OMEGA, a Randomized, Placebo-Controlled Trial to Test the Effect of Highly Purified Omega-3 Fatty Acids on Top of Modern Guideline-Adjusted Therapy After Myocardial Infarction

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Background—There is no randomized, double-blind trial testing the prognostic effect of highly purified omega-3 fatty acids in addition to current guideline-adjusted treatment of acute myocardial infarction.

Methods and Results—OMEGA is a randomized, placebo-controlled, double-blind, multicenter trial testing the effects of omega-3-acid ethyl esters-90 (1 g/d for 1 year) on the rate of sudden cardiac death in survivors of acute myocardial infarction, if given in addition to current guideline-adjusted treatment. Secondary end points were total mortality and nonfatal clinical events. Patients (n=3851; female, 25.6%; mean age, 64.0 years) were randomized in 104 German centers 3 to 14 days after acute myocardial infarction from October 2003 until June 2007. Acute coronary angiography was performed in 93.8% and acute percutaneous coronary intervention in 77.8% of all patients. During a follow-up of 365 days, the event rates were (omega and control groups) as follows: sudden cardiac death, 1.5% and 1.5% (P=0.84); total mortality, 4.6% and 3.7% (P=0.18); major adverse cerebrovascular and cardiovascular events, 10.4% and 8.8% (P=0.1); and revascularization in survivors, 27.6% and 29.1% (P=0.34).

Conclusions—Guideline-adjusted treatment of acute myocardial infarction results in a low rate of sudden cardiac death and other clinical events within 1 year of follow-up, which could not be shown to be further reduced by the application of omega-3 fatty acids.

Clinical Trial Registration—URL: http://www.clinicaltrials.gov. Unique identifier: NCT00251134.

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Key Words: death, sudden • fatty acids • myocardial infarction • omega-3 fatty acids • prevention

During >2 decades, data were accumulating that n-3 polyunsaturated fatty acids (omega-3 fatty acids) may be effective in reducing the risk of cardiovascular disease and fatal cardiovascular events.1–3 Since the publication of the Gruppo Italiano per lo Studio della Sopravvenienza nell’Infarto Miocardico (GISSI)–Prevenzione trial, general interest focused on potential antiarrhythmic effects of eicosapentaenoic acid and docosahexaenoic acid, thereby preventing sudden cardiac death (SCD) after acute myocardial infarction.4,7 However, in the GISSI-Prevenzione trial, the treatment under investigation was not blinded, and only a low or moderate proportion of patients received modern interventional and medical treatment. In the GISSI trial, only 5.0% of the patients had coronary revascularization at baseline, and only 4.7% were on cholesterol-lowering drugs at hospital discharge.6 This is in contrast to the current treatment of acute myocardial infarction and secondary prevention, including early revascularization by percutaneous coronary intervention, routine use of clopidogrel, β-blockers, statins, and angiotensin-converting enzyme inhibitors, as well as rehabilitation supporting lifestyle changes. Therefore, currently there is no clear scientific evidence that supplementation with omega-3 fatty acids in addition to current guideline-adjusted therapy improves the prognosis of patients surviving acute myocardial infarction.
myocardial infarction. At least, potential positive effects might be attenuated by the current therapy of myocardial infarction and secondary prevention. Apart from these considerations, the potential of omega-3 fatty acids to provide antiarrhythmic effects under clinical conditions is not yet fully clarified and may vary, depending on individual clinical conditions.8–17

Therefore, the primary objective of the present study was to determine the effect of highly purified omega-3 fatty acid ethyl esters-90 on the rate of SCD in patients surviving acute myocardial infarction (ST-elevation myocardial infarction [STEMI] and non-STEMI) and receiving current guideline-adjusted treatment within 1 year of follow-up. The secondary objective was to evaluate the effects on total mortality and other prespecified clinical events.

Methods

Study Design and Ethics

The OMEGA trial is a prospective, randomized, double-blind, controlled trial including 3851 patients within 3 to 14 days after acute myocardial infarction (STEMI or non-STEMI). Patients were recruited from 104 German study centers (heart centers, university hospitals, and community hospitals). The study drug was given over a period of 12 months in addition to guideline-adjusted treatment after acute myocardial infarction. The trial protocol and all amendments were approved by the local ethics committees.

