Cost analysis and health-related quality of life of home and self-care satellite haemodialysis

Raija K Malmström¹, Risto P Roine², Anne Heikkilä², Pirjo Räsänen²-³, Harri Sintonen³-⁴, Riitta Muroma-Karttunen⁵ and Eero Honkanen⁵

¹Porvoo Hospital, Helsinki and Uusimaa Hospital Group, Porvoo, ²Group Administration, Helsinki and Uusimaa Hospital Group, ³Finnish Office for Health Technology Assessment, ⁴Department of Public Health, Helsinki University and ⁵Division of Nephrology, Helsinki University Hospital, Helsinki, Finland

Abstract

Background. Home haemodialysis (HHD) and self-care satellite dialyses (SHD) have been suggested to offer significant benefits over conventional in-centre haemodialysis. However, little is known about differences between these two modalities. The purpose of the study was to analyse costs and health-related quality of life (HRQoL) of HHD and SHD.

Methods. On 15 October 2004, a total of 65 patients attended self-care haemodialysis in the area. Of those patients, 33 were on HHD and 32 on SHD. Cost data were collected from those study patients who were on dialysis the whole calendar year 2004 (23/33 HHD and 28/32 SHD patients). HRQoL was measured by the generic 15D instrument. The questionnaire was administered to all the study patients. A total of 23/33 of HHD and 24/32 of SHD patients returned the questionnaire.

Results. Direct medical costs of dialysis and hospital treatment were higher in HHD (31 834 ± 6046 EUR/year, mean ± SD) than in SHD (27 528 ± 4325), P < 0.005. By contrast, travel costs were lower in HHD (426 ± 743 EUR/year) than in SHD (5228 ± 4326), P < 0.001. Costs of pharmaceuticals did not differ significantly. There was no significant difference in the total costs between HHD and SHD (38 477 ± 7685 and 39 781 ± 10 226 EUR/year), P = not significant. There were no significant differences in the total 15D score or in the 15 dimensions of the 15D instrument between home and satellite patients.

Conclusions. HHD and SHD are, from the patient’s perspective, equally effective in providing health. Although there were significant differences in the distribution of costs (which needs to be taken into account when evaluating different treatment strategies), total costs were similar. However, in the HHD setting, patients had on average more and longer sessions. Patient preference should be the main decisive factor when choosing between home or satellite haemodialysis.

Keywords: costs; dialysis; health-related quality of life; home haemodialysis; satellite haemodialysis

Introduction

The number of dialysis patients is constantly growing due to ageing of the population, increasing incidence of type 2 diabetes and the longer life expectancy of dialysis patients [1]. To cope with the increasing demands to expand dialysis capacity, it is essential to develop treatment modalities for those patients who do not necessarily need hospital (in-centre) haemodialysis (HD). Therefore, the interest has lately focused on self-care dialysis modalities such as peritoneal dialysis (PD), home haemodialysis (HHD) and self-care satellite haemodialysis (SHD).

In the Helsinki metropolitan area we have had an active self-care dialysis strategy for two decades. Accordingly, PD has been the number one choice for a new dialysis patient. However, all self-care patients are not suitable for PD because of medical and social reasons. Therefore, we have actively developed alternative self-care systems for patients on HD. Two self-care SHD units were established in the 1980s and the HHD program was intensified in 1998 [2]. By November 2007 >38 000 HD sessions had been conducted at home.

The costs of dialysis treatment have been studied in several countries, including Finland where Salonen et al. [3] compared the costs of hospital HD, continuous ambulatory peritoneal dialysis (CAPD) and cadaver kidney transplantation. Recently, a comparison of hospital HD and SHD was published in England [4]. However, the concept of ‘satellite HD’ appears to have a different meaning in different centres and countries varying from a real self-care satellite, where patients are responsible for their treatments [5], to a branch of an in-centre dialysis with no self-care system [6]. Results of the UK study may not be valid in other settings. In the current study, we compared HHD and self-care SHD in a cross-sectional design in patients originally suitable
for either modality. The main difference between HHD and SHD in our area is the location, where dialysis treatment takes place (i.e. home versus satellite) and the fact that in SHD the patients are assisted by nurses. To shed light on the question which modality should be preferred from an economic and a patient perspective we compared the total costs and the HRQoL of the patients of these two self-care HD modalities, HHD and SHD.

