

Physician training programs significantly improve diagnosis in cases coded as anaphylaxis over time: A major factor compounding time-trend data?



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Clinical Implications

- Allergy training programs have improved physician recognition and correct coding of anaphylaxis. This may be a confounding factor in studies relying on coding data to assess time trends in anaphylaxis presentation.

TO THE EDITOR:

Recent studies based on hospital admissions have reported a significant increase in anaphylaxis prevalence. These studies rely on accurate diagnosis and coding data from medical records, which has been identified as a potential shortcoming.¹⁻³ The aim of this study was to investigate the extent of anaphylaxis miscoding, how this changed after intensified training programs and new anaphylaxis guidelines, and whether this contributed to apparent changes in prevalence over a 10-year period. This also provided an opportunity to examine changes in characteristics of the presenting cases (age and triggers) over time.

We conducted a detailed retrospective chart examination of all cases coded as anaphylaxis presenting to the main tertiary Pediatric Emergency Department (PED) in Perth, Australia, where all coding is performed by medical staff. We compared data from 2003-2004 (period 1), when *International Classification of Diseases, Tenth Revision* codes commenced, with data from 2012 (period 2), after intensified training programs and new anaphylaxis guidelines were introduced. All cases (aged 0-16 years) coded as anaphylaxis were independently reviewed by 2 specialist allergists/clinical immunologists. We used criteria from the 2006 Second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium for the definition and management of anaphylaxis.⁴ Information was collected on standardized forms. This yielded 136 cases from period 1 (from a total of 83,832 presentations to the PED for 2003-2004) and 177 cases from period 2 (from a total of 71,822 presentations for 2012).

There were significantly more coding errors in 2003-2004 (44 of 136; 32%) than in 2012 (18 of 177; 10%). Most miscoded cases (62%) presented with urticaria and angioedema in the absence of cardiovascular or respiratory symptoms, indicating that this combination is most subject to misclassification.

A diagnosis of anaphylaxis was verified in 92 of 136 (68%) cases in 2003-2004 and 159 of 177 (90%) cases in 2012, indicating a 2-fold increase in presentations with anaphylaxis

($P < .001$). An increase in food allergy was the main contributing factor ($P < .001$), largely from tree-nut allergies (Table I).

There were consistent trends for increases in verified anaphylaxis in all age groups (Figure 1; Table I), most evident in infants (birth to age 2 years) who had a 3.6-fold increase ($P < .001$).

Subanalysis of this group suggested that infants aged between 12 and 24 months showed the largest increase for PED presentations with anaphylaxis (0.54/1000 in 2003 compared with 2.69/1000 in 2012), indicating a 5-fold increase.

We also examined for potential underdiagnosis of anaphylaxis analyzing 400 randomly selected cases of emergency department presentations attributed to conditions with an associated diagnosis.

We manually reviewed 150 randomly selected cases coded for "urticaria and angioedema" and 50 cases coded for "wheezing and asthma" in each time period. Of these cases of various allergic manifestations, anaphylaxis was underdiagnosed in 8.5% (17 of 200) in 2003-2004 compared with 7.5% (15 of 200) in 2012. All cases of underdiagnosis were found in the group coded for "urticaria and angioedema." To estimate the rate and impact of underdiagnosis for anaphylaxis, we performed further analysis on the basis of cases coded for "urticaria and angioedema" (total of $n = 487$ in 2003-2004 and $n = 406$ in 2012, as we found missed diagnosis of anaphylaxis only in this subgroup). On the basis of the estimate of total anaphylaxis cases for both time periods, we found an underdiagnosis rate of 37% (63% correctly diagnosed) in 2003-2004 and 20% (80% correctly diagnosed) in 2012.

To our knowledge, this is the first study to examine changing patterns of emergency presentations of pediatric anaphylaxis in the context of coding errors. Furthermore, we examined emergency presentations rather than hospital admissions because not all children who present to PED with anaphylaxis require admission. Our data reveal changing time trends in the appropriateness of coding (improving from 68% to 90% in all cases coded as anaphylaxis), which significantly underestimates the true increase in cases correctly coded as anaphylaxis over the period of study.

We cannot exclude that more accurate coding was also partly caused by improved documentation rather than true improvement in diagnosis ability, especially as teaching about detailed documentation of anaphylaxis symptoms is entailed in our training program.

It is possible that other studies that have relied entirely on coded hospital admissions or emergency presentations may have incorrectly estimated the time trends in anaphylaxis or been confounded by coding errors in other ways because there have been changes in the training and awareness of medical staff. Additional inaccuracies are likely to have been introduced in centers where hospital coding was performed by administrative staff.

Coding errors (such as overdiagnosis of anaphylaxis) have obvious implications for patients, families, and the health care system. Consequences include anxiety/stress in the family, overprescription of adrenaline autoinjectors, and impact on subsequent referrals and future management decisions by other

TABLE 1. Demographic characteristics, suspected triggers, adrenaline autoinjector prescription, arrangement of immunology follow-up, and age group distribution of children presenting to the PED with anaphylaxis

