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Original Research

# Evaluation of the cold weather plan for England: modelling of cost-effectiveness

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ABSTRACT

*Objective:* To determine the conditions under which the Cold Weather Plan (CWP) for England is likely to prove cost-effective in order to inform the development of the CWP in the short term before direct data on costs and benefits can be collected.

*Study design:* Mathematical modelling study undertaken in the absence of direct epidemiological evidence on the effect of the CWP in reducing cold-related mortality and morbidity, and limited data or on its costs.

*Methods:* The model comprised a simulated temperature time series based on historical data; epidemiologically-derived relationships between temperature, and mortality and morbidity; and information on baseline unit costs of contacts with health care and community care services. Cost-effectiveness was assessed assuming varying levels of protection against cold-related burdens, coverage of the vulnerable population and willingness-to-pay criteria.

*Results:* Simulations showed that the CWP is likely to be cost effective under some scenarios at the high end of the willingness to pay threshold used by National Institute for Health and Care Excellence (NICE) in England, but these results are sensitive to assumptions about the extent of implementation of the CWP at local level, and its assumed effectiveness when implemented. The incremental cost-effectiveness ratio varied from £29,754 to £75,875 per Quality Adjusted Life Year (QALY) gained. Conventional cost-effectiveness (<£30,000/QALY) was reached only when effective targeting of at-risk groups was assumed (i.e. need for low coverage (~5%) of the population for targeted actions) and relatively high assumed effectiveness (>15%) in avoiding deaths and hospital admissions.

*Conclusions:* Although the modelling relied on a large number of assumptions, this type of modelling is useful for understanding whether, and in what circumstances, untested plans are likely to be cost-effective before they are implemented and in the early period of implementation before direct data on cost-effectiveness have accrued. Steps can then be taken to optimize the relevant parameters as far as practicable during the early implementation period.



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## Introduction

Preparedness for winter cold continues to be important for health protection, and the management of largely predictable seasonal pressures on health and social care services in England. Even under warming induced by climate change, prolonged periods of winter cold will persist well into the 21st century,[1,2] as will the chance of disruptive extreme cold such as occurred during the winters of 1946–1947,[3] 1962–1963,[4,5] 2009–2010[6] and 2010–2011.[7] Although most of the health burden of cold weather in England does not occur on extremely cold days,[8] extreme cold conditions can incur disproportionately severe impacts on health care services if they are unprepared when they do happen.

The Cold Weather Plan (CWP) for England, operational since 2011, was established to '... prepare for, alert people to, and prevent the major avoidable effects in health during periods of severe cold in England'.[9] It combines the Cold Weather Alert (CWA) forecasting service run by the Met Office each winter, and guidance to the NHS (community, primary and secondary health care), local authorities (social care) and other public bodies and voluntary organizations, on what actions to take in response to alert levels issued by the CWA service. The actions proposed in the CWP are set out in very general terms to allow local authorities and the NHS to tailor their plans to suit local circumstances and fit within available resources.

The CWA forecasting service issues five alert levels: 'Level 0' (long-term preparedness), 'Level 1' (winter preparedness), 'Level 2' (alert and readiness), 'Level 3' (severe weather action) and 'Level 4' (national emergency). Level 0 is triggered all year. It reminds authorities of the need for long-term planning for the coming winter and entails actions that should be phased throughout the year. Level 1 is triggered on 1st November and prompts authorities to put in place general preparedness actions during the period from 1st November to 31st March. Level 2 is triggered whenever a mean temperature of 2 °C and/or widespread ice and heavy snow are forecasted within 48 h with 60% confidence. Level 3 is triggered when the conditions described in Level 2 happen. Finally Level 4 is declared by the Government when the weather conditions are very severe and/or prolonged. Levels 2 to 4 unlike 0–1 are provided on a geographical basis rather than country-wide basis.

There have been very few economic evaluations of health-related weather forecasting services in England. Sampson et al.[10] carried out an exploratory analysis of the likely costs and benefits of health-related weather forecasting services. One of their key findings was that health care services need to engage with a forecasting service to realize its full potential. They identified the main value of forecasting services as helping health services plan ahead to cope with their likely workload in ways that could take account of weather conditions.

The objective of this study was to estimate the cost-effectiveness of the CWP. However, because the CWP has only been operating for three winters, there is as yet insufficient direct epidemiological evidence on its impact on health and health services and information on its costs. Our analysis was therefore carried out to explore through simulation the conditions under which the CWP is (or can be made to be) cost-effective.

## Methods

Full details of the methods are provided in the Supplementary Material.

### *Modelling framework to calculate health benefits and costs*

Fig. 1 shows the modelling framework used to calculate the health benefits and direct costs of the CWP. It is divided into three main components (represented by the dashed large rectangles). The first component (block A) calculates the cold-attributable disease burden pre-CWP defined in terms of the numbers of premature deaths and emergency hospital admissions. The calculation of the daily cold-attributable disease burden is a function of the temperature-dependent fractional excess risk and the daily baseline health burden. This burden would represent the pre-CWP scenario because the exposure-response relationships used in the health impact calculations are based on epidemiological analysis of historical data before the introduction of the CWP.[8]

The second component (represented by block B in the figure) takes into account the extent of implementation of the CWP, given that no plan is ever completely implemented as intended, as well as its effectiveness in preventing mortality and hospital admissions. Two unknown parameters are introduced to determine the effectiveness of the implemented CWP: (i) the upper bound of the proportion of avoidable premature deaths and hospital admissions that would be averted if the CWP were fully implemented $(\delta)$; and (ii) the average degree of implementation of the CWP $(\zeta)$. The effectiveness of the implemented CWP is the product of these two parameters $(\delta\,\zeta)$ which gives the proportion of burden averted.

The third component of the framework is represented by block C in Fig. 1. The numbers of premature deaths and hospital admissions averted are the product of the health burden pre-CWP and the effectiveness of the CWP $(\delta\,\zeta)$. These numbers are combined to express the health benefits in Quality Adjusted Life Years (QALYs). There is also a health benefit associated with increased contact with primary and social care services as a result of implementing the CWP (also measured in QALYs).

The cost of the additional contacts with primary and social care services depends on the degree of implementation of the CWP, and the number and nature of contacts pre-CWP. The cost savings are estimated directly from the number of reduced hospital admissions associated with successful implementation of the CWP assuming that each admission avoided leads directly to a commensurate saving (unlikely in practice).

### *Cost-effectiveness analysis*

Cost-effectiveness analysis is concerned with analysing the incremental costs and incremental benefits of a 'new intervention' compared with 'current practice'. In this analysis, the 'new intervention' is the CWP and 'current practice' is the set