

EDITOR'S NOTE

Following an extensive hot period in November 2016, a sudden cool change associated with severe thunderstorm activity brought about a freak catastrophic thunderstorm asthma epidemic in Melbourne. The intense demands placed on the healthcare system (e.g. requests for emergency assistance coming every 4.5 s) were unprecedented and described by some as equivalent to 150 bombs exploding across Melbourne sequentially. Two articles in this issue of the Internal Medical Journal (Hew et al. and Schumacher) highlight the pathophysiological mechanisms and the public health lessons to be learnt.

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EDITORIALS

The Melbourne thunderstorm asthma event: can we avert another strike?

Thunderstorms have been recognised to precipitate asthma attacks for over 30 years. Events have been reported from Europe, North America, the Middle East and Australia.¹ Previously, the largest documented outbreak occurred in June 1994, when 640 patients presented to London emergency departments within a 30-h period.² This has now been surpassed by the thunderstorm event in Melbourne on 21 November 2016. In excess of 9900 patients presented to hospitals with asthma attacks.³ Ambulances and emergency services were overwhelmed, as more than 2300 calls flooded the 000 emergency line with almost one call every 4 s. An extra 60 ambulances were deployed but tragic cases occurred with two people dying while waiting for paramedics to arrive, and others suffering hypoxic brain damage and subsequent hospital death. In all, nine deaths have been linked to this episode, making it by far the most lethal event to date.⁴

Notwithstanding the tragedy of the 'November 21 thunderstorm asthma event', the huge collective response from the Department of Health and Human Services, Ambulance Victoria paramedics, hospital emergency departments (public and private hospitals accepting public patients), general practitioners, pharmacists, nurses, peak bodies (especially the National Asthma Council and Asthma Australia) and the general public/carers should be acknowledged for tempering its impact. This valiant and impressive team effort should be applauded in the wake of this unprecedented catastrophic event.

Box 1 Thunderstorm-related asthma

- Close temporal relationship between the onset of thunderstorm and asthma epidemic onset
- Thunderstorm asthma epidemics are limited to pollen (and occasionally outdoor mould) seasons
- No high levels of gaseous and particulate air pollution during thunderstorm asthma outbreaks
- Pollen-allergic subjects are usually protected if they stay indoors with windows closed
- Highest risk is for subjects not prescribed anti-asthma treatment or poorly adherent seasonal asthmatics BUT subjects with seasonal rhinitis and without prior asthma can experience severe bronchoconstriction (latent asthma)
- Non-pollen-allergic subjects do not experience thunderstorm asthma

There is now an urgent need to publicise the mechanisms underlying thunderstorm-related asthma, so that we can mitigate the consequences of similar events in future. Scientific advances – many from Australia – have helped piece this puzzle together (Box 1).

We have known for more than 20 years that patients who experience thunderstorm-related asthma in Melbourne suffer seasonal allergic rhinitis (SAR) and are sensitised to rye grass (*Lolium perenne*) pollen.⁵ This was confirmed in the recent episode (unpubl. data). Many of these patients also suffer from seasonal asthma. While other grasses and even fungal spores have been suggested to be important elsewhere, wind-pollinated rye

grass appears to be the predominant seasonal allergen in south-eastern Australia. The topography of the vast rye grass pasture lands surrounding the Great Dividing Range north-east of Melbourne contributes to the heavy pollen load dumped on Melbourne in times of extreme thunderstorm activity. This explains why Melbourne episodes have been confined to springtime.¹

The second major advance occurred under the guidance of the late Bruce Knox, former Professor of Botany, University of Melbourne, when he showed how storm moisture could rupture rye grass pollen grains, causing each grain to release hundreds of starch granules carrying the major rye grass pollen allergens.^{5,6} Intact pollen grains are greater than 35 µm in diameter and generally get deposited in the upper airway to trigger allergic rhinitis symptoms, but the smaller starch granules measure less than 3 µm across, and so are exquisitely respirable into lower airways.⁷ Experimental bronchial challenge in thunderstorm-susceptible asthmatics using these starch granules causes significant bronchoconstriction.⁷ Clinical research performed at Wagga Wagga in New South Wales linked epidemic asthma days to the presence of thunderstorm outflows.⁸ These winds bring respirable allergen particles down to ground level in high concentration, where they can be inhaled.

Now that we understand how thunderstorm-related asthma occurs, can we mitigate the risk of future events? Several steps can indeed be taken.

