The costs of radon mitigation in domestic properties
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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 use of a procedure of radon mitigation in domestic properties.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population was represented by all domestic properties in Northamptonshire.

Setting
The setting was residential properties. The economic study was carried out in Northamptonshire, UK.

Dates to which data relate
The effectiveness and resource use data were gathered from July 1993 to July 1999. The price year was 1997.

Source of effectiveness data
The effectiveness evidence was derived from a single study.

Link between effectiveness and cost data
The costing was undertaken prospectively on the same house sample as that used in the effectiveness analysis.

Study sample
Power calculations to determine the sample size were not performed. The sample consisted of 73 properties with 176 residents and an occupancy rate of 2.41 per property. These properties represented 15.6% of all the properties in Northamptonshire where mitigation work was carried out during the study period. The action level for mitigation proposed by the NRPB was set at 200 Bq/m3.

Study design
The study was based on the observation of the sample of domestic properties. The radon level was measured before the mitigation programme started, and after mitigation work to ensure a significant reduction of the radon level had been completed. The same company performed all the mitigation work, thereby reducing the influence of other variables.
Analysis of effectiveness
The primary outcome assessed was the effect of the mitigation programme on the radon levels. Therefore, the reduction of the radon dose in the sample was measured. The dose-saving was calculated as an effective radiation dose, using the relationship that 1 milliSievert (mSv) equals 126,000 Bq/m3 per hour, and an equilibrium factor of 0.5. The use of the effective dose quantity as an effectiveness measure permitted the degree of risk from radon to be evaluated. It also enabled comparisons to be made with the risks from other radiation sources. The authors also calculated the dose of radiation to which occupiers were exposed.

Effectiveness results
The average initial radon level was 478 Bq/m3 (range: 180 - 1,500). After the mitigation work, the average radon level was only 61 Bq/m3 (range: 8 - 200). The annual dose-saving per individual was equal to 0.0208 manSv (range: 0.0050 - 0.0744), with an annual dose-saving of 1.5184 manSv for the total study group.

When considering all the residents in each property, the average annual dose was 0.0517 manSv (range: 0.0080 - 0.2980), with a total annual dose-saving for the overall sample of 3.7740 manSv.

To calculate the dose of radiation to which occupiers of properties were exposed, as average occupancy of 72% (17 days and 17 minutes) was obtained from local survey date. See other publications of related interest.

Clinical conclusions
The radon mitigation programme was effective in reaching its objective of reducing the radon levels below the threshold set by the NRPB.

Methods used to derive estimates of effectiveness
Key assumptions in the effectiveness analysis were made on the basis of the authors' opinions, supported by published literature.

Estimates of effectiveness and key assumptions
A first assumption (defined as "heroic" by the authors) was the hypothesis that all households living in properties with radon levels above the critical threshold decided to proceed to mitigation work. This assumption was then relaxed in the sensitivity analysis.

A further assumption stated that each resident moved between rooms in a manner consistent with the NRPB-weighted average radon level. This assumption has since been shown by the authors, in an additional paper, to be incorrect. See "Other Publications of Related Interest" below.

Measure of benefits used in the economic analysis
The benefit measure used in the economic analysis was the number of estimated lung cancers avoided. This measure was calculated on the basis of the NRPB estimate, that 3.5E-04 (0.00035) lung cancers were induced per working level month.

Direct costs
A discount rate of 6% was used. The total costs of radon mitigation were calculated as the sum of the initial measurement with track etch detectors, the mitigation work, and the final retesting of the property. The cost/resource boundary adopted was not reported. The costs were estimated from actual data but the source of the data was not reported. The resources used were gathered from July 1993 to July 1999. The price year was 1997. All the costs obtained in the different years were converted into 1997 prices, using the price index series for housing repairs and maintenance charges that is part of the Retail Prices Index.
Statistical analysis of costs
No statistical analysis of the costs was reported.

Indirect Costs
The indirect costs (ie productivity losses) were not included in this paper.

Currency
UK pounds sterling (€).

