REUE | Original Article

Differences in the management of childhood asthma attacks between emergency departments and over time

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BACKGROUND AND OBJECTIVES. Asthma exacerbations are the most common emergencies seen in pediatric emergency departments (PEDs). Recommendations in international guidelines give the basis for treating these exacerbations, but there is no consensus about some treatments because of lack of evidence. We designed a questionnaire to survey the management practices used in Spanish PEDs and identify differences between them. A secondary aim was to compare these practices with those reported during a survey distributed in 2012.

MATERIAL AND METHODS. A 20-item questionnaire on the management of childhood asthma was designed and sent to members of the Spanish Society of Pediatric Emergencies (SEUP). The responses were compared with those collected by the same research group 10 years earlier.

RESULTS. A total of 269 responses were received from 72 hospitals in 16 Spanish autonomous communities. More than 90% of the respondents surveyed use the Pulmonary Score for the initial evaluation, and the treatment of mild to moderate exacerbations with metered dose bronchodilators is now widespread (95% of respondents). Likewise, spacers are now used by the vast majority (99.3%). Nebulized bronchodilators are administered by 52% of the respondents for severe exacerbations. A majority (69%) use a weight-based rule (weight/3) to calculate the number of puffs of salbutamol to administer. Protocols for administering ipratropium bromide are highly diverse. Prednisolone is the oral corticosteroid most widely used (68.5%), followed by dexamethasone (30%). The second-line treatment used most often is magnesium sulfate (91.8%), followed by high-flow oxygen therapy (58.7%). Notable changes since the earlier survey include significantly greater use of the Pulmonary Score for evaluation (91.1% vs 43%; $P < .01$), use of metered dose inhalers to administer bronchodilators in moderate exacerbations (95.2% vs 40.7% in ; $P = .02$) and severe exacerbations (48% vs 2.7% ; $P < .01$), and administration of magnesium sulfate (91% vs 12%).

CONCLUSION. We detected differences between PEDs with respect to the doses and forms of administering bronchodilators, the usual choices of oral corticosteroids, second-line treatments, and regimens prescribed for home management.

Keywords: Asthma exacerbation. Asthma. Corticosteroids. Pediatrics.

Divergencias sobre manejo de la crisis asmática en niños en urgencias

INTRODUCCIÓN. Las exacerbaciones asmáticas suponen la urgencia médica más frecuente en los servicios de urgencias pediátricos. El tratamiento de las crisis asmáticas en los niños se basa en recomendaciones de guías internacionales. Sobre algunos aspectos del tratamiento no existe consenso por falta de evidencia. El objtivo de este trabajo es conocer las prácticas utilizadas en el manejo de las exacerbaciones asmáticas en las urgencias pediátricas españolas e identificar las divergencias.

MATERIAL Y MÉTODOS. Se diseñó una encuesta de 20 preguntas sobre el manejo de la exacerbación asmática en niños y se difundió a los miembros de Sociedad Española de Urgencias Pediátricas. Los resultados se compararon con los obtenidos en una encuesta del mismo grupo realizada en 2012.

RESULTADOS. Se obtuvieron 269 respuestas de 72 hospitales y 16 Comunidades Autónomas. Más del 90% de los encuestados utilizaba el *Pulmonary Score* (PS) para la evaluación inicial. En las crisis leves y moderadas la administración de broncodilatadores con inhalador de dosis múltiple (MDI) se ha vuelto una práctica generalizada (95% de encuestados), así como tener cámaras propias en los servicios de urgencias (99,3%). En las crisis graves un 52% administraba los broncodilatadores nebulizados. Para el cálculo del número de pulsaciones a administrar en cada dosis de salbutamol la regla más utilizada fue el peso/3 (69%). El bromuro de ipratropio se usaba con pautas muy heterogéneas. El corticoide oral más utilizado es la prednisolona oral (68,5%) seguido de la dexametosona (30%). El tratamiento de segunda línea más utilizado en urgencias fue el sulfato de magnesio (91,8%) seguido por la oxigenoterapia de alto flujo (58,7%). Comparando los resultados con la encuesta de 2012 aumentaron de forma significativa el uso del *PS*

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(43% *vs* 91,1%, p < 0,01), el uso de MDI para la administración de broncodilatadores en las crisis moderadas (40,7% *vs* 95,2%, p = 0,02) y graves (2,7% *vs* 48%, p < 0,01) y el uso de sulfato de magnesio en urgencias (12% *vs* 91%), p < 0,01.

CONCLUSIONES. En el tratamiento de las exacerbaciones asmáticas en urgencias en niños existen divergencias en las dosis y forma de administración de broncodilatadores, el corticoide oral utilizado, el tratamiento de segunda línea y el tratamiento pautado al alta a domicilio.