First, we need to become better at identifying individuals at risk. The risk appears to be confined to rye grass-allergic patients, which includes up to one in six individuals living in south-eastern Australia. These patients may be easily identified at any time of the year by serum-specific IgE or skin prick testing to rye grass pollen, both of which are currently underutilised in community practice. There is a direct relationship between the level of serum-specific IgE levels and risk of asthma symptoms on allergen exposure, and this relationship is strongest for grass pollen.⁹

In Victoria, the majority of young asthmatics are sensitised to rye grass. Unfortunately, many have ongoing poor asthma control and so are vulnerable to acute triggers. Inhaled corticosteroids are under-prescribed and markedly under-used.¹⁰ Most patients do not have action plans.¹⁰ Community management of asthma needs to be improved at many different levels,¹¹ and the threat of thunderstorm asthma adds a further impetus to do so.

Importantly, 36–44% of people who present to emergency departments with thunderstorm asthma may never have previously suffered asthma.^{12,13} This also has been confirmed in the recent event (unpublished data). Current asthma guidelines do not cater for this group of 'latent asthmatics' as they, by definition, have never had asthma.

Therefore, such guidelines may need to be updated to include the requirement for the SAR group without previous asthma to be provided with bronchodilator (reliever) medication for thunderstorm asthma crisis situations. For SAR patients with occult or poorly perceived concomitant seasonal asthma, the 'wheeze and sneeze' catchphrase promoted by Asthma Australia may be a useful way to be encouraged to present for medical attention, and for general practitioners to be more aggressive in searching out and treating seasonal asthma in SAR patients.

It has long been known that allergen immunotherapy is effective in improving asthma control.¹⁴ Current barriers to rye grass immunotherapy include convenience and cost. Nevertheless, thunderstorm-related asthma reminds us that rye grass allergy can be dangerous as well as annoying, and immunotherapy should be offered more systematically to appropriate patients.

At a government level, health system responses are being carefully re-examined, involving community elements (general practice and pharmacies), ambulance services and hospital responses. This is being undertaken in light of the Melbourne thunderstorm when ambulance and other services were overwhelmed by demand.

The final question of thunderstorm prediction remains a challenge. Many thunderstorms occur during springtime in south-eastern Australia, but the majority do not cause thunderstorm asthma. The presence of thunderstorm outflows in the Wagga Wagga area predicted only one-third of asthma epidemic days.⁸ It is notable, however, that the six major thunderstorm epidemics reported in Melbourne (1984, 1987, 1989, 2003, 2010 and 2016)^{5,15–17} have all occurred in November during the peak of the pollen season. While we are still in urgent need of algorithms to predict catastrophic events reliably, there is enough information for the Melbourne populace to be much better prepared for November thunderstorms, particularly if rainfall has been high in the preceding winter as in 2010 and 2016,¹⁷ and the thunderstorm follows several days of high or extreme pollen counts. Pollen count and weather apps that can alert patients through their smart phones are already available, but a standardisation of message and response is needed specifically for thunderstorm asthma.¹⁸ Patients need to activate their asthma action plans and stay indoors with the windows closed, particularly when the cool thunderstorm outflow hits.

Climate change is predicted to result in more extreme weather events, and elevated CO₂ levels can increase photosynthesis, plant growth and pollen yields in favourable (wet) conditions.¹⁹ Due to the north-westerly wind direction associated with thunderstorm asthma in Melbourne, there is also the opportunity through real-time analysis of excess emergency presentations in the

north and west of the city, to give citizens in other areas of Melbourne warning (e.g. by emergency text message) of an unfolding thunderstorm asthma event. Such real-time analysis is already available in Australia and overseas.²⁰ A recent search of the terms 'asthma', 'allergy', 'rhinitis' and 'pollen' using Google Trends, a web-based surveillance tool, over a 13-year period from 2004 to 20 December 2016, indicated clear identification of the 2016 Australian asthma outbreak (J. Bousquet and R. O'Hehir, pers. comm., 2017).

The catastrophic Black Saturday bush fires of 2009 in Victoria resulted in a sea-change in community preparedness and attitudes to bush fires throughout Australia. We believe that the Melbourne thunderstorm asthma disaster of 2016 should provide a similar seismic shift in the

management of SAR and asthma. To a large extent, we already understand the mechanisms and the groups at risk; we also have excellent medications for asthma and rhinitis, and possess modern communications technology to deliver our message. We can and must do better.