Definition of End Points and Monitoring

The primary end point of SCD was defined as unexpected death resulting from heart disease occurring within 1 hour of the first symptoms or unviewed overnight. Also included was sudden cardiac arrest (occurring within 1 hour of the first symptoms) with initially successful cardiopulmonary resuscitation and subsequent death during the hospital stay within 3 weeks.

Other prespecified secondary end points were total mortality; major adverse cerebrovascular and cardiovascular events, defined as total mortality, reinfarction, or stroke in survivors; and revascularization, defined as percutaneous coronary intervention and/or coronary artery bypass grafting. Furthermore, implantable cardioverter-defibrillator–terminated ventricular tachycardia or fibrillation during 12 months of follow-up was analyzed as an additional, not prespecified end point.

SCD, the primary end point, was adjudicated by a blinded End Point Committee on the basis of the case report forms and medical records. Analysis of the secondary end points is based on information provided by the investigators in the case report forms. Onsite monitoring aimed at identifying missing reports and ensuring completeness of data. Clinical events during follow-up were assessed during visit 2 (telephone contact 3±1 month after randomization) and at the final visit in the study centers 12 months after randomization. Patient compliance was checked during visit 2 and by pill counts at the final visit. Assessment of the individual fish consumption is based on self-reports of the study participants at the beginning of the study, at visit 2, and at the end of the study as documented on special case report forms. Adverse events were evaluated by an independent data safety monitoring board. To establish transparency of design and analysis procedures, study design and methods of the OMEGA trial have previously been described in detail.18

Study Drugs

The test drug (omega) was a soft gelatin capsule containing 1 g omega-3 acid ethyl esters-90 (460 mg eicosapentaenoic acid, 380 mg docosahexaenoic acid). Control was a soft gelatin capsule containing 1 g olive oil. Both drugs were supplied by Pronova Biocare a.s. (Lysaker, Norway).

Study Population

The study includes female and male patients with a minimum age of 18 years who were admitted to hospital for acute STEMI or non-STEMI and gave written informed consent to participate in the study. All participating centers were advised to provide guideline-adjusted standard treatment of acute myocardial infarction, including secondary prevention. Only patients without known adverse reactions to fish oil or olive oil were randomized.

During the ongoing study, it became apparent that total mortality would be lower than expected. An analysis of potential reasons showed that the proportion of high-risk patients in the study was lower than observed in all-day care.19,20 On the other hand, following the study protocol, it was the aim of the OMEGA trial to closely reflect clinical practice in Germany. Therefore, the Steering Committee specified the baseline characteristics for patients’ enrollment in April 2005. Beginning in April 2005, 75% of the patients enrolled had to have 1 or more of the following clinical characteristics: no early revascularization, ejection fraction <40%, presence of diabetes mellitus, and age >70 years. The inclusion period after myocardial infarction was prolonged from day 3 to 7 to day 3 to 14.

Randomization and Blinding

After inclusion, each patient was supplied with study drugs sufficient for the whole study period. The appearance of the drugs or the drug containers did not allow patients and physicians to deduce the study arm. Every container was labeled with a 4-digit number that concealed the actual treatment and was documented by the investigator on the patient’s case report form. Randomization was always done in blocks of 8 drug containers (4 omega, 4 control). Randomization was stratified by center. Blinding was maintained until general unblinding of the study after closure of the database.

Statistical Analysis

Based on the Antibiotic Therapy After Acute Myocardial Infarction: A Prospective Randomized Study (ANTIBIO) study and the Acute Coronary Syndromes registry (ACOS), the sample size calculation assumed a total mortality of 8% within 1 year for the control group.19–21 Taking into account the anticipated risk profile and the data of the GISSI-Prevenzione trial,6 the proportion of SCD was assumed to be 44% of total death, resulting in an SCD rate of 3.5% in the control group. Assuming a risk reduction of 45% by omega-3 acid ethyl esters-90, as suggested by the data of GISSI-Prevenzione,6,7 an SCD rate of 1.9% was anticipated for the omega group of the trial. With these assumptions, a significance level α=2.5% (1 sided), a β error of 20%, and a dropout rate of 8.8%, the number of patients required for evaluation of the rate of SCD was 1900 in each arm. The dropout rate was calculated as a maximal rate based on the data of previous German myocardial infarction registries.19,20

Data analysis was performed according to the intention-to-treat principles. For the analysis of mortality, 14 patients (6 in the omega group, 8 in the control group) who were lost to follow-up were excluded because the determination of life status was not possible. Analysis of the end points was performed with χ² or the Fisher exact test; baseline comparisons were performed with the Fisher exact test, χ² test, or the Wilcoxon test when appropriate. Kaplan–Meier curves were calculated for visualizing deaths and SCDs during follow-up. All statistical analyses were performed with SAS version 9.1.3 (SAS Institute Inc, Cary, NC).

