

Parent reported allergy and anaphylaxis in 4173 South Australian children

CA BOROS,¹ D KAY² and MS GOLD¹

¹University of Adelaide Department of Paediatrics, Women's and Children's Hospital and ²South Australian Government Department, Education Training and Employment, Division of Health Care Management Women's and Children's Hospital, North Adelaide, South Australia, Australia

Objectives: To determine the prevalence of parent reported allergy and anaphylaxis in a sample of children and to investigate the first aid management of anaphylaxis in the schools and preschools that these children attend.

Methods: The study sample comprised 4173 South Australian children aged 3–17 years. Information was collected regarding parent-reported allergy and anaphylaxis. All children with known anaphylaxis were contacted and an attempt was made to contact those with reports of allergy to ascertain if these children had anaphylaxis. A telephone questionnaire was used to verify reports of anaphylaxis and determine the cause, severity and school first aid management of anaphylaxis.

Results: The rate of parent reported allergy and anaphylaxis was 7.3 and 0.59 per 100 children, respectively. Two-thirds of children with anaphylaxis did not have emergency medication available at school, an emergency action plan, or a teacher on site able to administer adrenaline for first aid use.

Conclusions: Children attending preschool or school may have had a past history of anaphylaxis. Arrangements for first aid management of these children while in this environment are often inadequate.

Key words: allergy; anaphylaxis; management; prevalence.

Anaphylaxis is the most severe form of acute allergy and is thought to affect 1–2% of the population.¹ In children the vast majority of anaphylactic reactions are triggered by exposure to insect venom (bee, wasp or jumper ant venom) or food proteins (cows milk, egg, nuts, fish and shellfish). In a small number of children the triggers may be multifactorial or unidentified.² Although childhood morbidity from anaphylaxis, including hospital admission, is not uncommon, mortality from anaphylaxis is rare. In Australia during a 22-year period there have been 25 deaths shortly after a bee sting, giving a mortality rate of 0.086/1 000 000 population per year.³ Five of these deaths occurred in children less than 5 years of age. The childhood mortality from food anaphylaxis in Australia is not known.

A recently completed retrospective review of Australian children with a history of anaphylaxis indicated that recurrent anaphylactic reactions occur with a frequency of 0.4 episodes per child per year and that 17% of these episodes occur at preschool or school (M Gold, 1998 pers. comm.). In addition, case studies have indicated that deaths in childhood due to food anaphylaxis have certain features in common. In the United States of America most reactions occur away from home and at school, there is a delay in administration of injectable adrenaline due to lack of recognition of the severity of the situation and there is usually a history of a previous reaction to the ingested allergen with coexisting asthma and/or other atopic

conditions.^{4–7} The relevance of these findings in the United States of America to the Australian preschool and school situation has not been studied.

Children at increased risk of anaphylaxis need to be clearly identified at the time of enrolment at child care. School staff need to be made aware of the trigger(s) for each child so that inadvertent exposure can be avoided.^{8–10} They require knowledge of the early signs and symptoms of anaphylaxis, and an appropriate first aid action plan should be in place.^{9,10} If adrenaline must be administered by school staff as part of this plan, additional training and consent procedures may be required.^{8,9} The attitudes of school personnel also become of paramount importance.⁸ The greatest risk of mortality occurs in children at school and child care centres with staff who have had little or no education in the management of such situations and who are unwilling or unable to administer adrenaline.^{8–11}

In 1996 the Department of Education, Training and Employment (DETE) of South Australia and the Allergy Service of the Women's and Children's Hospital, Adelaide, sought to establish policy and a training programme to prevent, recognize, and initiate first aid management for children with anaphylaxis. The initial aim of this programme was to document the prevalence rates of parent reported allergy (PRA) and anaphylaxis in children attending child care and school centres in South Australia. For those children with a history of anaphylaxis, additional information was sought to document the first aid management of anaphylaxis by school staff.