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References

- 1 D'Amato G, Vitale C, D'Amato M, Cecchi L, Liccardi G, Molino A *et al.* Thunderstorm-related asthma: what happens and why. *Clin Exp Allergy* 2016; **46**: 390–6.
- 2 Venables KM, Allitt U, Collier CG, Emberlin J, Greig JB, Hardaker PJ *et al.* Thunderstorm-related asthma – the epidemic of 24/25 June 1994. *Clin Exp Allergy* 1997; **27**: 725–36.
- 3 Inspector General of Emergency Management, Victoria State Government. Review of Response to the Thunderstorm Asthma Event of 21–22 November 2016 Preliminary Report. [cited 2017 Feb 10]. Available from URL: <http://www.igem.vic.gov.au/home/reports+and+publications/reports/review+of+response+to+the+thunderstorm+asthma+event+of++november+2016+preliminary+report>
- 4 Health.Vic., Victoria State Government. Thunderstorm Asthma Events Update. [cited 2017 Feb 10]. Available from URL: <https://www2.health.vic.gov.au/about/media-centre/mediareleases/thunderstorm-asthma-events-update>
- 5 Bellomo R, Gigliotti P, Treloar A, Holmes P, Suphioglu C, Singh MB *et al.* Two consecutive thunderstorm associated epidemics of asthma in the city of Melbourne. The possible role of rye grass pollen. *Med J Aust* 1992; **156**: 834–7.
- 6 Knox RB. Grass pollen, thunderstorms and asthma. *Clin Exp Allergy* 1993; **23**: 354–9.
- 7 Suphioglu C, Singh MB, Taylor P, Bellomo R, Holmes P, Puy R *et al.* Mechanism of grass-pollen-induced asthma. *Lancet* 1992; **339**: 569–72.
- 8 Marks GB, Colquhoun JR, Girgis ST, Koski MH, Treloar AB, Hansen P *et al.* Thunderstorm outflows preceding epidemics of asthma during spring and summer. *Thorax* 2001; **56**: 468–71.
- 9 Olivieri M, Heinrich J, Schlünssen V, Antó JM, Forsberg B, Janson C *et al.* The risk of respiratory symptoms on allergen exposure increases with increasing specific IgE levels. *Allergy* 2016; **71**: 859–68.
- 10 Reddel HK, Sawyer SM, Everett PW, Flood PV, Peters MJ. Asthma control in Australia: a cross-sectional web-based survey in a nationally representative population. *Med J Aust* 2015; **202**: 492–7.
- 11 Tay TR, Abramson MJ, Hew M. Closing the million patient gap of uncontrolled asthma. *Med J Aust* 2016; **204**: 216–7.
- 12 Davidson AC, Emberlin J, Cook AD, Venables KM. A major outbreak of asthma associated with a thunderstorm: experience of accident and emergency departments and patients' characteristics. Thames Regions Accident and Emergency Trainees Association. *BMJ* 1996; **312**: 601–4.
- 13 Girgis ST, Marks GB, Downs SH, Kolbe A, Car GN, Paton R. Thunderstorm-associated asthma in an inland town in south-eastern Australia. Who is at risk? *Eur Respir J* 2000; **16**: 3–8.
- 14 Abramson MJ, Puy RM, Weiner JM. Injection allergen immunotherapy for asthma. *Cochrane Database Syst Rev* 2010: CD001186.
- 15 Egan P. Weather or not. *Med J Aust* 1985; **142**: 330.
- 16 Erbas B, Akram M, Dharmage SC, Tham R, Dennekamp M, Newbigin E *et al.* The role of seasonal grass pollen on childhood asthma emergency department presentations. *Clin Exp Allergy* 2012; **42**: 799–805.
- 17 Howden ML, McDonald CF, Sutherland MF. Thunderstorm asthma – a timely reminder. *Med J Aust* 2011; **195**: 512–3.
- 18 Melbourne Pollen Count and Forecast. School of Biosciences, The University of Melbourne. [cited 2017 Feb 10]. Available from URL: <http://www.melbournepollen.com.au/index.php/melbourne-pollen-count-app>
- 19 D'Amato G, Vitale C, De Martino A, Viegi G, Lanza M, Molino A *et al.* Effects on asthma and respiratory allergy of climate change and air pollution. *Multidiscip Respir Med* 2015; **10**: 39.
- 20 Elliot AJ, Hughes HE, Hughes TC, Locker TE, Brown R, Sarran C *et al.* The impact of thunderstorm asthma on emergency department attendances across London during July 2013. *Emerg Med J* 2014; **31**: 675–8.