Adverse Events

During the study, all adverse events were continuously documented by the investigators and reported to the assigned clinical research organization and the sponsor. Identifying missing reports and securing the completeness of the records was one goal of the onsite monitoring. The aggregated events (accumulated according to MedDRA-coded System Organ Classes and High Level Terms) were
judged by the data safety monitoring board to deduce any imbalances between the study arms.

In addition, to account for potential lack of precision (e.g., some malignancies were documented in the neoplasms category and others as associated with the affected organs), the study guidance pre-defined 20 groups into which all events were classified: malignancy, bleeding, infections, allergies, cardiac, gastrointestinal, surgical, neurological, vascular, psychiatric, injuries, pulmonary, hematologic, urogenital, musculoskeletal, skin, sense organs, endocrine, hepatobiliary, and other. Classification was done hierarchically and blinded to study arms. Every event was assigned to 1 group only, with priority to those first on the list whenever appropriate (e.g., pulmonary neoplasm was assigned to malignancy and not to pulmonary).

Responsibilities
The Institut für Herzinfarktforschung Ludwigshafen an der Universität Heidelberg was responsible for the study design, database maintenance, and data analysis; it vouches for the data and the analyses. The manuscript was written by members of the institute in close cooperation with the coauthors. The clinical research organization, Galenus Medical (Frankfurt, Mainz), was responsible for the collection of the data and management of adverse events. Trommsdorff Arzneimittel GmbH sponsored the study and supported study coordination and management of adverse events. The sponsor did not have any influence on data analysis and interpretation. With U. Del Castillo as coauthor, the sponsor only had the opportunity to comment the manuscript but could not influence its content and data interpretation.

Results
Recruitment and Study Population
In total, 3851 patients were randomized for the study between October 2003 and June 2007. Thirty-three patients had no documentation of the hospital stay for the following reasons: withdrawal of informed consent (n=13) and interruption of documentation by local investigators after noticing conflicts with inclusion and exclusion criteria after initial recruitment of the patients (n=20). Thus, 3818 patients were available for analysis of baseline characteristics and hospital course. Because 14 patients were lost to follow-up, 3804 patients (98.8% of all randomized patients) could be included into the end-point analysis (Figure 1).

Baseline Characteristics
The baseline characteristics of the study groups are shown in Table 1. The mean age of the total population was 64.0 years; 74.4% were male. The distribution of demographic and clinical characteristics between the omega group and the control group was homogeneous.

Primary coronary angiography was performed in 93.8% of all patients. Distribution of culprit lesions and stenoses >50% was as follows: left main coronary artery, 0.9% and 3.1%, respectively; left anterior descending, 38.0% and 63.4%; circumflex artery, 19.1% and 45.8%; and right coronary
artery, 33.0% and 56.2%. Again, there were no significant differences between the study groups. Sex-based differences were not present; data on race- or ethnicity-based differences have not been collected.

In-Hospital Treatment
In 80.6% of all patients, acute revascularization was performed, with thrombolysis playing only a minor role. Short- and long-term therapy included guideline-driven medication in the vast majority of patients (Table 2). This also applies for medication at discharge (Table 3). Apart from diuretics, which were given more frequently in the omega group, short-term and discharge treatment did not significantly differ between the study groups.