METHODS

The South Australian DETE provides an administrative structure for a total of 1050 preschools, schools, and child-care centres. Approximately 180 157 children or 75% of the total

Correspondence: Dr CA Boros, McLeod Clinical Research Fellow, c/o University of Adelaide Department of Paediatrics, Women's and Children's Hospital, 72 King William Road, North Adelaide 5006, South Australia, Australia. Fax: (08) 8204 7031; email: tboros@medicine.adelaide.edu.au

CA Boros, FRACP, Clinical Research Fellow. D Kay, BEd, Grad Dip Lang & Lit. MS Gold, FRACP, MD,

Accepted for publication 16 August 1999.

population of children between 3 and 17 years of age in South Australia are enrolled at these sites. Fifty-five school sites (primary and secondary) were eligible for inclusion in the study, as they were part of an ongoing health-care management project. The aim of the project was to develop clear guidelines regarding the roles and responsibilities of DETE staff regarding the daily and emergency management of asthma, epilepsy, diabetes and anaphylaxis. School sites were selected in order to form a representative sample of the school population regarding social strata, size, location, proximity to health-care services, and the ethnic mix. Four hundred and nine preschool sites were eligible for study and were randomly selected from a DETE computerized list which was arranged in alphabetical order. Every second preschool on the list was selected, with the exception of three sites, where it was known that the primary or secondary school at the same site had been asked to participate. Invitations to participate were initiated in writing, with a follow-up telephone call to principals/directors/school support officers (SSO) at each site to explain the purposes of the study and requirements for participation.

School support officers and principals were asked to compile a list of children at their site suspected of having allergy and/or anaphylaxis on the basis of information contained in school health records. The information contained in school health records is compiled from a standardized form sent to parents at the beginning of each academic year. At most sites, this information is transcribed onto a computerized database. The form asks parents to document any 'relevant medical condition' and list details of symptoms and treatment. For the purpose of the study, PRA was defined as the report by a parent of the child having an 'allergy' to insect venom, food, medication or any other trigger listed by the parent. Reports of hay-fever, asthma, or eczema were excluded. Suspected anaphylaxis was defined as a report by a parent of a past history of anaphylaxis and/or when a parent indicated a serious allergic reaction which required an emergency first aid response by school staff.

A standardized consent form was then sent by principals/SSO to the parents of all children with PRA and suspected anaphylaxis. This ensured confidentiality for those parents who did not wish to participate in the study. The consent form requested the participation of the parent in a telephone questionnaire regarding their child's allergy or suspected anaphylaxis. Those parents who agreed to participate in the study were asked to provide their child's full name, telephone contact details and the cause(s) of their child's allergy. These forms were returned to the school and then forwarded by the SSO to the investigators.

Telephone questionnaires were standardized and performed by the principal investigator in all cases using open-ended questions. The questionnaire aimed to differentiate anaphylaxis from non-anaphylactic allergic reactions or other non-allergic reactions. On the basis of the questionnaire it was then determined if the child's reaction met the clinical criteria for anaphylaxis. Anaphylaxis was defined as a rapidly evolving generalized allergic reaction resulting in multisystem involvement with symptoms of airway tract obstruction (wheezing, stridor), skin rash (urticaria, angioedema), gastrointestinal involvement (nausea, vomiting, abdominal pain, diarrhoea), and cardiovascular involvement (loss of consciousness).¹⁰

If the clinical criteria for anaphylaxis were met, and the child had experienced more than one anaphylactic reaction, the telephone questionnaire was directed at eliciting signs and symptoms regarding the worst reaction. Further information

was then obtained from all parents of children with anaphylaxis regarding the triggers, previous management, and whether an emergency action plan existed. The details of the action plan were then elicited, whether medication for emergency use had been prescribed, whether it was available within the child care centre or school and whether or not school staff were willing and able to administer the medication. Parents were also asked if their child had a history of asthma. Asthma was defined as a wheezing illness in a child 12 months of age or older responding to inhaled bronchodilator therapy.