	ED cases		P value
	2003-2004	2012	
ED cases	83,832	71,822	
Initial cases, n	136	177	
True cases, n	92	159	
Proportion correctly identified	67.6%	89.8%	
Patient characteristics of true cases			
	2003-2004	2012	P value
Sex, n (%)			
Male	69 (75.0)	111 (69.8)	.379
Female	23 (25.0)	48 (30.2)	
Age (y), mean $\pm$ SD	6.6 $\pm$ 4.2	5.8 $\pm$ 4.4	.182
Presentations with true anaphylaxis by age, n (%)			
<2 y	15 (16.3)	44 (27.7)	.253
2-<6 y	30 (32.6)	47 (29.6)	
6-<10 y	25 (27.2)	35 (22.0)	
10-<13 y	15 (16.3)	18 (11.3)	
14-<16 y	7 (7.6)	15 (9.4)	
Trigger, n (%)			
Food	46 (50.0)	114 (71.7)	<.001
Drug	3 (3.3)	4 (2.5)	
Insect	26 (28.2)	14 (8.2)	
Other	3 (3.3)	4 (2.5)	
Unknown	14 (15.2)	24 (15.1)	
Food trigger, n (%)			
Peanut	14 (30.4)	33 (29.0)	
Tree nut	9 (19.6)	26 (31.6)	
Egg	10 (21.7)	17 (14.9)	.255
Cow milk	6 (13.0)	5 (4.4)	
Fish and other seafood	1 (2.2)	5 (4.4)	
Other	6 (13.0)	18 (15.8)	
Adrenaline autoinjector prescription, n (%)	53 (57.6)	133 (83.6)	<.001
Arrangement of specialist follow-up, n (%)	81 (88)	158 (99.4)	<.001
Rates of true cases			
	2003-2004	2012 (fold increase from 2003-04)	P value
In ED (per 1000)	1.10	2.21 (2.0)	<.001
0-<2 y	0.54	1.91 (3.6)	<.001
2-<6 y	1.16	2.09 (1.8)	.011
6-<10 y	1.89	3.05 (1.6)	.065
10-<13 y	1.66	2.41 (1.4)	.278
14-<16 y	0.89	2.02 (2.3)	.068

ED, Emergency department.

nonspecialist physicians. This may also lead to misinterpretation of symptoms on further occasions, and inappropriate advice for schools and other community carers. This highlights the importance of follow-up assessment by services specialized

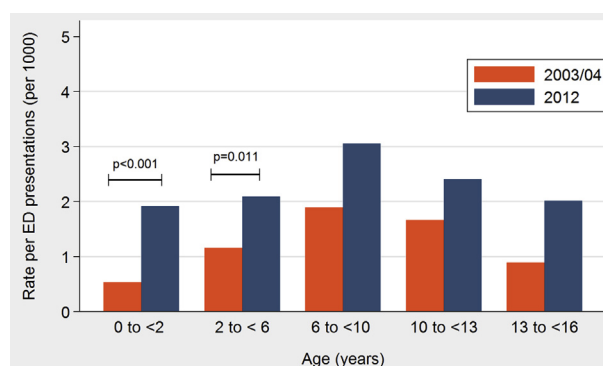


FIGURE 1. Increasing trend in verified anaphylaxis PED presentations in all age groups comparing the years 2003-2004 and 2012. The increase was most evident in infants (birth to age 2 years). ED, Emergency department.

in allergy assessment^{5,6} and the benefits of training nonspecialist physicians^{6,7} in the face of increasing service burden of allergic disease. Our investigation reveals a clear improvement in diagnosis and subsequent interim advice and management (Table 1), reflecting the benefits of more comprehensive anaphylaxis guidelines accessible online, and compulsory PED training and teaching sessions on anaphylaxis delivered by pediatric allergists.

Consistent with a recently published Australian study,¹ our data have shown a significant increase in cases coded as anaphylaxis when comparing 2003-2004 and 2012 (Table 1; Figure 1). We cannot exclude that the incidence and increase in anaphylaxis may have been different considering the potential underdiagnosis of anaphylaxis in children coded for associated diagnoses. Previous publications have shown a substantial rate of underdiagnosis of anaphylaxis in the group coded for various allergic manifestations.^{8,9}

We found an underdiagnosis of anaphylaxis in 17 of 200 (8.5%) cases in 2003-2004 and 15 of 200 (7.5%) cases in 2012 in the group coded for various allergic manifestations. Cases of missed anaphylaxis (underdiagnosis) were exclusively found in the group coded for "urticaria and angioedema." On the basis of the estimate of total anaphylaxis cases for both time periods, we found an estimated underdiagnosis of 37% (63% correctly diagnosed) in 2003-2004 and 20% (80% correctly diagnosed) in 2012. We cannot exclude that the estimated total rate of missed anaphylaxis cases would have been higher if more asthma/wheezing cases were included in our manual review.

Although these data are derived from a random sample, they nonetheless indicate that underdiagnosis of anaphylaxis is important and needs to be considered in analyzing anaphylaxis data. Comparing the years 2003-2004 and 2012, it also appears that the rate of missed diagnosis and accurate coding improved. This may be due to changing circumstantial factors (eg, improved training programs and guidelines). There is an urgent need to evaluate the true impact of underdiagnosis of anaphylaxis (*International Classification of Diseases, Tenth Revision* codes) on time trend data and how this may have changed due to circumstantial factors in the future in well-designed studies.

Consistent with recent studies based on hospital admissions,^{1,2} our analysis on verified anaphylaxis PED presentations

confirms an increase in food-related anaphylaxis across all age groups, most evident in infants, who had a 3.6-fold increase ($P < .001$). This highlights the pressing need to recognize and manage anaphylaxis in this young age group. More importantly, it stresses the need to understand the underlying causes, and develop early interventions that can modify the natural history of disease or prevent it in the first place.

In summary, accurate diagnosis and coding of anaphylaxis is crucial for the evaluation of epidemiological trends, adequate education/guidance of primary care takers, and reduction of costs in the health care system. This could be achieved by improving collaborations between pediatric allergists and emergency physicians, reinforcing guidelines and training programs.

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