Table 1. Baseline Characteristics at Hospital Admission

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Omega Group (n=1925)</th>
<th>Control Group (n=1893)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, % (n)</td>
<td>75.1 (1445/1925)</td>
<td>73.7 (1396/1983)</td>
<td>0.35</td>
</tr>
<tr>
<td>Age, median, y</td>
<td>64.0</td>
<td>64.0</td>
<td>0.46</td>
</tr>
<tr>
<td>Lower and upper quartile</td>
<td>54.0–72.0</td>
<td>54.0–72.0</td>
<td></td>
</tr>
</tbody>
</table>

Clinical presentation

| STEMI, % (n)                          | 59.2 (1140/1925)     | 58.8 (1114/1983)       | 0.87|
| NSTEMI, % (n)                         | 40.8 (785/1925)      | 41.2 (779/1983)        | 0.82|
| Resuscitation, % (n)                  | 1.6 (31/1925)        | 1.7 (33/1983)          | 0.75|
| New York Heart Association class IV, % (n) | 5.7 (109/2020)     | 5.6 (105/1891)         | 0.87|
| Kllp class III/IV, % (n)              | 3.3 (66/1914)        | 3.8 (71/1884)          | 0.48|
| Heart rate, bpm                       | 75.0 (64.0–89.0)     | 74.0 (64.0–87.0)       | 0.29|
| Systolic blood pressure, mm Hg        | 140 (120.0–160.0)    | 140 (120.0–160.0)      | 0.43|
| Atrial fibrillation, % (n)            | 5.9 (114/1925)       | 5.3 (100/1893)         | 0.39|
| Left bundle-branch block, % (n)       | 3.6 (70/1925)        | 2.6 (49/1893)          | 0.06|
| Moderate (35%–44%) and severe (<35%) reduction of ejection fraction | 24.8 (451/1815) | 23.3 (408/1754) | 0.27 |

History, cardiovascular risk factors, and concomitant disease

| Previous myocardial infarction (>14 d), % (n) | 15.3 (294/1925) | 13.5 (255/1893) | 0.11 |
| Previous stroke, % (n)                      | 5.8 (112/1925)    | 5.1 (97/1893)    | 0.35 |
| Previous percutaneous coronary intervention, % (n) | 13.5 (259/1925) | 11.7 (222/1893) | 0.11 |
| Previous bypass grafting, % (n)            | 6.6 (127/1925)    | 5.7 (107/1893)   | 0.22 |
| Body mass index, kg/m²                      | 27.6 (25.1–30.4)   | 27.3 (24.9–30.1)   | 0.12 |
| Hypertension, % (n)                        | 66.9 (1287/1925)   | 66.1 (1251/1893)  | 0.61 |
| Hypercholesterolemia, % (n)                | 50.5 (972/1925)    | 48.5 (918/1893)    | 0.22 |
| Diabetes mellitus, % (n)                   | 27.6 (532/1925)    | 26.4 (500/1893)    | 0.39 |
| Current smoker, % (n)                      | 35.9 (691/1925)    | 37.5 (709/1893)    | 0.32 |
| Family history of coronary artery disease, % (n) | 21.8 (419/1925) | 21.4 (406/1893) | 0.81 |
| Peripheral artery disease, % (n)           | 6.5 (125/1925)     | 6.0 (113/1893)     | 0.50 |
| Creatinine ≥176.84 μmol/L (2 mg/dL), % (n) | 1.8 (34/1925)     | 1.7 (33/1893)      | 0.96 |
| Chronic obstructive pulmonary disease, % (n) | 5.6 (108/1925)    | 6.4 (122/1893)     | 0.28 |

Table 2. In-Hospital Treatment: Short-Term Treatment of Myocardial Infarction

<table>
<thead>
<tr>
<th>Omega Group (n=1925), % (n)</th>
<th>Control Group (n=1893), % (n)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percutaneous coronary intervention</td>
<td>77.9 (1499/1925)</td>
<td>77.6 (1469/1892)</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>8.3 (160/1924)</td>
<td>8.4 (159/1892)</td>
</tr>
<tr>
<td>No acute revascularization</td>
<td>19.4 (374/1925)</td>
<td>19.3 (366/1892)</td>
</tr>
<tr>
<td>β-blockers</td>
<td>86.4 (1663/1925)</td>
<td>85.0 (1609/1893)</td>
</tr>
<tr>
<td>Angiotensin-converting enzyme inhibitors</td>
<td>69.2 (1332/1925)</td>
<td>69.7 (1320/1893)</td>
</tr>
<tr>
<td>AT1 receptor blockers</td>
<td>6.3 (122/1925)</td>
<td>5.7 (107/1893)</td>
</tr>
<tr>
<td>Statins</td>
<td>81.1 (1562/1925)</td>
<td>81.9 (1551/1893)</td>
</tr>
<tr>
<td>Acetylsalicylic acid</td>
<td>94.4 (1818/1925)</td>
<td>94.4 (1787/1893)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>87.8 (1690/1925)</td>
<td>88.6 (1678/1893)</td>
</tr>
<tr>
<td>Glycoprotein IIb/IIIa inhibitors</td>
<td>42.2 (812/1925)</td>
<td>43.1 (815/1893)</td>
</tr>
<tr>
<td>Heparin (unfractionated)</td>
<td>67.4 (1298/1925)</td>
<td>69.0 (1307/1893)</td>
</tr>
<tr>
<td>Diuretics</td>
<td>27.0 (519/1925)</td>
<td>26.1 (495/1893)</td>
</tr>
</tbody>
</table>

