Lung cancer deaths from indoor radon and the cost effectiveness and potential of policies to reduce them

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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.

CRD summary
This study examined the cost-effectiveness of preventive policies to control indoor radon in new and existing homes. The implementation of prevention measures in new homes was highly cost-effective from the perspective of society, while the current policy of identifying and remediating existing homes with high radon levels was neither cost-effective nor effective in reducing lung cancer mortality. The study was conducted using sound methodology, although some aspects of the analyses are reported only in the on-line appendices. The authors' conclusions appear to be valid.

Type of economic evaluation
Cost-effectiveness analysis, cost-utility analysis

Study objective
The objective was to determine the number of deaths from lung cancer (LC) related to radon in the home, and to examine the cost-effectiveness of alternative preventive policies to control indoor radon in both new and existing homes, in two separate analyses.

Interventions
For existing homes, the basic preventive measure consisted of sealed membranes. The policy was to offer free (government funded) radon measurement to homeowners in areas where 5% or more of homes had radon measurements above 200 becquerels per cubic meter (Bq/m$^3$, high radon, i.e. areas where the mean indoor radon concentration was 64Bq/m$^3$ or more), on a rolling basis, through a series of targeted programmes. If the measured radon concentration was high (over 200Bq/m$^3$), then homeowners were advised to remediate at their own expense.

For new homes, the basic preventive measure was supplemented with under-floor ventilation such as a radon sump and pipe (full prevention). The policy was to install basic radon prevention, while building all new homes, in areas where 3% or more of homes had high radon (mean concentration 52Bq/m$^3$ or more) and full prevention in areas where 10% or more of homes had high radon (mean concentration 87Bq/m$^3$ or more).

These policies were compared with a strategy of no intervention.

Location/setting
UK/community.

Methods
Analytical approach:
This economic evaluation was based on two decision models. The time horizon of the analysis was 100 years. The authors stated that a societal perspective was adopted, including the viewpoint of the National Health Service (NHS), the Health Protection Agency (HPA), and households.

Effectiveness data:
The clinical data were derived from a selection of known, relevant studies, the key characteristics of which were reported. For example, the distribution of measured radon concentrations in UK homes came from a nationwide representative survey, while the increase in risk of LC due to radon was obtained from data on more than 7,000 people.
with LC and more than 21,000 controls in nine European countries. A prospective study conducted in the USA was used to estimate the absolute risk of death due to LC in non-smokers. The key clinical outcome was the risk of death from LC associated with radon and smoking.

Monetary benefit and utility valuations:
The sources of utility valuations were not reported.

Measure of benefit:
Both life-years (LYs) and quality-adjusted life-years (QALYs) were used as summary benefit measures. These were discounted at an annual rate of 1.5%.

Cost data:
The main cost categories were radon prevention (invitation, measurement, and remediation), LC treatment, and other health care expenses arising from added life expectancy. The costs and quantities associated with radon prevention measures were based on a consensus agreed by relevant agencies. The sources of other costs were not clearly reported. All costs were in UK pounds sterling (£) and the price year was 2007. Future costs were discounted at an annual rate of 3.5%.

Analysis of uncertainty:
Both a univariate and a probabilistic sensitivity analysis were carried out to address the issue of uncertainty. In the former, plausible ranges of values were used, but the sources of these ranges were not reported. In the latter, the model inputs were varied simultaneously using probabilistic distributions for each input.

Results
For new homes, the discounted benefits gained with the basic preventive measures to prevent radon per 1000 households remediating were 39.9 LYs and 31.2 QALYs, with an additional cost of £248 for society (£148 for the NHS, £0 for the HPA, and £100 for households). From the perspective of society, the incremental cost per LY gained was £6,226 and the incremental cost per QALY gained was £7,953 (£4,752 for the NHS and £3,201 for both the HPA and households).

The sensitivity analysis suggested that, even in areas with low radon concentration levels, the preventive measures were cost-effective, with cost-utility ratios well below the commonly quoted threshold of £20,000 per QALY. The most influential model inputs were cost and effectiveness of installing basic protection measures. The probabilistic sensitivity analysis indicated that a policy of basic measures had a probability of being cost-effective of 94% at a threshold of £20,000 per QALY.

