.520	0.468	0.988	1.1:1.0
Halibut	0.374	0.091	0.465	4.1:1.0
Cod	0.154	0.004	0.158	38.5:1.0
Haddock	0.162	0.076	0.238	2.1:1.0
Catfish				
Channel, farmed	0.128	0.049	0.177	2.6:1.0
Channel, wild	0.137	0.100	0.237	1.4:1.0
Swordfish	0.681	0.087	0.768	7.8:1.0
Grouper	0.213	0.035	0.248	6.1:1.0
Shrimp	0.144	0.171	0.315	1.0:1.2

[a] Data from reference 27.

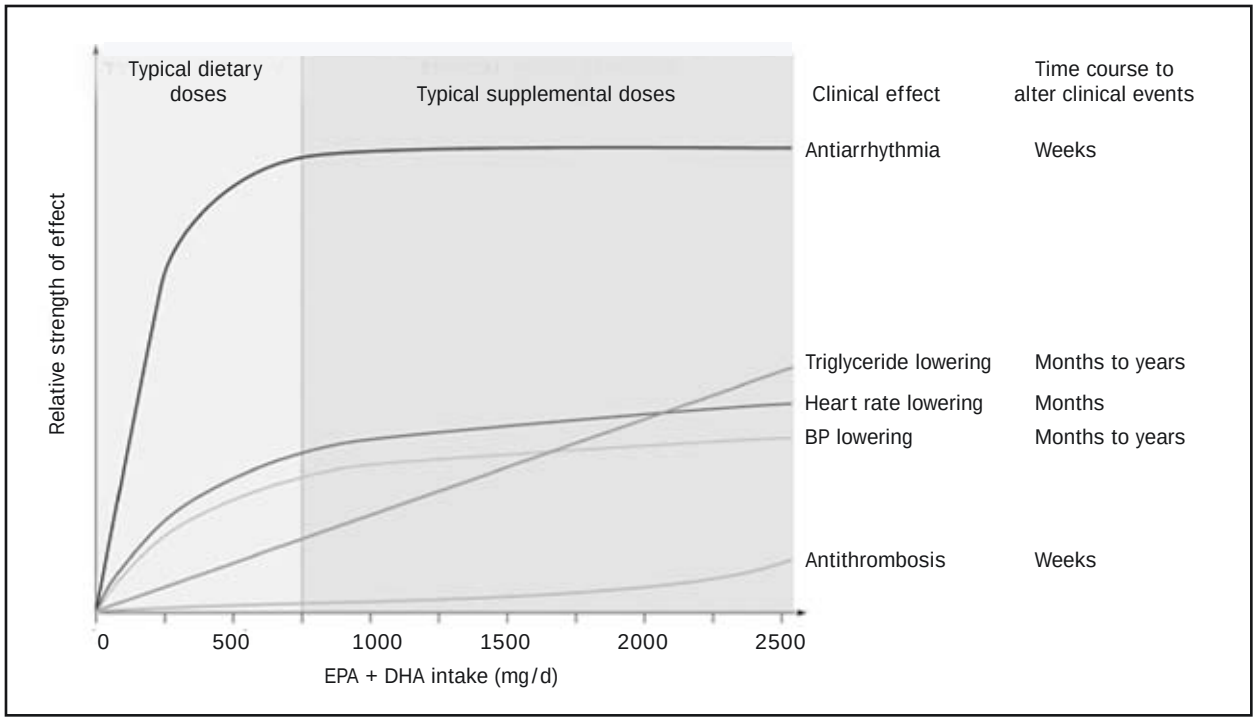

FIGURE 4. Schema of potential dose responses and time courses for altering clinical events of physiologic effects of fish or fish oil intake. BP = blood pressure; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid. From *JAMA*,[31] Copyright © 2006, American Medical Association. All rights reserved.

left-ventricular systolic function,[37] mixed results were reported for 3 trials using omega-3 fatty acids in patients with implantable cardioverter-defibrillators.[34-36] A large randomized trial of omega-3 fatty acids in 7000 patients with chronic heart failure is projected to be complete in 2008 and should help to clarify the effects of DHA and EPA on outcomes in patients with reduced left-ventricular function.[38]