Table 3. In-Hospital Treatment: Medication at Discharge

<table>
<thead>
<tr>
<th>Omega Group*† (n=1914), % (n)</th>
<th>Control Group* (n=1885), % (n)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-blockers</td>
<td>93.9 (1796/1913)</td>
<td>94.3 (1778/1885)</td>
</tr>
<tr>
<td>Angiotensin-converting enzyme inhibitors</td>
<td>82.9 (1586/1913)</td>
<td>83.7 (1578/1885)</td>
</tr>
<tr>
<td>AT1 receptor blockers</td>
<td>8.2 (156/1913)</td>
<td>7.7 (145/1885)</td>
</tr>
<tr>
<td>Statins</td>
<td>94.6 (1810/1913)</td>
<td>93.8 (1768/1885)</td>
</tr>
<tr>
<td>Acetylsalicylic acid</td>
<td>95.6 (1828/1913)</td>
<td>95.1 (1792/1885)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>88.0 (1683/1913)</td>
<td>88.8 (1673/1885)</td>
</tr>
<tr>
<td>Phenprocoumon (vitamin K antagonist)</td>
<td>4.7 (90/1913)</td>
<td>4.3 (81/1885)</td>
</tr>
<tr>
<td>Calcium channel blockers</td>
<td>8.1 (154/1913)</td>
<td>7.8 (147/1885)</td>
</tr>
<tr>
<td>Diuretics</td>
<td>36.3 (695/1913)</td>
<td>32.9 (620/1885)</td>
</tr>
<tr>
<td>Digitalis</td>
<td>3.7 (71/1913)</td>
<td>3.4 (64/1885)</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>1.6 (30/1913)</td>
<td>1.2 (23/1885)</td>
</tr>
<tr>
<td>Oral antidiabetics</td>
<td>11.8 (225/1913)</td>
<td>11.0 (208/1885)</td>
</tr>
<tr>
<td>Insulin</td>
<td>10.1 (193/1913)</td>
<td>9.9 (187/1885)</td>
</tr>
</tbody>
</table>

*Patients who died before discharge were excluded (omega group, 11; control group, 8).
†Medication at discharge was not documented for 1 patient of the omega group, giving a denominator of 1913.
Relative to the whole study population, the rate of SCD during follow-up was 1.5%, with no difference between the study groups (omega group, 1.5%; control group, 1.5%; \(P=0.84\); odds ratio, 0.95; 95% CI, 0.56 to 1.60). Relative to all study participants, total mortality during follow-up was 4.2%. Again, there was no significant difference between the study groups (omega group, 4.6%; control group, 3.7%; \(P=0.18\); odds ratio, 1.25; 95% confidence interval, 0.90 to 1.72; Table 4 and Figure 2A and 2B).

In the group of survivors, reinfarction occurred in 4.3% and stroke in 1.1%, adding to a total number of major adverse cerebrovascular and cardiovascular events of 9.6% during 1-year of follow-up. No significant differences in the rate of major adverse cerebrovascular and cardiovascular events could be observed between the omega and control groups (Table 4).