Subjects and methods

Organization

The predialysis programme, including the selection of the modality of dialysis as well as training for HHD and SHD (as well as for PD), is centralized to a single centre (Helsinki University Hospital) for the entire Helsinki metropolitan area (population 1.4 million, number of patients on dialysis on 31 December 2004: 387). Trained patients are then referred either to HHD or to one of two self-care SHD units according to patient preference. The HHD unit has a team of three nurses for training and maintenance of 30–50 patients (patient:nurse = 10–17:1). The SHD units have a total of 7.5 nurses and 9–10 dialysis stations for 32–36 patients. Each nurse assists 4–6 SHD patients during one dialysis shift (patient:nurse = 4–5:1). The HHD patients are trained to perform the dialysis alone, the mean training time being 4–6 weeks. Only exceptionally, an assistant (spouse, another family member or a friend) is trained for the patient, but HHD nurses offer a 24-h phone back-up service for them.

Both in HHD and SHD blood access was by an arteriovenous fistula, only exceptionally by arteriovenous graft. Dialyzer reuse was not performed. Blood pressure was measured by the patients themselves with similar equipment for both HHD and SHD.

In HHD a patient may choose to perform dialysis whenever it is suitable. The schedule and the length of dialysis are flexible according to the patients’ needs, and also long slow (8 h) night dialysis is possible. HHD patients visit the dialysis centre and meet a nephrologist 6–12 times per year and visit their local primary health care laboratory for laboratory values are the mean of the last two measurements before 15 October 2004. Data on the occurrence of dialysis-related complications were collected over a 1-month period (October 2004). The possible costs due to all complications in 2004 are included in our costs estimates.

Patients and data collection

On 15 October 2004, a total of 65 patients attended self-care HD in the area and were included in the study. Of those patients, 33 were on HHD and 32 on SHD (both satellite units were included). Travel and medication data were available only for whole calendar years. Therefore, the cost data were collected from those study patients who were on dialysis the whole calendar year of 2004 (23/33 HHD and 28/32 SHD patients). The HRQoL questionnaire was handed out to the patients on 15 October 2004, and 23/33 of HHD and 24/32 of SHD patients returned the questionnaire. In HHD the mean age of the responders and non-responders did not differ ([50.2 and 46.5 years, \( P = \text{not significant (ns)} \)], whereas in SHD the responders were significantly older (67.0 years) than non-responders (51.6 years), \( P < 0.05 \).

Clinical parameters were collected from the patient records. The body weight and blood pressure are the mean of three consecutive dialysis sessions starting from 15 October 2004. Ultrafiltration volume was calculated as the mean of ultrafiltration per HD session over a 2-week period. Laboratory values are the mean of the last two measurements before 15 October 2004. Data on the occurrence of dialysis-related complications were collected over a 1-month period (October 2004). The possible costs due to all complications in 2004 are included in our costs estimates.

Costs of treatment

Finland has a public healthcare system funded mainly by local municipalities and government from general taxes. A global budget for the hospital covers HD costs. The costs of travel and medication are not covered by the hospital. They are reimbursed directly to the patients by the Social Insurance Institution.

We aimed at establishing the total direct health care costs of dialysis patients in the year 2004. The perspective is
societal in the sense that, apart from productivity costs due to the possible absence from work and visits to primary health care physicians, which are rare in the studied groups, all use of resources in 2004 was identified and valued at the prices in that year. No attention was paid regarding to whom the costs eventually accrued and how they were reimbursed. The costs thus represent gross real costs at 2004 prices.

All costs are presented per patient. All cost data include overhead costs caused by infrastructure, administration, amortization, etc. The collection of cost data was divided into four parts, which are included in total costs. Firstly, the detailed hospital costs for each patient during the year 2004, whether dialysis related or not, were collected separately from the hospital database. They include outpatient visits to different clinics, surgical procedures, inpatient treatment, laboratory, radiology and other costs (pathology, dental and blood components). Dental care was given by the hospital only on special occasions for patients undergoing preparation for kidney transplantation. To the hospital costs we added the costs of dialysis sessions. They were 162 EUR in HHD and 159 EUR in SHD. They cannot be detailed by items, but they include salaries, IV drugs (low molecular weight heparin, vitamin D, iron), priming solutions, anticoagulants, needles, gauges, etc. and ‘the dialysis package’ purchased from a supplier. The package includes the dialysis equipment (which are thus not owned by the hospital), supplies, technical maintenance and logistics. Both HHD and SHD patients were dialyzed in the training centre or in the hospital dialysis centre if they had operations, vascular access problems or other major health problems. Therefore, the costs of dialysis per 1 year also include some in-centre dialysis costs.

