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Review

What is the effect of the weather on trauma workload? A systematic review of the literature

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ABSTRACT

Background: Hospital admission rates for a number of conditions have been linked to variations in the weather. It is well established that trauma workload displays significant seasonal variation. A reliable predictive model might enable targeting of high-risk groups for intervention and planning of hospital staff levels. To our knowledge there have been no systematic reviews of the literature on the relationship between weather and trauma workload, and predictive models have thus far been informed by the results of single studies.

Methods: We conducted a systematic review of bibliographic databases and reference lists up to June 2014 to identify primary research papers assessing the effect of specified weather conditions including temperature, rainfall, snow, fog, hail, humidity and wind speed on trauma workload, defined as admission to hospital, fracture or a Road Traffic Accident (RTA) resulting in a seriously injured casualty or fatality.

Results: 11,083 papers were found through electronic and reference search. 83 full papers were assessed for eligibility. 28 met inclusion criteria and were included in the final review; 6 of these related to the effect of the weather on trauma admissions, one to ambulance call out for trauma, 13 to fracture rate and 8 to RTAs.

Increased temperature is positively correlated with trauma admissions. The rate of distal radius fractures is more sensitive to adverse weather than the rate of hip fractures. Paediatric trauma, both in respect of trauma admissions and fracture rate, is more sensitive to the weather than adult trauma. Adverse weather influences both RTA frequency and severity, but the nature of the relationship is dependent upon the timecourse of the weather event and the population studied. Important methodological differences between studies limit the value of the existing literature in building consensus for a generalisable predictive model.

Conclusions: Weather conditions may have a substantial effect on trauma workload independent of the effects of seasonal variation; the population studied and timecourse of weather events appear critical in determining this relationship. Methodological differences between studies limit the validity of conclusions drawn from analysis of the literature, and we identify a number of areas that future research might address.

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Introduction

The precision of short and medium range weather forecasting has improved significantly in recent years with advances in observational methods, data assimilation and modelling techniques [1,2]. Hospital admission rates for a number of conditions, most notably in respiratory and cardiovascular disease [3–5], have been linked to variations in the weather, and it is well established that trauma workload displays significant seasonal variation [6,7]. Weather forecasts are used to good effect in the commercial sector to predict consumer demand; a reliable predictive model in healthcare might enable targeting of high risk groups for intervention and effective planning of hospital staff levels [8–10]. Moreover, the recent trend toward networks for major trauma and centralisation of care means that relatively small changes in the incidence of trauma resulting from adverse weather conditions may lead to shifts in workload at major trauma centres sufficiently large to justify adding weather forecasts to resource planning [11].

The existing literature suggests a complex relationship between weather conditions and rates of injury. Unclear definitions of 'trauma' and of what constitutes an 'adverse' weather condition (with respect to duration or severity) limit the ability to interpret the significance of observed effects [12]. It is generally acknowledged that warmer weather is associated with a higher volume of trauma [13,14] and that trauma in children is more closely associated to the weather than adult trauma [12,15]. However, to our knowledge there have been no systematic reviews of the literature on this subject and there remains confusion as to the strength of the evidence for planning trauma services based upon weather forecasts. Predictive models have thus far been informed by the results of single studies without full consideration of the relationship between weather and trauma. Most models have been derived from studies with different designs, definitions of trauma, localities and population groups.

Our objective was to assess the strength of the evidence supporting an association between specific weather conditions and trauma service workload. Published studies that recorded trauma admissions, fractures or RTAs resulting in a seriously injured casualty or fatality as the outcome measure were sought, as each of these place a considerable demand upon trauma services. RTAs were singled out as a cause of trauma as they represent the most common cause of major trauma and a significant economic burden to healthcare systems around the world [16,17].

Methods

The methodology of this study is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement for systematic reviews [18]. Studies were identified by searching electronic databases and scanning reference lists of selected papers. There was no restriction in the population group considered by age or geographical location. The intervention considered was a specified weather condition(s) including temperature, rainfall, snow, fog, hail, humidity and wind speed, with the comparator being an absence or reduced severity of this weather condition. The outcome measure was trauma that resulted in increased workload to trauma services, defined as admission to hospital, fracture or RTA resulting in a seriously injured casualty or fatality.

Search strategy

The Medline (1946–January 2014) and Embase (1974–January 2014) databases were searched using the following terms: [trauma*.mp OR fracture*.mp OR exp Accidents, Traffic/or road traffic accident*.mp OR exp Accidents, Traffic/or road traffic collision*.mp] AND [exp Cold Temperature/or exp Climate/or exp Weather/or weather*.mp or exp Seasons/]. The Cochrane Library was searched using the following terms: [trauma* OR fracture* OR road traffic accident* OR road traffic collision*] AND [weather* OR climate* OR season* OR temperature*]. The last search was run in January 2014 and we conducted a limited update literature search from January 2014 to June 2014 using Medline (Pubmed) to find related articles. We only included full papers or systematic reviews and papers in the English language. Studies related to catastrophic weather events (e.g. hurricanes, tornadoes) or to periods of time identified by the authors as displaying highly uncharacteristic weather for that region or those related to the effect of the weather on people undertaking specific activities (e.g. injuries associated with skiing, hot-air ballooning, windsurfing) were excluded due to lack of generalisability of the findings. Titles and abstracts of papers were reviewed to produce a list of studies for full-paper review.

Eligibility criteria

Papers were required to meet the following eligibility criteria for inclusion:

- Unambiguous definition of weather condition(s) being considered (e.g. 'rain', 'snow' and not e.g. 'clear' or 'adverse' without further clarification).
- Use of a defined, objective information source for weather information (e.g. not obtained retrospectively from patient).
- Weather information provided at least daily (e.g. not a monthly average).
- For papers that did not specify the type of trauma, an outcome measure that, at the minimum, was admission to hospital or severe injury prompting an ambulance call (not e.g. attendance at Emergency Department (ED) without subgroup analysis of severe injuries).
- For papers related to RTAs, an outcome measure that indicates the severity of the crash and includes subgroup analysis of serious or fatal crashes.

Results

A total of 11,083 papers were identified by applying the search criteria. After removal of duplicates there were 9532 papers