### Table 4. Primary and Secondary End Points Within 365 Days

<table>
<thead>
<tr>
<th></th>
<th>Omega Group</th>
<th>Control Group</th>
<th>(P)</th>
<th>(OR^*) (95% CI)</th>
<th>(RD), % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients analyzed, n</td>
<td>1919</td>
<td>1885</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudden cardiac death, % (n)</td>
<td>1.5 (28/1919)</td>
<td>1.5 (29/1885)</td>
<td>0.84</td>
<td>0.95 (0.56–1.60)</td>
<td>−0.1 (−0.9–0.7)</td>
</tr>
<tr>
<td>Total mortality, % (n)</td>
<td>4.6 (88/1919)</td>
<td>3.7 (70/1885)</td>
<td>0.18</td>
<td>1.25 (0.90–1.72)</td>
<td>0.9 (−0.4–2.1)</td>
</tr>
<tr>
<td>MACCE, % (n)</td>
<td>10.4 (182/1752)</td>
<td>8.8 (149/1701)</td>
<td>0.10</td>
<td>1.21 (0.96–1.52)</td>
<td>1.6 (−0.3–3.6)</td>
</tr>
<tr>
<td>Revascularization: PCI + CABG in survivors, % (n)</td>
<td>27.6 (466/1686)</td>
<td>29.1 (482/1654)</td>
<td>0.34</td>
<td>0.93 (0.80–1.08)</td>
<td>−1.5 (−4.6–1.6)</td>
</tr>
<tr>
<td>ICD–terminated ventricular tachycardia or fibrillation in survivors, % (n)</td>
<td>0.5 (9/1705)</td>
<td>0.1 (2/1689)</td>
<td>0.06</td>
<td>4.47 (0.97–20.74)</td>
<td>0.4 (0.0–0.8)</td>
</tr>
</tbody>
</table>

OR indicates odds ratio; CI, confidence interval; RD, risk difference; MACCE, major adverse cerebrovascular and cardiovascular events; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; and ICD, implantable cardioverter-deﬁbrillator.

*ORs are univariate, calculated with simple proportions.

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**Figure 2.** Kaplan–Meier diagrams (\(P\) values are those of the univariate analysis; see Table 4). A, Survival without SCD during the 1-year follow-up (red line, omega group; blue line, control group). B, Total survival during the 1-year follow-up (red line, omega group; blue line, control group).
During follow-up, 28.4% of all surviving patients experienced coronary revascularization, the majority of which had percutaneous coronary intervention. Almost half of all surviving patients (48.1%) were rehospitalized. Neither the frequency of revascularization procedures nor the rate of rehospitalizations differed significantly between the study groups (Table 4).

SCD and total mortality rates were increased in the subgroups of patients without acute revascularization (SCD and total mortality, 3.7% and 10.4%), with a left ventricular ejection fraction <35% (8.0% and 18.7%), with diabetes mellitus (2.2% and 6.9%), and with age >70 years (2.7% and 8.6%). In all these predefined subgroups, the rate of clinical events during follow-up did not significantly differ between the omega and control groups (Figure 3).

At the end of the study, the average level of low-density lipoprotein cholesterol was 2.46 mmol/L and did not significantly differ between the study groups. The level of triglycerides was low in both groups, with a small difference in favor of the omega group (omega group, 1.37 mmol/L [1.00 to 2.01 mmol/L]; control group, 1.43 mmol/L [1.05 to 2.09 mmol/L]; P<0.01).

Fish Consumption During the Trial
The weekly consumption of fish as reported by the patients is given in Table 5. The data show that fish consumption significantly increased during the study in both groups.

Adverse Events
With 2 exceptions, the analyses of the data safety monitoring board revealed no differences between the study arms. For neoplasms, the total numbers were 19 (omega group) versus 8 (control group); for cardiac device therapeutic procedures (primarily pacemaker and defibrillator insertions), the total numbers were 16 (omega) versus 2 (control). An accumulation of a specific neoplasm could not be found. Within the predefined subgroups of adverse events, as outlined in Methods, no significant differences between the study groups could be found. In particular, there were no differences within the subgroups in malignancies (omega, 32; control, 26) and rhythmologic events (omega, 99; control, 84). In total, 3473 (omega, 1769; control, 1704; P=0.27) adverse events were recorded.

Statistical Power of the Study
On the basis of the present results, the anticipated statistical power of 80% was not reached. In an a posteriori calculation, the statistical power was 44% to detect a 45% risk reduction in SCD as anticipated by the study protocol (see Methods) and 19% for a risk reduction of 25%.

Discussion
The OMEGA trial shows that guideline-adjusted treatment of acute myocardial infarction results in a low rate of fatal and nonfatal clinical events during the following year, during which an additional reduction of event rates by application of 1 g/d omega-3-acid ethyl esters-90 could not be achieved. This applies for the primary end point of SCD and for total death and other secondary end points as outlined in Table 4. The results of the study will critically be discussed below.