Palabras clave: Crisis asmática. Asma. Encuesta. Corticoides. Pediatría.

Introduction

Asthma exacerbations (AEs) account for 5–10% of medical emergencies in pediatric emergency departments (PEDs).[1] Although international asthma guidelines provide high-level evidence recommendations for the management of AEs in children, several controversial aspects remain—such as the oxygen saturation threshold for initiating oxygen therapy, optimal salbutamol doses based on weight and severity, the number and duration of ipratropium bromide doses in severe crises and its indication in moderate ones, optimal doses of oral corticosteroids, and second-line therapies for children with severe asthma—for which clear recommendations are lacking due to the absence of high-quality studies.[2-5] A recent study reviewing 158 asthma management guidelines from different countries concluded that current recommendations for pediatric AE management have substantial deficiencies, with limitations in strength and quality due to a lack of "high-quality studies," particularly regarding severe or critical asthma treatment.[6] Various studies conducted in the United States, the United Kingdom, and Canada have found variability in AE management across emergency departments of different hospitals, regions, and even among providers within the same hospital.[7-9] In 2012, the Respiratory Pathology Working Group of the Spanish Society of Pediatric Emergency Medicine (GPR-SEUP) published a survey that found differences in AE management in children treated in emergency settings, including the use of initial assessment scales, administration of bronchodilators via metered-dose inhaler (MDI), bronchodilator doses, and the use of magnesium sulfate as a second-line therapy.[10]

Given the above, we designed this study with the primary endpoint of assessing the variability in routine practices for AE management in pediatric emergency departments and identifying the areas with the greatest divergence to establish future improvement measures.

As a secondary endpoint, we sought to compare the evolution of current practices with those reported in the 2012 survey conducted in the same population.

Material and methods

We conducted a survey was designed with questions on asthma management and treatment (Appendix 1). Using a Delphi methodology (an iterative and anonymous process with several phases: question design, response rounds, critique and revision, feedback, and consensus), the GPR-SEUP working group selected the 20 most relevant and/or significant questions out of the 50 initially proposed by all group members.

The anonymous online survey was distributed among SEUP physician members via several email rounds. Demographic data of participants were collected. Incomplete or incorrectly filled forms were excluded from the analysis. Results were compared for the questions that were also included in the 2012 survey by the same group. Data were analyzed using IBM SPSS Statistics v21. Student's t test was used to compare means for quantitative variables, and the chi-square test was used for categorical variable percentages between the 2012 and 2023 results, with $P < .05$ considered statistically significant.

Results

A total of 269 responses were obtained from 72 hospitals across 16 Spanish autonomous communities. Among respondents, 67.5% were attending physicians. Forty-nine percent worked exclusively in PEDs, and over half had more than 5 years of experience in emergency medicine (Table 1).

A total of 91.1% of respondents used the Pulmonary Score (PS) to assess severity at initial evaluation. Eighty-five percent had a specific protocol for severe or critical asthma cases. Capnography was used during initial evaluation by 21% of respondents (Table 2).

During initial management, 63% of respondents administered oxygen therapy when oxygen saturation (SpO_2) dropped < 92%; 16% did so < 93%; 14.5% < 94%; and 4.8% also considered the patient's age. Regarding bronchodilator administration via MDI and spacer, 99.3% of centers had their own inhalation chambers. More than 95% administered bronchodilators via MDI in mild and moderate crises (Table 2). In severe crises, 48% used MDI, and in children with critical asthma, only 8% used this method. To determine the number of salbutamol puffs per dose, the most widely used formula was patient's weight/3 (61% of respondents), followed by fixed-dose regimens based on weight (5 puffs for < 25–35 kg and 10 puffs for > 25–35 kg). Regarding ipratropium bromide, 49.2% of respondents administered it along with salbutamol during the three sets of bronchodilator doses given in the first hour; 40% used it in all sets administered in the PED, and 7% administered it only in odd-numbered sets (Table 2).