Although DHA is far more abundant than EPA in the myocardium,[14] supplementation with DHA and EPA raises the levels of both.[14] Risk of SCD has been reduced in studies that provide both DHA and EPA in roughly equivalent proportions. The discordance between the GISSI-Prevenzione study,[7] in which DHA and EPA reduced SCD, and the JELIS study,[8] in which EPA alone did not reduce SCD, might indicate that DHA is the more important omega-3 fatty acid for stabilizing the myocardial cell membranes and preventing dangerous rhythm abnormalities. However, the difference could also be a function of the high baseline intake of fish by the Japanese participants in the JELIS Trial (the typical Japanese person consumes 8 times more DHA and EPA than the typical American),[39] which would also explain the very low incidence of SCD in this trial. Only 35 of the 18,645 patients, split almost evenly between the control and omega-3 fatty acid groups, experienced SCD during the 5 years of JELIS.[8]

ADVERSE EFFECTS

In prospective placebo-controlled trials, no adverse effects were observed to occur at a frequency of more than 5%, and no difference in frequency was noted between the placebo and omega-3 fatty acid groups.[24,40] The most commonly observed adverse effects are nausea, gastrointestinal upset, and a "fishy burp." Steps to reduce burping and improve adherence include taking the omega-3 fatty acid at bedtime or with meals, keeping the fish oil capsules in the freezer, or using enteric-coated products. The FDA made the recommendation that "consumers not exceed a total of 3 grams per day of DHA and EPA omega-3 fatty acids," the equivalent of ten 1-gram capsules of standard fish oil (30% DHA and EPA). Early studies indicated that omega-3 fatty acids might prolong bleeding times (but not beyond the normal range), raising concerns that higher intakes could increase risk for hemorrhagic complications. However, a recent comprehensive report by Harris[41] concluded that virtually no increased risk for clinically remarkable bleeding has been seen in patients with doses of omega-3 fatty acids up to 7

g/d of DHA and EPA, even when taken in combination with other antiplatelet medications.

One of the potential dangers of a diet high in fish (not fish oil) is the consumption of toxic contaminants, such as methyl mercury. For this reason, the FDA has advised that children and pregnant or nursing women specifically avoid king mackerel, shark, swordfish, and tile fish because they are particularly high in mercury.[42] Interestingly, the Avon Longitudinal Study of Parents and Children (ALSPAC),[43] which followed 11,875 British women during their pregnancy and beyond, found that the children of women who ate fish in excess of US FDA/Environmental Protection Agency recommendations during pregnancy (ie, 3 fish meals/week) had better cognitive and behavioral development than offspring of women who consumed less fish during their pregnancies (Figure 5).[43] However, causality cannot be inferred in this retrospective study because of baseline differences in the groups that could have accounted in part for differences in neurocognitive development. Nevertheless, the ALSPAC study[43] and a meta-analysis by Mozaffarian and Rimm[31] provide reassurance regarding the favorable risk-benefit ratio of fish consumption.

Most commonly consumed omega-3 fatty acid–rich fish and seafood, such as salmon, shrimp, sardines, trout, herring, and oysters, are very low in mercury. Farm-raised salmon and rainbow trout are safe because they have mercury levels similar to their wild counterparts and as much or more omega-3 fatty acids.[44] Fortunately, mercury is water soluble and protein bound and is therefore not extracted into fish oils. Thus, fish oil supplements contain negligible amounts of mercury.[45]