Secondly, the costs of travel and outpatient medication at retail prices, including erythropoietin, were obtained from the Social Insurance Institution. Over-the-counter pharmaceuticals were not included.

Thirdly, the costs of laboratory visits to the primary health care for determination of haemoglobin and potassium and the costs of home installations for HHD were estimated. The costs of HHD patients’ laboratory visits to primary health care were estimated to be 200 EUR/patient/year, based on our schedule for haemoglobin and potassium controls for HHD patients. Home installation for a new HHD patient includes water connections and modifications for the electricity. The costs of installations averaged 1000 EUR per patient. It is impossible to estimate the exact annuity of these initial costs since the life span, i.e. the average number of years on HHD, is not known. We divided the costs of installation by the total time on dialysis for all study HHD patients in 2004 that resulted in 520 EUR installation costs per year on HHD. However, this is probably an overestimate but may be balanced by the extra costs of water and electricity in HHD that were not included in the costs.

Fourthly, if an assistant (spouse, another family member or a friend) was used in HHD, the remuneration was 229.29 EUR/patient/month in 2004, paid by the municipality directly to the assistant.

**Statistical analysis**

All statistical analyses were performed by using SPSS statistical software version 13. The differences in categorical variables were assessed with Pearson’s chi-square test and in continuous variables with Student’s *t*-test. The variance in the 15D score and level values of each of the 15 dimensions were explained by linear regression analysis with age and sex as explanatory variables to see whether there is a statistically significant difference in the score and level values between the groups, when age and sex have been standardized. Linear regression analysis was also used to explore whether weight and diabetes have an effect on the different items of costs, when age and group are controlled for. Results were considered statistically significant when the two-tailed *P*-value was <0.05.

**Results**

**Patients**

Demographic and clinical characteristics of the study patients are presented in Tables 1 and 2. Thirty-three patients
were on HHD and 32 on SHD. In both groups, there were more men than women. SHD patients were 14.2 years older than HHD patients and they had been on HD for a longer time than HHD patients. Patients on HHD were also taller than those on SHD. In HHD three patients had two and two patients had three previous kidney transplantations. In SHD three patients had one and three patients had two previous kidney transplantations.

The HHD patients took advantage of the flexibility that HHD offers, as their dialysis sessions were more frequent and longer. Ten HHD patients were on constant or periodic night dialysis. A total of 18/30 (60%) of HHD and 2/13 (15%) of SHD patients (age <65 years) were employed full-time or half-time ($P < 0.01$). There were no significant differences in plasma phosphorus, ionized calcium or albumin levels between the study groups. Haemoglobin and potassium levels were slightly lower in the HHD group. Pre- and postdialysis blood pressure values did not differ significantly between the study groups.

### Complications

Dialysis-related adverse events reported over a 1-month period were nausea (three in HHD, one in SHD), muscle cramps (three in HHD and six in SHD) and headache (one in both HHD and SHD). Hypotensive episodes were reported less often in HHD (3 patients) than in SHD (10 patients) ($P < 0.05$).

### Health-related quality of life

There were no significant differences in the total score (0.84 and 0.85 in HHD and SHD, respectively, $P = n.s.$) or in the 15 dimensions of the 15D instrument between home and satellite HD patients (Figure 1) even when adjusting for age and sex.