First, the sample size calculated and the expected event rates of the OMEGA study were based on the data of the ANTIBIO Study, the ACOS registry, and the GISSI Prevenzione Trial.6,7,19–21 However, guideline-adjusted therapy has
been improved considerably within the past years, resulting in an unexpected low rate of SCD and other clinical events after acute myocardial infarction. In addition, the data suggest that when the present trial was designed, the potential beneficial effect of omega-3 fatty acids was overestimated. Although pooled data of previous randomized trials with a high proportion of myocardial infarction patients even showed a risk reduction for SCD of 57%, these studies were not based on current guideline-adjusted therapy of acute myocardial infarction. As a consequence, the anticipated power of 80% could not be achieved in this study. Assuming a lower risk reduction for SCD by omega-3 fatty acids of 30% instead of 45%, the number of patients needed to achieve a power of 80% increases to ≈20,000, an extension that could not be realized within the setting of this trial. The presented data therefore do not allow a final answer on the potential benefit of the additional application of highly purified omega-3 fatty acids for secondary prevention after acute myocardial infarction.

Second, high levels of fish consumption during the study also could have influenced the clinical event rate during follow-up. Indeed, in both study groups, self-reported fish consumption increased significantly during the study, which may have contributed to the low event rate and may have attenuated a potential beneficial effect of the study drug. However, in the GISSI trial, a high percentage of study participants (73.2%) also had at least 1 fish meal per week at the beginning of the study, which increased to 87.7% at the end of the study.7

Third, despite the above considerations, the results of the OMEGA study call for a critical review of a potential benefit of omega-3 fatty acids under the conditions of current guideline-adjusted therapy of acute myocardial infarction. This applies not only for the primary end point of SCD but also for the secondary end points, which did not even show a trend for a beneficial effect within 1 year of follow-up.

In the GISSI trial a significant reduction in SCD by application of 1 g/d omega-3 fatty acids could already be demonstrated within 6 months of treatment; thus, the follow-up period of 1 year of the OMEGA trial appears to be sufficient.7 Still, a more favorable long-term effect of omega-3 fatty acids during an extended follow-up period cannot be totally excluded.

Apart from the limitations discussed above, the results of the OMEGA study appear to be in line with recent meta-analyses that show a considerable heterogeneity in the effect of a variety of fish oil application forms on the rate of SCD, depending on the clinical condition under investigation.14-17,22,23 Therefore, the clinical effects of omega-3 fatty acid supplementation may vary, depending on the clinical conditions and the population under investigation. On the basis of these considerations, the different outcomes of the GISSI Prevenzione trial and OMEGA are not contradictory but, apart from the different duration of follow-up in both studies, rather may reflect the strongly different clinical conditions under which both trials were undertaken.

Fourth, the necessity to reevaluate the assumption that supplementation with omega-3 fatty acids could be beneficial under any clinical condition also arises from the complex interactions of omega-3 fatty acids at the molecular and cellular levels.24 These multiple molecular effects may not necessarily result in a homogeneous beneficial clinical effect because the molecular interactions of omega-3 fatty acids not only differ between the compounds such as eicosapentaenoic acid and docosahexaenoic acid but also may depend on specific local tissue conditions. For example, the activity state of membrane-bound proteins may vary between ischemic and nonischemic myocardial regions, potentially resulting in different molecular effects of omega-3 fatty acids in these regions.25 Therefore, the clinical consequences of the molecular and cellular interactions of omega-3 fatty acids may be difficult to predict and may vary under different clinical conditions.

**Study Limitations**

Apart from the limitations discussed in the above section, the inclusion criteria have been modified during the ongoing study by the decision made by the steering committee in April 2005 that extended the inclusion period after acute myocardial infarction and increased the proportion of patients with increased risk as defined in Methods. This intervention resulted in 21.6% of the total study population with 2 or more predefined risk factors. As demonstrated in the total study population, in all subgroups with increased risk, there was no significant reduction of clinical events by omega-3 fatty acid supplementation (Figure 3).

**Conclusions**

The results of the OMEGA trial demonstrate a low rate of SCD, total mortality, and major adverse cerebrovascular and cardiovascular events within 1 year of follow-up after guideline-adjusted treatment and secondary prevention of acute myocardial infarction. A further reduction of these low event rates by supplementation with highly purified omega-3 fatty acids remains to be proven and is not supported by the present study. However, the inadequate statistical power of the OMEGA trial mandates larger randomized trials with a long-term follow-up to further clarify the potency of omega-3 fatty acid supplementation to improve clinical outcome in the presence of current guideline-adjusted treatment of acute myocardial infarction.