The study was approved by the Women's and Children's Hospital Research Ethics Committee and was performed with the full participation of the DETE.

RESULTS

Of the 55 eligible school and 409 preschool sites seven and 35, respectively, participated in the final sample providing a study group of 4173 children. The 374 non-participating preschool sites and 48 non-participating school sites were excluded because the principal/director at the site declined the offer to participate in the study. The final study sample represented 2% of the total population of children enrolled at DETE sites and included 2211 preschool (age 3–5 years) and 1962 school children (ages 5–17 years).

Principals and SSO identified 259 children (7.3%) whose parents reported them to have at least one allergic trigger (Table 1). The most common allergic trigger reported by parents was insect venom ($n = 110$), followed by antibiotics ($n = 103$), food ($n = 55$) and then a group of miscellaneous triggers ($n = 36$). In 38 cases, parents reported multiple allergic triggers for their child.

Twenty-four children were suspected of having a past history of anaphylaxis because of information supplied by parents. The parents of these children were contacted following consent procedures and the telephone questionnaire confirmed that each case fulfilled the study definition for anaphylaxis. Consent forms were also sent to the parents of the remaining 235 children in whom an allergy was reported. Only 94 parents (36%) responded, with all but two willing to participate in the telephone questionnaire. Therefore, 92 parents undertook the telephone questionnaire. One child with a past history of anaphylaxis, for which the school had a record of PRA only, was identified. Hence, 25 children with a past history of anaphylaxis, according to the study definition, were identified. The overall prevalence of anaphylaxis in the study sample was 0.6% with food anaphylaxis being more common than insect venom anaphylaxis (Table 2). Anaphylaxis was more prevalent in preschool than school children with food being the major trigger in preschools and insect venom in schools (Table 2).

For the children with anaphylaxis, the median time interval between the presenting episode and the questionnaire was 3 years (range 0.25–9.08 years). In most children with anaphylaxis, their worst reaction was their presenting episode (22/25). This reaction had occurred at home in 23 children and at school in two children. Nineteen of these children were preschool children less than 4 years of age who spent most of their time at home. Almost all children with food anaphylaxis had their initial reaction before 3.5 years of age and almost all those with insect venom anaphylaxis experienced their first reaction at or after 4 years of age. Twenty of the 25 children received emergency medical treatment, and 14 required hospitalization. Three

Table 1 Specified triggers in 304 parental reports of allergy and anaphylaxis

Trigger	Allergic triggers	Anaphylactic triggers
Insect venom:		
Bee	83	8
Mosquito bites	12	
Ant bites	12	
Wasp venom	1	
Spider bites	1	
Undefined	1	1
Sub-total	110 (36%)	9 (3%)
Antibiotics:		
Penicillin/penicillin derivatives	78	1
Non-penicillin	22	1
Unspecified	3	
Sub-total	103 (34%)	2 (0.7%)
Food:		
Peanuts and other nuts	16	10
Fruit and vegetables	13	2
Eggs	7	2
Cows milk	7	2
Miscellaneous	6	1
Food chemicals (natural, colours and preservatives)	6	1
Sub-total	55 (18%)	18 (5.9%)
Miscellaneous:		
Unknown	8	1
Cat/animal fur	7	
Vaccine related	5	
Elastoplast	4	
UV sunscreen	3	
Medication	3	
Grass	3	
Flyspray	1	
Soap	1	
Sugar	1	
Sub-total	36 (12%)	1 (0.3%)
Total	304*	30 [‡]

*No. of children identified by parents with allergy = 259. *No. of children with > 1 allergic trigger = 38 (i.e. 2 or 3 triggers). [‡]No. of children with > 1 anaphylactic trigger = 6.

children received adrenaline prior to seeking medical attention as this was not their first reaction, and adrenaline had been prescribed by a paediatric allergist. Two children improved without any intervention before attending hospital and all recovered completely. In the 14 children with food anaphylaxis, six had reactions to more than one food allergen. Nuts were the most common anaphylactic trigger causing a reaction in nine children. Eight of nine children with anaphylaxis triggered by insect venom had experienced reactions to bee venom.

