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(The Met Office is the UK's national weather service, providing weather forecasts, climate change research, air quality forecasts, health forecasts, and many other services targeted at mitigating the effects of the weather and environment and protecting people, property and national infrastructures.)

Prevention in Practice

THUNDERSTORM ASTHMA

On 23 June 2005, the Met Office issued a warning that severe thunderstorms were likely to hit the South East of England in the next 24 hours. On the evening of Friday 24 June, primary care out-of-hours services and hospital accident and emergency departments in Northwest London were inundated by patients attending with acute asthma. The scale of these attendances – eight times more patients than usual in one hospital – meant that departments had to call in additional staff and some ran out of emergency supplies of bronchodilators, nebulisers and oral steroids for treating asthma. In this article, we will explain the background and some of the theories related to this type of epidemic of acute asthma – Thunderstorm Asthma.

Associations between the weather and use of healthcare services for asthma have aroused much interest in the scientific community. More specifically, a number of thunderstorm-related epidemics have been reported in various parts of the world. The first of these was reported in the UK, when an outbreak of thunderstorm asthma occurred in Birmingham and the surrounding area in July 1983. In a further epidemic, on the evening of Friday 24 June 1994, 12 London hospitals had to cope with 640 patients attending A & E departments with acute asthma during a 30-hour period, compared with the usual expected number of 60.

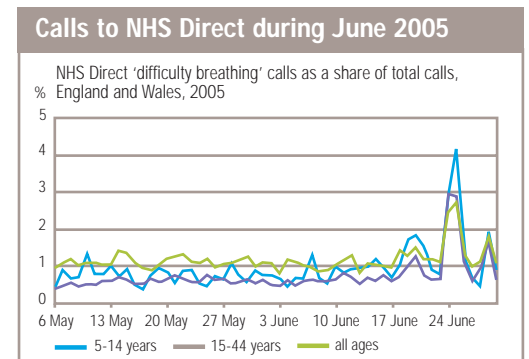
WHO GETS THUNDERSTORM ASTHMA?

The majority of patients presenting in casualty departments with acute asthma during thunderstorms are young atopic adults (20-40 years old) with no previous history of asthma. Most people who have been studied have a past history of allergy to grass pollen. Recent evidence suggests that allergy to fungal spores is an important aetiological factor in children and adults who suffer thunderstorm asthma. While other aeroallergens have been implicated in these epidemics, not many of the patients had a previous diagnosis of sensitisation to fungal spores. In fact, there is no skin prick test available for *Didymella*, believed to be an important fungal aeroallergen for these epidemics.

One study found that nearly half of the 640 patients who presented in twelve London hospitals during the thunderstorm asthma epidemic of June 1994 had had an

acute asthma attack for the first time. This clearly constitutes a potentially dangerous situation for this population, very few of whom had previously been prescribed any asthma medication. Fifteen percent of those presenting to hospital were admitted; two-thirds of them were treated for their attack; about a third were prescribed oral steroids; and 15 patients not admitted re-attended within 48 hours.

During the epidemic in South Eastern England of 24 June 2005, there was a 400% increase in 'difficulty breathing' calls to the telephone advice line at NHS Direct (see graph) and a 50% increase in general practice out-of-hours emergency patient attendances. One on-call doctor in Reading treated 55 patients requiring nebulisers, where he usually expected one. In London, hospitals reported high levels of attendances at A & E about two hours after the storm passed.



“The majority of patients presenting in casualty departments with acute asthma during thunderstorms are young atopic adults (20-40 years old) with no previous history of asthma”



Image of lightning over Norwich © Paul Davies

Prevention in Practice



HOW CAN THUNDERSTORMS CAUSE ASTHMA ATTACKS?

Thunderstorm asthma epidemics are the result of a complex combination of pre-conditions:

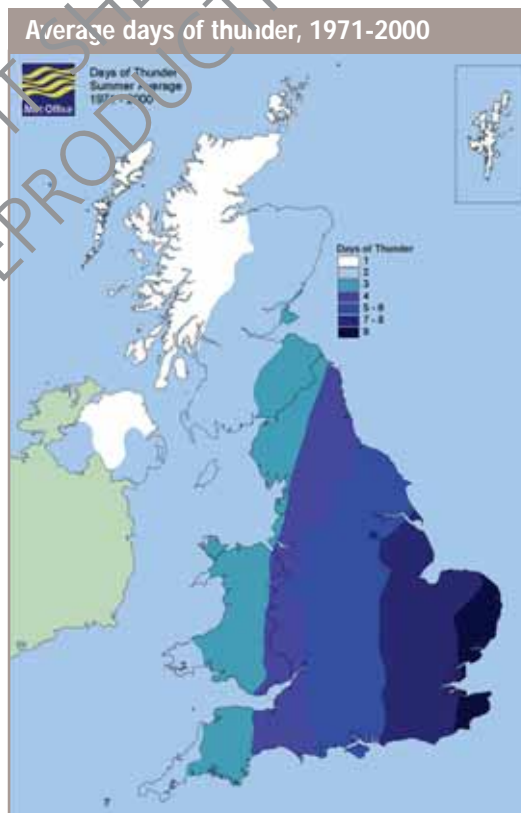
Population criteria

- Hayfever with previous chest symptoms
- Allergy to pollen or fungal spores currently circulating
- Not necessarily previous diagnosis of asthma

Environmental criteria

- High levels of aeroallergen (pollen or fungal spores)
- High temperatures for ~7 days
- No rain for ~7 days
- Humidity in correct range
- Ozone (possibly)
- Mesoscale thunderstorm (large-scale, low-level convergence).