### Costs

Detailed hospital costs are presented in Table 3 and total costs in Table 4. Overall hospital costs were 4306 EUR/year.
Table 3. Hospital costs (EUR)

<table>
<thead>
<tr>
<th></th>
<th>HHD (n = 23) Mean (range)</th>
<th>SHD (n = 28) Mean (range)</th>
<th>Mean difference 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialyses&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27 052 (23 490–33 458)</td>
<td>25 112 (18 767–29 628)</td>
<td>1940 (594–3286)</td>
</tr>
<tr>
<td>Out-patient visits</td>
<td>252 (0–1467)</td>
<td>96 (0–1617)</td>
<td>−39 (−39–352)</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>952 (0–5587)</td>
<td>549 (0–8074)</td>
<td>403 (−463–1268)</td>
</tr>
<tr>
<td>Surgical procedures</td>
<td>1193 (0–5000)</td>
<td>623 (0–5810)</td>
<td>570 (−341–1482)</td>
</tr>
<tr>
<td>Laboratory</td>
<td>1005 (401–2402)</td>
<td>905 (516–1830)</td>
<td>−131 (−131–330)</td>
</tr>
<tr>
<td>Radiology</td>
<td>1287 (0–8828)</td>
<td>195 (0–949)</td>
<td>193 (−193–1990)</td>
</tr>
<tr>
<td>Other&lt;sup&gt;b&lt;/sup&gt;</td>
<td>93 (0–793)</td>
<td>47 (0–482)</td>
<td>46 (−42–134)</td>
</tr>
<tr>
<td>Total</td>
<td>31 834 (24 518–45 753)</td>
<td>27 528 (19 278–41 049)</td>
<td>−6491 (−6491–3883)</td>
</tr>
</tbody>
</table>

Abbreviations: HHD, home haemodialysis; SHD, satellite haemodialysis.
<sup>a</sup>Dialyses includes costs of dialysis and dialysis-related outpatient visits to centre dialysis unit.
<sup>b</sup>Other includes costs of red cell transfusions, pathological laboratory and visits to dentist.

Table 4. Total costs (EUR)

<table>
<thead>
<tr>
<th></th>
<th>HHD (n = 23) Mean (range)</th>
<th>SHD (n = 28) Mean (range)</th>
<th>Mean difference 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital</td>
<td>31 834 (24 518–45 753)</td>
<td>27 528 (19 278–41 049)</td>
<td>4306 (1267–7346)</td>
</tr>
<tr>
<td>Laboratory in primary health care&lt;sup&gt;a&lt;/sup&gt;</td>
<td>200 (0–2632)</td>
<td>0 (0–12 148)</td>
<td>−4802 (−3001–6602)</td>
</tr>
<tr>
<td>Travel</td>
<td>426 (346–13417)</td>
<td>5228 (184–21 394)</td>
<td>−2007 (−4787–772)</td>
</tr>
<tr>
<td>Medication</td>
<td>5018 (0–2751)</td>
<td>7025 (184–21 394)</td>
<td>479 (17–940)</td>
</tr>
<tr>
<td>Assistant remuneration</td>
<td>479 (0–2571)</td>
<td>0 (0–2571)</td>
<td>1304 (−6491–3883)</td>
</tr>
<tr>
<td>Home installation&lt;sup&gt;a&lt;/sup&gt;</td>
<td>520 (28 512–56 031)</td>
<td>0 (25 675–63 982)</td>
<td>520 (1304)</td>
</tr>
<tr>
<td>Total</td>
<td>38 477 (24 518–56 031)</td>
<td>39 781 (25 675–63 982)</td>
<td>−6491 (−6491–3883)</td>
</tr>
</tbody>
</table>

Abbreviations: HHD, home haemodialysis; SHD, satellite haemodialysis.
<sup>a</sup>Values are estimates.

Higher in HHD than in SHD (P < 0.005). Dialysis-related costs and costs of radiology were higher in HHD but the costs of outpatient visits, hospitalizations, surgical procedures, laboratory and other costs were similar for both HHD and SHD.

We analysed the costs of hospitalizations, surgical procedures and radiology further. There was a lot of variation in hospitalizations and surgical procedures between the subjects both in HHD and SHD and the differences between the groups were not significant. There was no single indication above others for the hospitalizations and surgical procedures as they were due to common, mostly non-dialysis related reasons such as heart problems, infections and operations (knee, appendix, gallbladder, etc.). Looking at possible blood access related costs (which are included mainly in radiology costs in our hospital) revealed that three patients in HHD had major costs related to blood access problems (2054, 4154, 8611 EUR/patient/year, respectively). There were no blood access related costs in SHD.

