**Ramipril reduced mortality and cardiovascular morbidity in high risk adults**


**QUESTION:** In adults who are at high risk for cardiovascular (CV) events, does ramipril, an angiotensin converting enzyme (ACE) inhibitor, reduce CV events? (Vitamin E results will be reported separately.)

**Design**
Randomised (allocation concealed*†), blinded (patients, clinicians, and outcome assessors),* controlled 2 × 2 factorial design trial with planned interim analyses (Heart Outcomes Prevention Evaluation [HOPE] study).

**Setting**
161 centres in North America, 76 in 14 western European countries, and 30 in Argentina and Brazil.

**Participants**
9541 adults (mean age 66 y, 73% men) who were aged ≥55 years and had a history of coronary artery disease, stroke, peripheral vascular disease, or diabetes and ≥1 other CV risk factor. Exclusion criteria were heart failure, ejection fraction <0.4, use of an ACE inhibitor, uncontrolled hypertension, nephropathy, or myocardial infarction (MI) or stroke. Follow up was >99.9%.

**Intervention**
Adults were allocated to ramipril, 2.5 mg/d for 1 week, 5 mg/d for 3 weeks, then 10 mg/d (n = 4645), or to placebo (n = 4652).

**Main outcome measures**
MI, stroke, and CV mortality.

**Main results**
The study was stopped early. Adults in the ramipril group had lower rates of combined MI, stroke, or CV mortality; MI; stroke; CV mortality; all cause mortality (p for all comparisons ≤0.006) (table); revascularisation procedures (16% v 18%, p < 0.002); cardiac arrest (0.8% v 1.3%, p = 0.02); heart failure (9% v 12%, p < 0.001); and complications related to diabetes (6% v 8%, p = 0.05) than did adults in the placebo group.

**Conclusion**
Ramipril reduced mortality and cardiovascular morbidity in adults at high risk for cardiovascular events.

*See glossary.

**COMMENTARY**
Over the past decade, several studies have documented that ACE inhibitors reduce all cause mortality and probably CV morbidity in patients with left ventricular dysfunction and congestive heart failure. The HOPE study was designed to assess whether ACE inhibitors may also prevent CV events in a broader spectrum of high risk patients. This hypothesis was convincingly confirmed regardless of left ventricular function. Benefit was found across all subgroups and was additive to other therapies with proven secondary preventative effects. Furthermore, the preventive effect was beyond that expected from blood pressure lowering. The findings strongly support a direct CV protective effect of ramipril.

Of interest, patients with diabetes had the same relative benefit as patients without diabetes, despite the fact that the investigators had not required established CV disease for inclusion of the patients with diabetes. This finding strengthens the hypothesis that patients with diabetes should receive active preventive therapies. In a recent meta-analysis, Golan and colleagues argued that treating all middle aged patients with type 2 diabetes with ACE inhibitors on the basis of the protective effects on the kidneys alone would be cost effective. Considering the HOPE study results, this strategy is even more justified. The 30% reduction in new onset diabetes is also important but needs to be confirmed. Ramipril was easy to introduce and often well tolerated. Direct treatment costs will certainly increase as ACE inhibitors are used more often. However, the HOPE study may also provide the basis for savings, for example, through fewer echocardiographic screening tests of left ventricular function after MI and fewer revascularisations.

In the light of available evidence, we recommend that all middle aged patients with either established CV disease or diabetes and 1 additional risk factor (which almost all middle aged patients with diabetes have) should be considered for treatment with ACE inhibitors.

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**Ramipril v placebo for adults at high risk for cardiovascular (CV) events‡**

<table>
<thead>
<tr>
<th>Outcomes at mean 4 y</th>
<th>Ramipril</th>
<th>Placebo</th>
<th>RRR (95% CI)</th>
<th>NNT (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI, stroke, or CV mortality</td>
<td>14%</td>
<td>18%</td>
<td>22% (14 to 30)</td>
<td>26 (19 to 43)</td>
</tr>
<tr>
<td>CV mortality</td>
<td>6%</td>
<td>8%</td>
<td>26% (13 to 36)</td>
<td>50 (33 to 105)</td>
</tr>
<tr>
<td>MI</td>
<td>10%</td>
<td>12%</td>
<td>20% (10 to 30)</td>
<td>42 (27 to 69)</td>
</tr>
<tr>
<td>Stroke</td>
<td>3%</td>
<td>5%</td>
<td>32% (16 to 44)</td>
<td>67 (43 to 145)</td>
</tr>
<tr>
<td>All cause mortality</td>
<td>10%</td>
<td>12%</td>
<td>16% (5 to 25)</td>
<td>56 (32 to 195)</td>
</tr>
</tbody>
</table>

‡CV = cardiovascular; MI = myocardial infarction. Other abbreviations defined in glossary: RRR, NNT, and CI provided by authors.

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