The most frequently used corticosteroid for asthma exacerbations was oral prednisolone (68.5%), followed by oral dexamethasone (31.5%), with variability in dosages (1–2 mg/kg of prednisolone and 0.3–0.6 mg/kg of dexamethasone) and maximum doses (40–60 mg of prednisolone and 10–16 mg of dexamethasone) (Table 2). A total of 8% administered inhaled corticosteroids during the crisis,

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Table 1. Demographic data of respondents

Autonomous Community of employment	n	Percentage
Catalonia	65	24.16
Basque Country	47	17.47
Canary Islands	35	13.01
Murcia	32	11.90
Madrid	25	9.29
Andalusia	10	3.72
Valencia	10	3.72
Castile and León	9	3.35
Asturias	8	2.97
Galicia	7	2.60
Balearic Islands	6	2.23
Navarre	5	1.86
Aragon	3	1.12
Castile-La Mancha	3	1.12
La Rioja	2	0.74
Extremadura	2	0.74
Total	**269**	**100**
Professional level		
Attending physician working exclusively in pediatric emergency care	100	37.2
Attending physician working in emergency and other departments	82	30.5
Resident	87	32.3
Years worked in emergency care		
< 5 years	121	46.8
5–10 years	58	20.4
11–20 years	57	20.1
> 20 years	33	12.3

Source: Authors' own data.

and 20% considered atopic features when prescribing corticosteroids for moderate exacerbations in children younger than 5 years.

The most frequently used second-line therapy was magnesium sulfate (91%), followed by high-flow oxygen therapy (58.7%) and continuous salbutamol nebulization (44.6%). None of the respondents used theophylline or IV salbutamol in the PED.

Differences were observed in the prescribed home dose of salbutamol at discharge: the most common regimen was 2–4 puffs (50.4%), while others adjusted by weight or severity (Table 2). The most frequent oral corticosteroid regimen prescribed for home use was prednisolone for 3 days (50%), while 25% adjusted the duration and dose according to severity (Table 3).

More than 50% of respondents (Table 2) initiated maintenance inhaled corticosteroids in the PED for patients with persistent asthma, and 36.3% used different scales to assess persistent asthma (Pediatric Asthma Control Tool, Mini Pediatric Asthma Control Tool, or institutional scales).

Seventy-seven percent of respondents used written educational materials, most commonly those developed by SEUP.

When compared with the 2012 survey, there was a significant increase in the use of the PS—from 43.3% to 91.1% ($P < .01$)—as the initial severity assessment scale. Similarly, there was a significant rise in the use of MDI for bronchodilator administration in moderate crises—from 40.7% to 95.2% ($P = .02$)—and in severe crises—from 2.7% to 48% ($P < .01$). There was also a significant increase in the use of magnesium sulfate as a second-line therapy in the ED, from 12% to 91.8% ($P < .01$) (Table 2). For home management, prescribing inhaled corticosteroids as maintenance therapy from the emergency department increased significantly, from 29.3% to 51.9% ($P = .02$), and the use of written information and educational materials rose from 52% in 2012 to 77.3% ($P = .04$) (Table 3).

Discussion

Results reveal concordance and adherence to clinical practice guidelines in certain routine practices for AE management in PEDs, but also heterogeneity and inconsistency in others. The existence of protocols and clinical guidelines has been shown to reduce hospitalization rates, decrease the use of inhaled corticosteroids, and lower the rate of return visits.[9] According to the survey, most PEDs in Spain had clinical guidelines available—a higher percentage than that reported in surveys from other health care systems.[7,9] For initial assessment, international guidelines recommend using a validated scale to estimate severity.[4,5] The results show that the use of the PS in Spain has increased markedly and significantly (from 40% to > 90%) in the last 10 years. Stabilization of a child with critical asthma requires intensive management following the ABCDE mnemonic sequence and specific treatment.[11] According to the survey, one in five centers did not have a specific protocol for critical asthma, and capnography—recommended for the initial assessment of these children[4,5]—was used by 1 in 5 respondents.

Clinical practice guidelines recommend initiating oxygen therapy in the acute phase to maintain $SpO_2 > 94\%$.[2-5] However, according to the survey, the most widely used threshold among pediatricians to start oxygen therapy was 92%. Administration of bronchodilators via MDI and spacer has been shown to be equally effective as nebulization, with fewer adverse effects, in mild and moderate exacerbations.[13] Nearly all centers already had inhalation chambers available, and most administered bronchodilators with MDI in mild and moderate crises. For severe exacerbations, recommendations differ: some guidelines recommend nebulization,[3] while others recommend MDI administration as the first option.[2,4] In our survey, half of physicians reported administering bronchodilators via MDI during severe exacerbations, vs < 3% in 2012. In patients with critical asthma who lack sufficient inspiratory capacity for MDI administration, nebulization would appear to be the preferred approach.[2-4] Despite this, 8% of respondents still used MDI in these patients. There is no consensus on the number of MDI puffs required to calculate the salbutamol dose,[3-5] as no studies directly compare different regimens. This variability is reflected in the heterogeneous dosing practices reported by respondents. Ipratropium bromide, when combined with salbutamol in the acute phase, has been shown to reduce hospitalization rates in children with AE.[3] The survey revealed discrepancies in the number of ipratropium bromide doses, frequency, and duration of administration across centers. Early administration of oral corticosteroids