Costs of pharmaceuticals were similar for HHD and SHD. HHD had special costs such as remuneration of an assistant (in selected patients), home installation and visits to primary health care laboratory. These costs were 1199 EUR/year per patient. The costs of travel were 4802 EUR/year higher in SHD than in HHD (P < 0.001).

The total costs of HHD and SHD were similar in both modalities. The weight of the patient and diabetes did not have a statistically significant effect on any items of costs, including total costs, when age and group (HHD and SHD) were controlled for.

Discussion

In this study we investigated whether the costs and HRQoL differ when a self-care HD patient is dialysed at home or in a satellite unit. The total costs of HHD (38 477 EUR) turned out to be fairly similar to those of SHD (39 781 EUR). They were also clearly smaller than the costs of other dialysis modalities in Finland reported by Salonen et al. [3] who in 1991–1996 found the total costs of hospital HD to be ~52 000 EUR/year in the first year and ~47 000
EUR/year in the next 2 years (valued at prices in 1997). The higher costs of dialysis in the HHD group compared to SHD were, in our material, offset by the much lower travel costs. Although the study was not designed as an equivalence study comparing the effectiveness of HHD and SHD, the fact that the HRQoL did not differ between the groups indicates that HHD patients were not disadvantaged regarding treatment outcome.

A recent comprehensive review of the cost-effectiveness of HHD versus hospital HD or SHD identified 27 studies meeting the inclusion criteria of the review [4]. The main problem in the studies was the selection of the patients to different dialysis modalities. In HHD, there were more men; the patients were younger and had less comorbidities than the hospital or satellite patients. As a conclusion, the authors stated that HHD is generally more effective than hospital HD, and modestly more effective than SHD.

In France, a study of 471 patients [5] with a 25-year follow-up showed survival benefits for HHD and SHD versus hospital HD but no survival difference between HHD and SHD. In SHD units the patients had their own dialysis machine and a flexible dialysis schedule. The estimated dialysis expenditure in France in 1994 was 74 000 EUR/year for hospital HD, 44 000 EUR for SHD and 37 000 EUR for CAPD and HHD. In a study from Holland, de Wit et al. [13] concluded that HHD was the most cost-effective alternative, followed by SHD and hospital HD. In a cost-minimization study from Canada [14] costs of hospital HD were 66 000 EUR/year (in 1993), SHD 42 000 EUR, CAPD 34 000 EUR and HHD 24 000 EUR.

Peeters et al. [15] published a systematic review of 25 economic evaluations in western European countries. Their findings agreed with the studies presented above; HHD was less costly than hospital HD and the costs of SHD were between those of HHD and hospital HD.

The actual costs of dialysis in different countries are difficult to compare because of the variable dialysis reimbursement/funding policies [16]. Also, the definitions and patient selection differ between studies. Studies comparing hospital HD to HHD, SHD and PD have large case-mix differences making the comparisons problematic. The present study aimed to study the total costs of the dialysis patients, whether dialysis related or not. It is difficult, even impossible, to separate the costs related to ESRD from those of other comorbidities, especially where diabetic patients are concerned.

Many studies have not included travel costs, although they may have a notable impact on the total costs of care of ESRD. Travel costs are also difficult to assess, because they may be borne by the patient, the hospital or the public healthcare system, and policies may vary even within a country [4]. In France, travel costs have been approximated to be 12–18% of the total dialysis costs [5]. In the present study, travel costs were 13% of the total costs in SHD and only 1% in HHD.

In the present study, the costs of pharmaceuticals were obtained from the Social Insurance Institution responsible for reimbursing medical expenses on a nation-wide basis. Therefore, we had accurate data on the real costs of outpatient pharmaceuticals at retail prices; only over-the-counter medications were not included. Medication incompliance of patients with ESRD is not rare as recently discussed by Loghman-Adham [17]. Thus, information on the use of medications collected from patient records may be biased, whereas in our study, based on reimbursement data, the patients had at least acquired the prescribed medications.

The costs of dialysis were higher in HHD compared with SHD. Technical maintenance of HHD dialysis machines and self-owned equipment for each patient may explain this difference, at least partly. Moreover, our HHD patients had ~20 more dialysis sessions per year than patients on SHD. This increased the payment to the dialysis supply provider, because the treatments are paid per dialysis session performed. The flexibility does not allow us to compare the dialysis dose adequacy targets with Kt/V. However, all patients had ≥12 h dialysis duration/week and the biochemical and blood pressure targets were achieved. No significant differences in blood pressure or biochemical outcomes were seen despite the more frequent dialysis schedule for HHD patients.