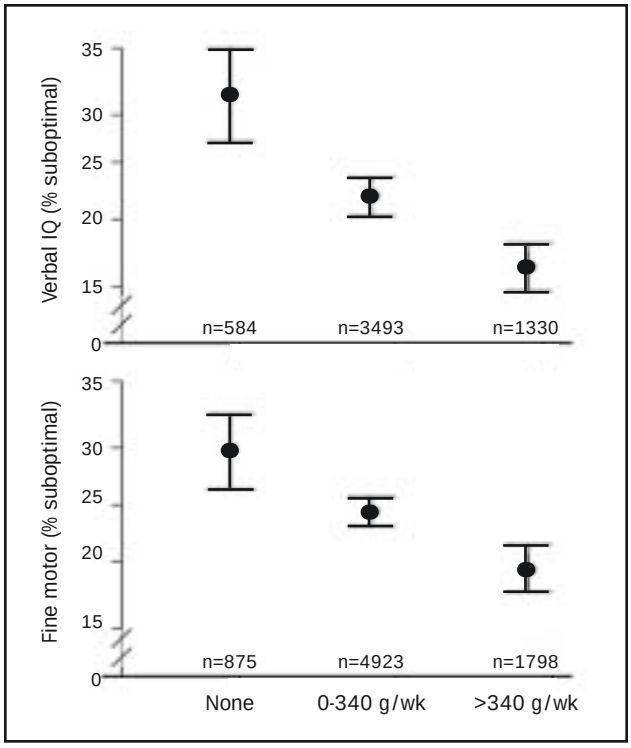

FIGURE 5. Outcomes in children according to tertiles of weekly seafood consumption by the mothers during pregnancy: the Avon Longitudinal Study of Parents and Children (ALSPAC). IQ = intelligence quotient. From *The Lancet*,[43] with permission from Elsevier.

PRIMARY AND SECONDARY PREVENTION OF CAD

To date, no randomized controlled trial has shown that omega-3 fatty acids reduce the risk of CV events and mortality in a primary prevention population. The evidence supporting a benefit in primary prevention comes instead from an observed 18% decrease in CV events in the 80% of patients in the JELIS trial without documented CAD (P=.13); this effect size was essentially the same as that observed in the secondary prevention cohort (19%, P<.05). In addition, prospective observational cohort studies have consistently found a significant inverse relationship between CAD risk and fish intake[46]; in these primary prevention studies, 1 fish meal per week was associated with a 15% reduction in CAD risk, and 5 or more fish meals per week were associated with a 40% decrease in risk.[46] More importantly, blood EPA and DHA levels in the highest quartile were associated with a 90% reduction in risk of SCD compared with the lowest quartile in 2 observational studies.[47,48] Currently, a large prospective study of 12,500 patients is under way to investigate omega-3 fatty acid supplementation in high-risk patients.

The Diet and Reinfarction Trial (DART),[6] the GISSI study,[7] and JELIS[8] (the subset of patients with CAD), all large well-designed trials, showed significant benefits for omega-3 fatty acids in patients with established CAD. However, other studies have not reported positive outcomes. The randomized trial reported by Ness et al[49] and Burr et al[50] and that by Nilsen et al[51] are cases in point. In the former,[49,50] patients with angina who were given fish oil capsules seemed to have higher rates of SCD than untreated controls. This trial was described as "well designed" but suboptimally "conducted or reported" in a review by von Schacky and Harris,[52] and thus its results are questionable. The Nilsen et al study[51] might not have shown a significant benefit to omega-3 fatty acid supplementation in post-MI patients because of the high background intake of fish oils in the Norwegian study participants, which could have masked the treatment effects. Despite the results of these studies, many international bodies including the AHA, American College of Cardiology, and the European Society of Cardiology have found the overall evi-

dence for benefit sufficiently strong to make public recommendations for increased omega-3 fatty acid intake for both primary and secondary prevention.[53]

RECOMMENDATIONS FOR ADMINISTRATION

The correct dosage of any fish oil product can be calculated simply by adding up the amount of DHA and EPA per capsule and dividing this number into the target daily doses for triglyceride lowering or primary or secondary prevention. For example, the standard fish oil concentrate contains 120 mg of DHA and 180 mg of EPA per 1-g capsule. Thus, 1 to 2 capsules of standard over-the-counter fish oil per day (300-600 mg of DHA and EPA) would meet the recommendations for primary prevention; 3 to 4 capsules per day (900-1200 mg of DHA and EPA), for secondary prevention; and 5 to 7 capsules twice daily (3000-4200 mg of DHA and EPA), for triglyceride lowering.

Omega-3 fatty acid supplements can be taken at any time, in full or divided doses, without raising concerns for interactions with any medications. For people who need larger doses of omega-3 fatty acids, liquid tasteless products are available that provide 1300 mg of DHA and EPA per teaspoon, and 3900 mg of DHA and EPA per tablespoon. One tablespoon of standard liquid fish oil taken twice weekly provides approximately the same amount of omega-3 fatty acids as 6 oz of salmon twice weekly (500 mg/d of DHA and EPA). Omega-3 fatty acids persist in cell membranes for weeks after consumption, and thus intermittent bolus dosing, ie, twice weekly intake of fish or fish oil, provides the same benefits as daily consumption of lower doses.[54]