Sensitivity analysis
Some specific sensitivity analyses were conducted. These varied the discount rate (6, 8.75 or 10%) and the accounting period (10, 20, 40 or 80 years) to take into account the uncertainty around the data. Another variable in the base-case estimates was the percentage of householders actually mitigating when the measured radon levels were above the NRPB threshold. The response rate was assumed to be 100% in the base-case and was considered at 20, 10 and 5% in the sensitivity analysis.

Estimated benefits used in the economic analysis
The estimated number of lung cancers avoided was not explicitly stated in the paper.

Cost results
The costs of the initial testing (56,900), mitigation programme (40,396 exclusive of VAT; 47,465 inclusive of VAT), and the final retesting (2,555) were reported.

The total costs of the mitigation programme were 106,720 (inclusive of VAT) and 99,651 (exclusive of VAT).

Synthesis of costs and benefits
The costs and benefits were combined by calculating the cost-effectiveness ratio. The total cost for each lung cancer saved per year was 885,938.

The annualised cost per lung cancer saved was also calculated, on the basis of different choices between the discount rates and accounting periods. If the appropriate discount rate and accounting period were 6% (as recommended by the UK Treasury) and 40 years (corresponding to the average life of a property in Northamptonshire), the annualised cost per lung cancer avoided was 81,723. As expected, by increasing the discount rates and the length of accounting period, the annualised cost per lung cancer saved was decreased.

Finally, assuming an accounting period of 40 years and a discount rate of 6%, the total cost per lung cancer saved increased dramatically when the percentage of householders actually mitigating moved from 100% (885,938; 81,723 when annualised at 6%) to 20% (2,768,716; 206,855 when annualised at 6%), to 10% (5,122,186; 363,270 when annualised at 6%), and to 5% (9,829,126; 676,101 when annualised at 6%).

The authors commented that the total programme costs increase as, when the percentage of householders actually mitigating is low, the total number of properties requiring testing in order to obtain 73 mitigations will increase. These increased test costs would be wasted, "as no potential benefit is generated in the form of lower exposure to radon that would follow the mitigation".

Authors’ conclusions
The potential benefits of radon mitigation in residential properties could be far greater than those achievable in workplaces and involve significantly lower costs, as assessed in other studies. “Only when 5% of households carried out
programmes of domestic mitigation did costs for domestic properties match those for workplaces.” The analysis has demonstrated that radon mitigation can represent a cost-effective method of addressing the factors that affect lung cancer.

**CRD COMMENTARY - Selection of comparators**
The mitigation programme in residential properties was implicitly compared to the same programme conducted in workplaces in the same areas. However, only limited cost and benefit data for the comparator were provided. You should consider whether these interventions are widely used in your own setting.

**Validity of estimate of measure of effectiveness**
The analysis of the effectiveness was based on a sample of residential properties but, as the authors recognised, it was assumed that all the households were similar in terms of the time spent in the properties. In fact, some populations, such as the elderly or unemployed, may spend more time in the house than school children and workers. Complications due to an increasingly mobile population were not accounted for in the analysis.

**Validity of estimate of measure of benefit**
The benefit measure was the number of lung cancer episodes avoided after the mitigation programme. This appears to have been appropriate to the study question. However, the estimated number of lung cancers avoided was not reported. Also, no benefit measure was reported for the comparator: only the annual dose reduction of manSv was indicated, and there was no mention of the lung cancers avoided in workplaces.

**Validity of estimate of costs**
The source of the cost data and the perspective of the study were not reported. Statistical analyses were not carried out on the quantities or prices. The cost of the mitigation programme was based on the use of sumps and fan to extract the radon gas, but the authors highlighted that other equally effective methods were available at lower costs. This consideration, however, is unlikely to have affected the study results.

**Other issues**
The authors made several comparisons of their findings with those from other studies. The issue of the generalisability of the results to other settings was not explicitly addressed. Sensitivity analyses were, however, carried out on some variables in the analysis. The authors have since published several papers that deal with many of the limitations highlighted in this abstract. See "Other Publications of Related Interest” below).

**Implications of the study**
An important implication of the study was represented by the fact that a significant proportion of householders, discovering that they had radon levels above the critical threshold, decided not to carry out any mitigation work. This was perhaps due to inadequate risk communication strategies. Further research should be focused on the factors underlying the decision to mitigate.

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None stated.

**Bibliographic details**

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Other publications of related interest


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