Of the 25 children with anaphylaxis only nine (36%) had been prescribed adrenaline for first aid use which was also available at school and could be administered by a member of the school staff (Table 3). Most children (17/25) had a written emergency first aid action plan in place for events occurring at preschool or school but only 10 of these children had adrenaline available at school either in injectable (EPIPEN, CSL Ltd, Parkville, Melbourne, Australia) or inhaled (EPIHALER, 3M Pharmaceuticals, Thornleigh, Australia) form. Only nine children had a medic-alert bracelet and wore this on a regular basis. Seventeen of the 25 children (68%) with anaphylaxis had a history of asthma unrelated to the anaphylactic event.

Table 2 Number and rate per 100 preschool ($n = 2211$) and school ($n = 1962$) children with anaphylaxis in South Australian schools

	Preschool Number $n = 2211$	School $n = 1962$	Preschool and School $n = 4173$
Insect venom:			
Bee	1	7	8
Undefined	1	1	2
Sub-total	2 (0.91)	8 (0.41)	10 (0.25)
Food:			
Cows milk	2	0	2
Egg	3	0	3
Nuts	8	0	8
Other	0	1	1
Sub-total	13 (0.59)	1 (0.51)	14 (0.32)
Antibiotic:			
Sub-total	0	1 (0.51)	14 (0.23)
Total	15 (0.68)	10 (0.51)	25 (0.60)

Table 3 Anaphylaxis management in schools and preschools

Anaphylaxis trigger	1. Formulated action plan at school	2. Medication available at school	3. Teacher able to administer medication	All three requirements met	Median age of children
Insect venom $n = 9$	7	7	4	3	4 years (8 months–8 years)
Food $n = 14$	9	9	9	6	1 year 2 months (5 months–10 years)
Antibiotics $n = 2$	1	1	0	0	1 child 10 months 1 child 12 months
Total $n = 25$	17 (68%)	17 (68%)	13 (52%)	9 (36%)	1 year 4 months (5 months–10 years)

DISCUSSION

This is the first study performed in Australian preschool and school children which has documented the prevalence of parent reported allergy and anaphylaxis and the first aid management plan for those with anaphylaxis. The parents of one in 17 children, at the time of enrolment, reported to schools that their children had an allergy to a specific trigger. It is likely that only a minority of these reactions are a manifestation of allergy but it was beyond the capacity of this study to ascertain the true nature of these reactions. The most commonly reported trigger was bee venom followed by antibiotics and food.

Twenty-five children in this study sample were identified as having had an anaphylactic reaction according to the defined criteria. The results of this study represent a minimal estimate of anaphylaxis in school and preschool children and do not represent the overall prevalence of anaphylaxis for children of all ages. It is possible that more children with a history of anaphylaxis will be identified in the study population. First, the parents of some children with anaphylaxis may not have provided any details regarding an allergic reaction or anaphylaxis at the time of school enrolment. Second, they may have indicated that the child had had an allergic reaction but then failed to return a consent form. Of the 259 parents reporting an allergy only 36% of parents could be contacted, but of the 92 parents who could be contacted, the telephone questionnaire identified only one child with anaphylaxis whose school medical records contained no information regarding this condition. The remaining 91 children had not had anaphylactic reactions despite parental reports of allergy. This suggests that parents readily report suspected allergic triggers and that few of these children have had previous anaphylactic reactions. Nevertheless, further studies are required to define the exact prevalence of anaphylaxis in children of all ages.

