A new methodology for cost-effectiveness studies of domestic radon remediation programmes: quality-adjusted life-years gained within primary care trusts in central England

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study investigated a remediation programme against radon. This consisted of the installation of sumps fitted with a fan which, when activated draws the radon-rich air out into the atmosphere. The comparator was no remediation.

Type of intervention
Primary prevention.

Economic study type
Cost-utility analysis.

Study population
The sample comprised 102 properties in Northamptonshire and North Oxfordshire, UK. Properties included in the study had to have validated results available that had been obtained according to the UK's National Radiological Protection Board protocol.

Setting
The setting was the community. Specifically, the analysis was conducted in the geographical area of four Primary Care Trusts (PCTs). The PCTs concerned were Cherwell Vale, Daventry and South Northamptonshire, Northampton and Northamptonshire Heartlands. The economic study was carried out in Northamptonshire and North Oxfordshire, UK.

Dates to which data relate
The remediation programme was implemented in properties between July 1993 and January 2003. The demographic and effectiveness data were obtained from sources published between 1993 and 2003. The cost data were derived from the UK's Retail Price Index and were reported in January 2004 prices.

Source of effectiveness data
The effectiveness data were derived from a single study.

Link between effectiveness and cost data
It appears that the costing has been carried out prospectively on the same sample of properties as that used in the effectiveness study.

Study sample
The sample size was not determined in the planning phase of the study. No retrospective power calculations appear to
have been conducted. Properties where remediation against radon had occurred and which were located in Northamptonshire and North Oxfordshire were included in the analysis. Overall, 102 remediated properties were included. The distribution between PCTs was 20 properties in Cherwell Vale, 28 in Daventry and South Northamptonshire, 31 in Northampton and 43 in Northamptonshire Heartlands.

**Study design**
The study could be characterised as a multi-centre, geographical correlation study. However, in several instances, secondary data obtained from the literature were used. The time horizon of the analysis was assumed to be 40 years and population-related data were retrieved from the 2001 UK Population Census.

**Analysis of effectiveness**
The primary health outcome used in the analysis was the total number of lung cancers averted because of remediation. This was calculated using estimates obtained from the National Radiological Protection Board. The characteristics of the residents of the properties were not discussed.

**Effectiveness results**
Applying a 40-year time horizon, the total lung cancers averted because of the remediation programme and related reductions in radiation dose were reported per PCT. The results were 1.18 in Cherwell Vale, 1.92 in Daventry and South Northamptonshire, 1.82 in Northampton and 3.13 in Northamptonshire Heartlands.

**Clinical conclusions**
It is rather difficult to provide any meaningful conclusions about the effectiveness results as the significance of them was not assessed through statistical analysis.

**Measure of benefits used in the economic analysis**
The measure of benefit used was the quality-adjusted life-years (QALYs) gained. The values for quality of life without the programmes were taken from an official published source (Department of Health), while utility scores for patients with lung cancer were obtained from the literature. Owing to the lack of available data, the mean utility score for each PCT sample without remediation was estimated by the authors using a specific algorithm. The calculated values for each PCT, as well as the equation used to derive them, were well documented. The QALYs were appropriately discounted at a rate of 3%.

**Direct costs**
The cost categories included in the analysis were the cost of testing properties for radon, remediating properties, retesting properties after remediation, maintaining the remediation system, and the cost of replacing the fans every 10 years. The authors only reported a summary total cost for each cost category for each PCT, that is, the unit costs and the resource quantities were not reported separately. The remediation costs included housing repairs and maintenance charges, the cost of fan replacement (including the cost of electrical appliances), fan operating costs with the electricity index, and testing costs. It was reported that mortgage interest payments were excluded. The sources and dates related to the costs were not reported. However, adjustments for inflation were conducted and all costs were reported for the price year 2004. The costs were appropriately discounted as the time horizon of the analysis was assumed to be 40 years.

**Statistical analysis of costs**
The costs appear to have been treated deterministically.

**Indirect Costs**
The indirect costs were not included in the analysis.

**Currency**
UK pounds sterling ()

**Sensitivity analysis**
A one-way sensitivity analysis was conducted to investigate variability in the data. The parameters tested were the proportion of properties in the PCT above the action level, the proportion of properties above the action level that proceeded with remediation, and utility scores for patients with lung cancer. A multi-way sensitivity analysis was also conducted to investigate "worst-case" and "best-case" scenarios. In this analysis, all three parameters mentioned above were simultaneously varied around best- and worst-case assumptions. Specifically, the "best-case" scenario assumed a remediation rate of 25%, 10% of properties above the action level, and a utility score of 0.2 for lung cancer patients. The "worst" case scenario assumed a remediation rate of 5%, 1% of properties above the action level, and a utility score of 0.8 for lung cancer patients.