The triglyceride-lowering dose is 3 to 4 g/d of DHA and EPA. This dose typically lowers triglyceride levels by 30% to 50%[25] and has been shown to reduce severely elevated (>500 mg/dL) triglyceride levels by 45%.[26] When added to baseline statin therapy in patients with triglyceride levels between 200 and 499 mg/dL, this dosage lowers triglycerides by an additional 23% to 29%.[24,55] Fish oil can only be prescribed in a capsular form, which contains omega-3 acid ethyl esters. Although typically more expensive than dietary supplements, the capsular form is a standardized preparation with FDA-approved safety and efficacy data and is the most concentrated source of DHA and EPA available.[56]

The AHA currently recommends that patients with CAD consume "about 1 gram" of a DHA and EPA combination per day.[1] This recommendation is based largely on the results of the GISSI-Prevenzione study, in which a dose of 850 mg/d was used. For people without known CAD or hypertriglyceridemia, the AHA recommends the consumption of approximately 2 servings per week of an oily fish such as salmon (ie, approximately 500 mg/d of DHA and EPA), which can raise red blood cell DHA and EPA levels by at least 50%.[54] Even half this intake has been suggested as a cardioprotective target in the general population.[31] For patients with clinically relevant hypertriglyceridemia, the AHA recommends 2.0 to 4.0 g/d of DHA and EPA. However, the lower end of this dose range is ineffective in most patients, and thus clinicians should target between 3.0 and 4.0 g/d to achieve meaningful triglyceride lowering.

Because no trials comparing DHA and EPA with CAD as an end point have been conducted, neither of these omega-3 fatty acids can be conclusively said to be more cardioprotective than the other. Evidence does show that DHA (4 g/d) can affect some surrogate risk markers (eg, blood pressure) more than an equivalent dose of EPA.[57] However, EPA was shown in the JELIS study to reduce CAD events even in a population with very high intakes of omega-3 fatty acids. Accordingly, it is currently recommended that both DHA and EPA (from either fish or supplements) be consumed in roughly equal amounts. Most patients with CAD find it difficult to consume enough fish to provide 1 g/d of DHA and EPA, much less the amount required to reach therapeutic levels for hypertriglyceridemia (3.0-4.0 g/d of DHA and EPA). Even patients who eat several fish meals per week often consume fish that are low in omega-3 fatty acids, such as cod, fried fish sandwiches, and catfish; as a result, these patients require a fish oil supplement to achieve optimal omega-3 fatty acid levels. Omega-3 fatty acid supplements should be given in conjunction with healthy lifestyle changes.

Target blood levels of DHA and EPA have been suggested as markers of cardioprotection.[9] For example, red blood cell membrane levels of greater than 8% appear to be associated with the lowest risk of CAD death[9,58] and with reduced risk of acute coronary syndromes.[59] In contrast, those with less than 4% DHA and EPA are associated with a higher risk of CV events.[59] Low blood omega-3 fatty acid levels are associated with increased risk of SCD[47] (Figure 6). Optimal membrane levels of omega-3 fatty acids usually are achieved with consumption of 1.0 to 1.5 g/d of DHA and EPA,[58] an intake similar to that in Japan.

CONCLUSION

Current data suggest that patients with known CAD should consume at least 1.0 g/d of long-chain omega-3 fatty acids; people without disease, at least 250 to 500 mg/d. Both DHA and EPA should be consumed. Regardless of statin

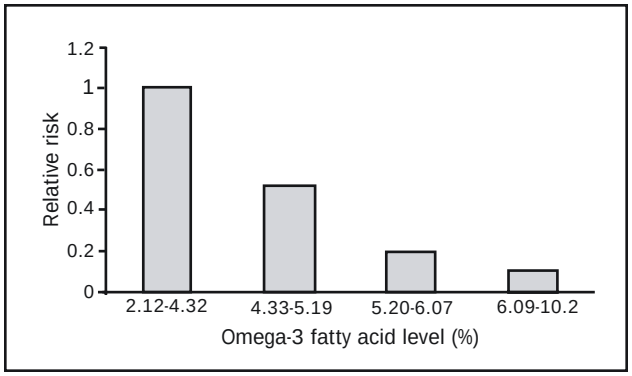

FIGURE 6. Relative risk of sudden cardiac death according to baseline blood levels of omega-3 fatty acids as percentage of total fatty acids. Data from reference 47.

use, patients with hypertriglyceridemia benefit from treatment with 3.0 to 4.0 g/d of DHA and EPA.

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