The prevalence of food anaphylaxis in children is poorly documented. Previous studies have documented wide-ranging prevalence rates of food allergy in the paediatric population, ranging from 2 to 27% in children under 3 years of age.^{12–15} This is most likely due to varying definitions of food allergy and the difficulty in confirming parental reports of food allergy using challenge studies.^{16–18} In this study the prevalence of food anaphylaxis was higher in preschool than school children and the overall prevalence was higher than that to insect venom. As expected food anaphylaxis is primarily a condition of young children and has a tendency to resolve with increasing age.¹⁹ The findings support the poorly documented but widely held belief that anaphylaxis to food in children is more common than that to insect venom. This finding would have been more striking had the study included children less than 3 years of age. Nuts were the major food trigger in preschool children. This has implications for the prevention of anaphylaxis in preschool centres with regard to food policy. No school children were detected with nut anaphylaxis. Nut allergy is thought to be lifelong, but recent studies have documented development of tolerance which may account for these findings.²⁰

Unlike food anaphylaxis the prevalence of anaphylaxis to insect venom has been documented in a childhood population. The reported rate of anaphylaxis to bee venom in girl and boy scouts is 0.15% and 0.3%, respectively.^{21,22} This is consistent with the rate of 0.36% for school age children in this study. Antibiotics accounted for the second most commonly reported allergic trigger but were the least common cause of anaphylaxis.

Antibiotic anaphylaxis is uncommon in children but skin rash associated with antibiotic use, usually in early infancy, is common.²³ Recent studies have shown that skin rash in this context is likely to be due to the underlying viral infection rather than a manifestation of antibiotic allergy.²⁴

The findings of this study have important implications for both educational and health-care providers. A history of anaphylaxis is common, with an estimated 1063 children currently enrolled in South Australian preschools and schools. School staff should have a duty of care to administer first aid to any child who becomes acutely unwell at school and is at risk of subsequent morbidity or mortality. Children with a past history of anaphylaxis, may and often do, require first aid at school but considerable problems arise because of the lack of health-care policy, staff support and training and the process required to implement first aid procedures in the school setting.^{25,26}

The first step in attending to the first aid needs of these children is to identify the children at the time of enrolment. One in 17 children in this study were reported to have an allergy by their parents but only 1 in 166 children were identified with anaphylaxis. The school health questionnaire in use at the time of the study seems to have identified the majority of children who had experienced an anaphylactic reaction. Details were recorded, however, for a large number of children who had had an adverse reaction to a number of triggers most of whom were not at great risk of anaphylaxis. The ideal school and preschool health questionnaire should primarily identify all children who have had previous anaphylactic reactions and these should be clearly differentiated from those who have experienced adverse reactions to a variety of triggers.

Once identified the next important step is to ensure that school and preschool staff are able to prevent, and recognize anaphylaxis and commence first aid management in children affected while at school. In this study, only nine out of 25 children identified with a history of severe anaphylaxis had adrenaline available at school, a formalized action plan in place to manage an emergency situation, and a trained school staff member who was willing and able to administer adrenaline using an EPIPEN (CSL Ltd, Parkville). In only half of the cases were school staff able to administer adrenaline. This may place the remainder at added risk of morbidity and even mortality with subsequent anaphylactic reactions at school.

As a result of this study the prevention, recognition and management of anaphylaxis in South Australian schools has changed fundamentally. These changes aim to prevent inadvertent episodes of anaphylaxis from occurring at school, and to ensure that those that do occur are recognized early and managed using the health-care plan.

ACKNOWLEDGEMENTS

This study was funded by the University of Adelaide Department of Paediatrics at the Women's and Children's Hospital, in North Adelaide, South Australia and the South Australian Government Department of Education, Training and Employment.

REFERENCES

- 1 Position Statement. The use of epinephrine in the treatment of anaphylaxis. *J. Allergy Clin. Immunol.* 1994; **94**: 666–8.