Summer in the UK is the season when thunderstorm asthma is a risk. This is because most thunderstorms occur in summer. Pollen tends to be associated with epidemics in early summer (eg the epidemic in London on 24 June 2005) and fungal spores with later epidemics



These are the data for summer. This gives an indication of risk of a thunderstorm asthma event. © Met Office 2006.

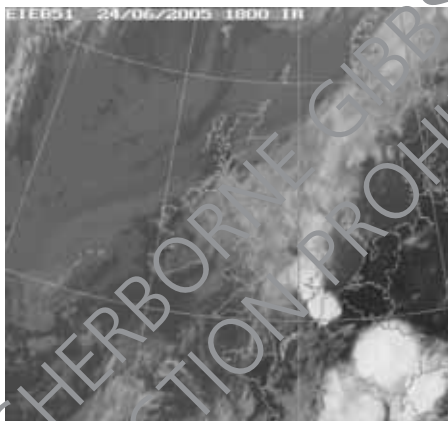
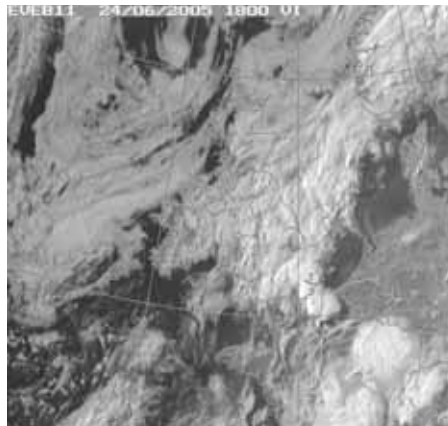
(eg East Anglia on 29 July 2002). There is some debate about whether pollen and spores might interact, and which fungal spores are important, particularly *Didymella* and *Alternaria*. There is also debate about the role of air pollution. For example, ozone is thought to be important, but primarily as an irritant of the airways increasing susceptibility to aeroallergens, rather than as a direct trigger.

A period of high temperatures and low rainfall is important for production and accumulation of pollen or spores, and humidity must be in the correct range (80%-95%) for their production and survival. Pollen grains and spores can pile up on the ground, but are washed away by rain.

The right conditions for the formation of a thunderstorm are unstable air and a mechanism for causing air to rise. Air is said to be unstable when a 'parcel' of air continues to rise of its own accord after being given an upward impetus. This instability is the result of a rapid fall of temperature with height, as well as a considerable amount of moisture.

Asthma thunderstorms are associated with large-scale convergence of air at ground level, which is the mechanism causing air to be driven upwards. This air cools, until it starts to condense onto particles held in the air (which may be dust, pollution, or pollen or spores). Energy released by condensation encourages the air to continue to rise, and a towering cloud is produced. The droplets in the cloud combine and fall as rain within the cloud, causing a downdraught. If the wind is stronger high in the cloud, this downdraught occurs in advance of the cloud. By the time it reaches the ground, the downdraught is experienced as a dry and cold gusting wind about 5 km ahead of any rainfall.

The rising air picks up the aeroallergens on the plant or ground, and draws them into the base of the cloud. The humidity is high here, which can cause the pollen grain or fungal spore to burst. Alternatively, the up- and downdraughts within the cloud can mechanically fracture the aeroallergens. The dry and cold downdraught brings these fragments to ground level and picks up more aeroallergens. These fragments are both smaller, and therefore more respirable and more likely to penetrate deeper into the lungs, and more allergenic than the whole grain or spore.



Visible and infrared satellite pictures of 24 June 2005 thunderstorm

LESSONS FOR THE FUTURE

While thunderstorm epidemics of asthma are relatively infrequent, there are some clear lessons we can learn for the future. These include:

Education for people with allergic rhinitis

- Warn of dangers that may occur during thunderstorms
- Advise them to close windows if there are thunderstorm warnings
- Advise them to consult a doctor if wheezy or short of breath during thunderstorms.

Protocols in emergency services (A & E and GP out-of-hours)

- Ensure adequate supplies of asthma medication and equipment (bronchodilators, nebulisers, spacers, oral steroids)
- Consider setting up an asthma clinic *eg* in a fracture clinic
- Consider drafting in additional staff
 - health professionals
 - pharmacists
 - managers.
- Repeated health messages via local news services if thunderstorms are expected.

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Didymella spores

Lightning occurs in clouds where sufficient electrical charges are separated, and is a good indicator of the vigour of the up- and downdraughts in the cloud. It is hypothesised that the electrical charge may cause pollen still on plants to rupture or induce the release of pollen. It used to be thought that the drop in temperature associated with thunderstorms was a trigger. However, the fragments of aeroallergens in the dry and cold gust ahead of lightning are likely to be more important than the temperature of the gust.

more information

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