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Table 2. Main results on emergency department treatment

				2023 N = 269 n (%)	2012[A] N = 300 n (%)	*P* value
Initial assessment		Use of Pulmonary Score		245 (91.1)	130 (43.4)	*P* < .01
		Use of capnography in the emergency department		57 (21.1)	–	–
		Specific protocol for critical asthma		230 (85)	–	–
Oxygen therapy		$SatO_2$ level below which oxygen therapy is initiated during initial care	95%	3 (1.1)		
			94%	39 (14.5)		
			93%	43 (16)	–	–
			92%	171 (63.6)		
			Depends on age	13 (4.8)		
Bronchodilator administration via spacer with MDI		Mild crisis		261 (97)	276.9 (92.3)	*P* = .4
		Moderate crisis		256 (95.2)	122.1 (40.7)	*P* = .02
		Severe crisis		129 (48)	8.1 (2.7)	*P* < .01
		Critical asthma episode		15 (5.6)	–	
Bronchodilator treatment		Number of puffs per salbutamol dose	Weight ÷ 3	186 (69)	213.6 (71.2)	*P* = .7
			Other rule[1]	52 (19.3)	28.2 (9.4)	*P* = .06
			5 puffs < 25–30 kg; 10 puffs > 30–35 kg	24 (8.9)	24.6 (8.2)	*P* = .9
		Ipratropium bromide regimen	Within the first 3 rounds and, if needed, in the 4th and 5th	84 (32.1)		
			In all 3 rounds of the 1st hour	129 (49.2)		
			While the patient remains in the emergency department	30 (11.5)	–	–
			In the 1st , 3rd, and 5th round	15 (5.7)		
			Other[2]	4 (1.5)		
Corticosteroids in exacerbations	Oral corticosteroid type and dosage	Prednisolone	1-2 mg/kg según gravedad	184 (68.4)	–	
			1 mg/kg	1 (0.4)	–	
			2 mg/kg	1 (0.4)	–	
		Dexamethasone	0,6 mg/kg	53 (19.7)		
			0,3-0,6 mg/kg según gravedad	29 (10.8)		
			0,3 mg/kg	1 (0.4)		
	Oral corticosteroid type and dosage	Prednisolone	60 mg	140 (53.1)		
			40 mg	54 (20.5)		
		Dexamethasone	12 mg	73 (27.7)	–	
			10 mg	48 (18.2)		
			16 mg	22 (8.3)		
	Inhaled corticosteroids in exacerbations			24 (8.9)	–	
	Atopic traits, allergy, and family history of asthma as criteria for prescribing corticosteroids in children younger than 5 years			55 (20.1)	–	
Second-line therapies	Magnesium sulfate in the emergency department			247 (91.8)	36 (12)	*P* < .01
	High-flow oxygen therapy in the emergency department			158 (58.7)	–	
	Continuous salbutamol nebulization in the emergency department			119 (44.6)		
	Theophyllines in the emergency department			0 (0)	–	
	Intravenous salbutamol in the emergency department			0 (0)	–	

N: number of responses; $SatO_2$: oxygen saturation.
[1]Includes: weight ÷ 2; 4 puffs for < 10 kg, 6 puffs for 10–20 kg, and 8 puffs for > 20 kg.
[2]Includes: administration within the 2nd and 3rd rounds, alternate rounds, or the first 3 followed by alternate rounds.
[a]Based on results published in Claret Teruel *et al.* Asthma exacerbation in emergency departments in Spain: What is our usual practice? An Pediatr (Barc). 2013;78:216–26.

has been shown to improve outcomes in moderate and severe exacerbations.[13] Numerous studies demonstrate the equivalence between oral prednisolone and dexamethasone.[14] In our study, prednisolone remained the most widely used corticosteroid. In children, there is no evidence supporting the use of inhaled corticosteroids during acute exacerbations; nevertheless, some pediatricians reported using them.[4] The usefulness of oral corticosteroids in preschoolers with mild wheezing associated with respiratory infections has been questioned in recent studies.[15] The survey revealed that some pediatricians consider atopic features when deciding whether to prescribe corticosteroids in preschoolers with AE.