- 2 Wiggins CA, Dykewicz MS, Paterson R. Idiopathic anaphylaxis: a review. *Ann. Allergy* 1989; **62**: 1–3.
- 3 Harvey P, Sperber S, Kette F, Heddle RJ, Roberts-Thomson PJ. Bee-sting mortality in Australia. *MJA* 1984; **140**: 209–11.
- 4 Sampson H, Mendelson L, Rosen J. Fatal and near-fatal anaphylactic reactions to foods in children and adolescents. *NEJM* 1992; **327**: 380–4.
- 5 Yunginger JW, Sweeney KG, Sturmer WQ et al. Fatal food-induced anaphylaxis. *JAMA* 1988; **260**: 1450–2.
- 6 Position Statement of the Canadian Paediatric Society. Fatal anaphylactic reactions to food in children. *Can. Med. Assoc. J.* 1994; **150**: 337–9.
- 7 Yunginger JW. Lethal food allergy in children. *NEJM* 1992; **327**: 421–2.
- 8 Hay GH, Harper TB, Courson FH. Preparing school personnel to assist students with life-threatening food allergies. *J. School Health* 1994; **64**: 119–21.
- 9 Wynn SR, Frazier CA, Munoz-Furlong A, Ostrom NK, Sampson HA, Yunginger JW. Anaphylaxis at school: Etiologic factors, prevalence, and treatment (Letter). *Pediatrics* 1993; **91**: 516.
- 10 American Academy of Paediatrics, Committee on school health. Guidelines for urgent care in school. *Pediatrics* 1990; **86**: 999–1000.
- 11 Position statement. American Academy of Allergy, Asthma and Immunology. Anaphylaxis in schools and other child-care settings. *J. All. Clin. Immunol.* 1998; **102**: 173–6.
- 12 Nicklas RA, Bernstein IL, Li JT et al. The diagnosis and management of anaphylaxis. *J. All. Clin. Immunol.* 1998; **101**(Suppl.): S481.
- 13 Sampson HA, Burks AW. Mechanisms of food allergy. *Annu. Rev. Nutr.* 1996; **16**: 161–77.
- 14 Bock SA. Prospective appraisal of complaints of adverse reactions to foods in children in the first 3 years of life. *Pediatrics* 1987; **79**: 683–8.
- 15 Chandra RK. Food hypersensitivity and allergic disease: a selective review. *Am. J. Clin. Nutr.* 1997; **66**: S526–9.
- 16 Kajosaari M. Food allergy in Finnish children aged 1–6 years. *Acta Paediatr. Scand.* 1982; **71**: 815–9.
- 17 Sampson HA. Food Allergy. *JAMA* 1997; **278**: 188–94.
- 18 Polanco I. Current status of digestive intolerance to food protein. *J. Pediatr.* 1992; **121**: S108–S110.
- 19 Burks WA, Sampson, H. Food Allergies in Children. *Curr. Probl. Pediatr.* 1993; **23**: 230–52.
- 20 Hourihane J O'B, Roberts SA, Warner JO. Resolution of peanut allergy: case-control study. *BMJ* 1998; **316**: 1271–5.
- 21 Settiple GA, Boyd GK. Prevalence of bee sting allergy in 4992 boy scouts. *Acta Allergol.* 1970; **25**: 286–91.
- 22 Abrishami MA, Boyd GK, Settiple GA. Prevalence of bee sting allergy in 2010 girl scouts. *Acta Allergol.* 1971; **26**: 117–20.
- 23 Rieder MJ. Mechanism of unpredictable adverse drug reactions. *Drug Safety* 1994; **11**: 196–212.
- 24 Mortureaux P, Leaute-Labreze C, Legrain-Liferman V, Lamireau T, Sarlangue J, Taieb A. Acute urticaria in infancy and early childhood. *Arch. Dermatol.* 1998; **134**: 319–23.
- 25 Bannon MJ, Ross EM. Administration of medicines in school: who is responsible? *BMJ* 1998; **316**: 1591–3.
- 26 Vickers DW, Maynard L, Ewan PW. Management of children with potential anaphylactic reactions in the community: a training package and proposal for good practice. *Clin. Exp. Allergy* 1997; **27**: 898–903.