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References

CLINICAL PERSPECTIVE
The OMEGA study demonstrates that current guideline-adjusted therapy of acute myocardial infarction results in low a rate of mortality, nonfatal reinfarction, or stroke during 1 year of follow-up. This low rate of major clinical events appears to be difficult to improve further with additional therapeutic regimens. In particular, an additional beneficial effect of omega-3 fatty acids on mortality and recurrent nonfatal myocardial infarction during follow-up of patients surviving acute myocardial infarction remains to be proven and is not supported by the OMEGA study.
OMEGA, a Randomized, Placebo-Controlled Trial to Test the Effect of Highly Purified Omega-3 Fatty Acids on Top of Modern Guideline-Adjusted Therapy After Myocardial Infarction

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심근경색에 대한 효과가 사라져가는 Omega-3 지방산에 대한 냉정한 보고: OMEGA 연구

한 기 준 교수 서울아산병원 심장내과

Summary

배경

급성 심근경색에 대한 현재의 치료요법에 대하여 omega-3 fatty acid가 여전히 미치는 영향을 평가한 이중행진 연구는 없다.

방법 및 결과

OMEGA 연구는 위약대비 이중행진으로 실시된 다기관 연구로서, omega-3-acid ethyl esters-90을 일 1g씩
1년간 두어하면서 급성 심근경색 생존자에서의 급성 심
근증 병인을 검증하였다. 이차 종양증은 총 사망률, 비지
병적 임상사건들이다. 총 3,851명의 대상자(여성 25.6%,
평균 연령 64.0세)들이 104개의 병원센터에서 2003년
10월부터 2007년 6월까지 조사되었으며, 이들은 급성
심근경색 후 3~14일 사이에 해탈하는 경우였다. 93.8%에
서 총질 환자환의 조사결과를 시행하였으며, 77.8%가 총
질 건설환되어험을 받았다. 1년간의 추적점검 동안
omega-3 두어군 및 대조군에서의 사망 발생률은 다음과
같다: 급성 심근경색의 각각 1.5%와 1.5%(P=0.84) 중 사망
률은 4.8%와 3.7%(P=0.18)로 보고, 심혈관계질환의 경우
10.4%와 8.8%(P=0.13)였으며, 심근경색의 재시술률은
27.5%와 29.1%(P=0.34)였다.

결론

현재의 급성 심근경색증의 치료요법으로 인하여 급성
심근경색의 발생률은 현저히 줄어들었으나, 이들은 omega-3 fatty acid 농용으로 인한 추가적인 변화를 보이지 않았다.
Commentary

Omega-3 fatty acid (OMEGA)는 위장, 성장, 과소성에 있어 다양한 투약시 작하는 것을 목적으로 투여되는 것으로 알려진다. 이는 OMEGA의 적정량의 섭취가 증식정량의 치료 및 관리에 도움이 된다고 알려져 있다. 일반적으로 OMEGA를 섭취하면, 항염증 작용, 약물 혈액, 혈압, 당뇨병, 심장병, 및 다른 질환에 대한 보호 효과가 증명되었다. 

본 연구는 OMEGA의 합리적 섭취량에 대한 연구이다. OMEGA는 전단기 및 후기에서의 다양한 질병의 치료에 효과가 있는 것으로 알려져 있다. 본 연구의 목적은 OMEGA의 적정량의 섭취가 증식정량의 치료 및 관리에 도움이 되는지 알아보는 것이었다.

본 연구에서, OMEGA의 적정량의 섭취가 증식정량의 치료 및 관리에 도움이 된다는 것을 보여주었다. 이는 증식정량의 치료 및 관리에 도움이 되는 것은 알코올 섭취에 의한 마비, 만성질환, 심장질환, 당뇨병, 및 기타 질환의 치료에 있어 중요한 효과를 보여주었다. 

본 연구의 결과는 증식정량의 치료 및 관리에 도움이 되는 OMEGA의 적정량의 섭취가 증명되었다. 이를 통해, 증식정량의 치료 및 관리에 도움이 되는 OMEGA의 적정량의 섭취가 증명되었다.