**Estimated benefits used in the economic analysis**
Compared with no remediation, the discounted total QALYs gained due to remediation in each PCT were 16.26 in Cherwell Vale, 26.70 in Daventry and South Northamptonshire, 25.18 in Northampton and 43.32 in Northamptonshire Heartlands.

**Cost results**
The total costs of the remediation programmes were reported for each PCT. The discounted total costs were 112,567 in Cherwell Vale, 220,161 in Daventry and South Northamptonshire, 259,956 in Northampton and 266,608 in Northamptonshire Heartlands.

**Synthesis of costs and benefits**
In the base-case analysis, the cost per QALY gained was 6,143 in Northamptonshire Heartlands, 6,924 in Cherwell Vale, 8,245 in Daventry and South Northamptonshire and 10,323 in Northampton.

The sensitivity analysis demonstrated that, when remediation rates increased or when the utility score for lung-cancer patients fell, or the proportion of households above the action level increased, the cost-effectiveness of remediation programmes improved for all PCTs.

Under a best-case scenario, the cost per QALY gained ranged from 1,921 in Northamptonshire Heartlands to 2,428 in Northampton.

Under a worst-case scenario, the cost per QALY gained ranged from 113,128 in Northamptonshire Heartlands to 139,195 in Cherwell Vale.

It was also reported that, at a threshold value of 30,000 per QALY gained, the implementation of remediation programmes would seem to be cost-effective for all PCTs.

**Authors’ conclusions**
The implementation of remediation programmes appears to have been cost-effective for properties located in radon affected areas.

**CRD COMMENTARY - Selection of comparators**
The technology compared was the implementation of a radon remediation programme, that is, sumps fitted with a fan.
However, the existence of alternative remediation programmes was not discussed. If there were any, which is likely, a more inclusive evaluation of comparators might have provided more comprehensive results.

**Validity of estimate of measure of effectiveness**
The analysis was based on a multi-centre geographical correlation study. However, many secondary data, obtained from the literature, were used in the analysis and no systematic review was reported. The lack of a systematic approach to identifying supplemental data does not ensure that the best available data are used in the analysis. In addition, there was no statistical analysis and the use of power calculations, to ascertain whether an appropriate sample size was used, was not reported. The overall approach taken might have introduced uncertainty into the results and may limit the interpretation of the study's findings.

**Validity of estimate of measure of benefit**
The authors used QALYs as the measure of benefit in the economic analysis. The utility values were either taken from the literature or calculated by the authors using specific equations (reported in full). The use of QALYs will facilitate comparisons with other technologies.

**Validity of estimate of costs**
Although the perspective adopted was not specifically reported, it does not appear to have been societal since the indirect costs were not included in the analysis. As only summary costs were reported for each cost category, it is difficult to know which unit costs were included (e.g. labour costs). In addition, this lack of reporting makes the analysis difficult to rework for other settings. The sources and of the costs and their related dates were not explicitly reported. However, discounting was appropriately conducted and the price year reported. The costs were treated deterministically and no sensitivity analysis of the costs or resource quantities was conducted to assess the robustness of the estimates used. This may introduce further uncertainty into the results.

**Other issues**
The major innovation of this study in comparison with previous studies in the same area was that it used health utility (QALYs) as the measure of benefit in the economic analysis. Owing to this factor, the current analysis demonstrated that remediation programmes are more cost-effective than found in previous studies. However, the issue of the generalisability of the results was not directly addressed. The authors do not appear to have presented their results selectively but the economic analysis, especially the resources used, relevant unit costs and their sources, was underreported. The study referred to properties located in areas characterised as radon affected areas and this was reflected in the authors’ conclusions. The authors did not report any limitations to their study.

**Implications of the study**
The authors did not make explicit recommendations for future research. However, the impact of residential mobility was not explored in the current study and more research information is required. In terms of policy implications, the authors clearly highlighted the role of PCTs in protecting against radon through the promotion of testing and remediation. Research should be conducted on behalf of the PCTs, with the aim of evaluating different forms of financial incentives (e.g. subsidies or grants, abolition of value added tax on remediation work, or discounts on Council Tax) addressed to householders in order to enhance the implementation of remediation programmes. In addition, cooperation between PCTs and general practitioners in informing patients of radon hazards and related health risks is particularly emphasised.

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Other publications of related interest
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