The strength of the study is that it describes the results of an existing dialysis organization for a quite large (1.4 million) population. However, the study has some limitations. It was based on a prevalent patient population and thus we may not have been able to avoid the possible bias of different study populations. On the other hand, in a cross-sectional prevalent study we were able to include also those patients who have been on dialysis for longer times and there was no selection of the patients for study purposes. However, in the future, a study of an incident patient population suitable for both modalities would be important to confirm the results. Furthermore, compared to general dialysis patients, our patients were fairly young, which limits the application of the results to older and frailer patient cohorts. Therefore, a larger study would be needed to obtain more generalizable results.

A possible source of bias is also the fact that our HHD patients were younger and had a shorter duration of dialysis than SHD patients. This may be partly explained by the fact that when the HHD programme, which started in 1998, only a few patients in the satellite programme, which had already existed for two decades, were willing to change their treatment to HHD. Since 1998, all new patients have been able to choose between HHD and SHD. HRQoL of self-care HD patients has been studied by Bremer et al. [18]. They found that patients on HHD reported better HRQoL when compared with patients on self-care hospital HD or traditional hospital HD. A study by Mowatt et al. [4] showed higher satisfaction scores in SHD compared to hospital HD. In our study, HRQoL did not differ between HHD and SHD measured with the generic 15D instrument.

The flexible schedule of HHD allows full-time or halftime employment and, therefore, is an optimal choice for patients at working age. Our study groups differed considerably regarding active participation in working life in favour of the HHD patients. The possibility of working regardless of dialysis is important for the patients, but also has a significant effect on the total costs of ESRD to the society. In our experience, if a patient is not working during the time on dialysis, it is very difficult for him/her to return to work after successful kidney transplantation.
Diabetes is increasing rapidly and is an important cause of ESRD and a frequent comorbidity in dialysis patients [1]. Also, in our study population the proportion of diabetics was high (36% in HHD and 22% in SHD). Our experiences with treating diabetics in HHD and SHD have been very encouraging, both modalities well suited to diabetics.

According to our experience, the patients often prefer self-care dialysis. Thus, it should be possible for them and their physicians to choose from a wide variety of dialysis modalities suited to the patient’s clinical status and preference. Accordingly, in an optimal case the dialysis organization should be able to provide all modalities, including home and self-care dialysis. A large patient population also offers the possibility of maintaining the necessary expertise for patient education. Essential requirements are early referral to a nephrologist and a comprehensive pre-dialysis education program that enhances self-care dialysis modalities [19,20]. The barriers of self-care dialysis [21] should be regularly evaluated and discussed in each centre.

Home dialysis modalities are optimal choices for patients living in sparsely populated areas with long distances. This has led to the widespread use of HHD in Australia and New Zealand. In our area, the longest travel distances for the PD and HD patients to the training centre are ~150 km, but we have also trained HHD patients living up to 300 km from our centre in collaboration with other regional hospitals. We also provide a 24-h phone support for our HHD patients. Also, the travel costs should be taken into account when the locations of new satellites are planned. If HHD is not possible, the next choice should be SHD, not expensive hospital HD. According to our experience, >60% of the dialysis patients can be treated in self-care modalities, i.e. PD, HHD and SHD.

In conclusion, despite the fact that in the HHD setting patients had on average more and longer dialysis sessions, HHD and self-care SHD appear to be, from the patient’s perspective, equally valuable, and HHD patients were not disadvantaged regarding their HRQoL. Although there are significant differences in the distribution of costs between the two modalities (which needs to be taken into account when evaluating different treatment strategies), total costs were similar and clearly less than costs observed for hospital HD in other studies.

Acknowledgments. This work was financially supported by the Finnish Office for Health Technology Assessment and a special governmental subsidy for health sciences research. The authors wish to thank MB Anna-Maija Itkonen and the nursing staff of home and satellite dialysis units of Helsinki University Hospital for their assistance with collecting the data.

Conflict of interest statement. None declared.

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Received for publication: 27.2.07 Accepted in revised form: 3.12.07