Full preventive measures, for new homes in areas with at least 10% of homes above 200 Bq/m³, were not cost-effective (£53,500 per QALY gained).

For existing homes, the discounted benefits gained with the current government policy per 1000 households remediating were 270.8 LYs and 212.0 QALYs, with an additional cost of £7,809 for society (£1,008 for the NHS, £4,750 for the HPA, and £2,051 for households). The incremental cost per LY gained from the perspective of society was £28,833. The incremental cost per QALY gained was £36,829 for society (£4,752 for the NHS and £32,077 for both the HPA and households). This figure was above the UK threshold for cost-effectiveness.

The probabilistic sensitivity analysis indicated that this policy had a probability of being cost-effective of 16% at a threshold of £20,000 per QALY, and 54% at a threshold of £30,000 per QALY.

The sensitivity analysis suggested that these policies were highly cost-effective for current cigarette smokers, but not at all cost-effective for those who had never smoked.

Authors’ conclusions
The authors concluded that the implementation of prevention measures in new homes in selected areas was highly cost-effective from the perspective of society, while the current policy of identifying and remediating existing homes with
high radon levels was neither cost-effective nor effective in reducing LC mortality.

**CRD commentary**

**Interventions:**
A formal justification for the selection of the comparators was not provided, but the strategies appear to have been appropriately selected as they represented viable preventive strategies in the authors’ setting.

**Effectiveness/benefits:**
The approach used to identify the primary sources of data was not described. Thus, these sources were presumably known to the authors. In the paper itself, only a few details on these studies were provided, which prevents a comprehensive evaluation of the quality of the clinical or epidemiological evidence. Detailed information on these aspects of the research can be found in the on-line appendices (1 and 3). Furthermore, data on the sources of the utility valuations required to calculate the QALYs were not provided. Both the benefit measures were appropriate, given their wide external validity.

**Costs:**
The choice of a broad perspective was appropriate in that it covered all expenses regardless of the payer. The costs were presented as macro-categories and a detailed breakdown of items was not given. This reduces the transparency of the economic analysis. Moreover, the sources used to derive the costs and quantities of resources were not described in detail in the paper itself, however extensive details are available in the on-line Appendix 3. The price year and the use of discounting were reported.

**Analysis and results:**
The synthesis of costs and benefits was appropriately performed. The issue of uncertainty was satisfactorily addressed using appropriate methods, which focused both on individual and multiple aspects of the model. The results of both the base-case and the sensitivity analyses were clearly presented. The authors discussed some strengths and limitations of their study. For example, it was noted that the analysis considered the clinical and economic impact of fatal LC but not non-fatal LC, which might have substantial implications for the cost-effectiveness results.

**Concluding remarks:**
The study appears to have been carried out using sound methodology, although some aspects of the analyses were reported only in the on-line appendices. In general, the authors’ conclusions appear to be valid.

**Funding**
Supported by Cancer Research UK, the Medical Research Council, the European Commission, and the National Institute for Health Research.

**Bibliographic details**
Gray A, Read S, McGale P, Darby S. Lung cancer deaths from indoor radon and the cost effectiveness and potential of policies to reduce them. BMJ 2009; 338: a3110

**Original Paper URL**
http://www.bmj.com/content/338/jan06_1/a3110

**Other publications of related interest**


Stigum H, Strand T, Magnus P. Should radon be reduced in homes? A cost-effect analysis. Health Phys
2003;84:227-35.

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Aged; Air Pollution, Indoor /adverse effects /economics /prevention & control; Carcinogens, Environmental /toxicity; Cost-Benefit Analysis; Environmental Exposure /adverse effects /economics /prevention & control; Environmental Restoration and Remediation /economics; Government Programs /economics; Great Britain /epidemiology; Health Policy /economics; Humans; Lung Neoplasms /economics /etiology /mortality; Middle Aged; Neoplasms, Radiation-Induced /economics /etiology /mortality; Program Evaluation; Quality-Adjusted Life Years; Radon /toxicity; Risk Assessment

**AccessionNumber**
22009100247

**Date bibliographic record published**
02/03/2009

**Date abstract record published**
29/04/2009