Recommendations for the treatment of very severe or critical exacerbations are unclear and lack strong evidence.[6] Different guidelines propose various second-line therapies (such as high-flow oxygen, magnesium sulfate, intravenous salbutamol, and theophylline) for severe AE unresponsive to initial therapy,[3-5,16] but there are no clear criteria for their use. According to the survey, in Spain the most widely used second-line therapy in the PED was magnesium sulfate, used by 9 out of 10 respondents—its use has doubled in the past 10 years—followed by high-flow oxygen (used by two-thirds of respondents) and continuous nebulization (by 50%). In contrast to studies in English-speaking countries[6,7] where these are employed,

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Table 3. Main results on home treatment

			2023 N = 267 n (%)	2012 N = 300 n (%)	*P* value*
Oral corticosteroid for home treatment	Prednisolone	3 days	134 (50)	–	–
		5 days	11 (4.1)		
	Dexamethasone	1 day	46 (16.2)		
		2 days	11 (4.1)		
	Based on severity		65 (24.3)		
Initiation of inhaled corticosteroids as maintenance therapy in the ED			139 (51.9)	87.9 (29.3)	**.02**
Scale to identify persistent symptoms	None		169 (63.8)	193.8 (64.6)	.9
	Pediatric asthma control tool		47 (17.7)	106.2 (35.4)	.7
	Other		32 (12.1)		
	Mini pediatric asthma control tool		17 (6.5)		
Use of asthma education information sheets	Yes	SEUP	124 (46.3)	156 (52)	**.04**
		Department's own sheets	74 (27.6)		
		Family-based education	9 (3.4)		
Number of salbutamol puffs per dose at home	2–4 per dose		133 (50.4)	–	
	Based on weight		93 (35.2)		
	Based on severity		34 (12.9)		
	Other[1]		4 (1.6)		

N: number of responses; ED: emergency department; SEUP: Spanish Society of Pediatric Emergencies.
[1]Includes: 4–6–8 based on weight, 4–5 puffs, 4 puffs, or 5 puffs.

neither theophylline nor intravenous salbutamol were used in Spanish emergency departments for children with very severe or critical AE.

Regarding discharge treatment, various approaches were used to calculate the salbutamol dose—an issue already noted in the survey conducted 12 years ago. This variability likely stems from the lack of clarity in existing guidelines. For instance, the Spanish Asthma Management Guidelines (GEMA) recommend administering 2–4 puffs in mild exacerbations and up to 10 in severe cases, without specifying the dose by age or weight.[3] The Global Initiative for Asthma (GINA) recommends 2 puffs per dose in children younger than 5 years for mild or moderate exacerbations, and 6 puffs for severe exacerbations, but provides no specific guidance for those older than 5 years.[2] Half of respondents prescribed maintenance inhaled corticosteroids from the PED for children with persistent asthma, although no clear recommendations exist on this practice.[2,3] Studies in other countries have shown that appropriate follow-up and management in primary care improve asthma control in children,[9] suggesting that maintenance therapy initiation and monitoring should be reserved for primary care.

This is the first nationwide survey on asthma management in pediatric emergency settings in Spain in the past 10 years. The study's limitations include the inherent constraints of an anonymous survey, which may not reflect actual clinical practice, and the potential bias arising from distribution among SEUP members, who likely possess greater knowledge of pediatric asthma management than physicians in general pediatric emergency settings in Spain.

Conclusions

In Spain, significant differences remain in several aspects of pediatric AE management in emergency departments. Compared with 2012 data, improvements were observed in the use of assessment scales for initial evaluation, bronchodilator administration via MDI in mild and moderate exacerbations, and the use of magnesium sulfate in emergency settings.

However, major variations persist in the use of MDI for severe exacerbations, the number of salbutamol puffs per dose, oral corticosteroid dosing and maximum doses, ipratropium bromide administration frequency and duration, second-line therapies used in emergency care, and the initiation of maintenance therapy from the PED. High-quality studies are needed in these specific areas to establish clear recommendations and standardize clinical practice. One of the working group's upcoming initiatives aims to publish updated recommendations based on the latest available evidence, focusing on the aspects of pediatric asthma management that this survey identified as most divergent.

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ADDENDUM

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Annex 1. Survey on controversial aspects in the management of children with asthma exacerbation in the emergency department

PHYSICIAN IDENTIFICATION
1. Age
2. What is your position?
3. Do you work exclusively in the emergency department?
4. Hospital

A. INITIAL ASSESSMENT
1. Do you use any scales to assess the severity of the asthma attack? Which one?*
2. Do you have a specific algorithm following the ABCDE approach for unstable patients with severe or critical asthma?
3. Below what oxygen saturation level do you initiate oxygen therapy?

B. EMERGENCY TREATMENT
4. Does your emergency department have its own inhalation chambers?
5. In which patients do you administer salbutamol and ipratropium bromide using an MDI and spacer?*
6. How do you calculate the number of puffs of inhaled β-agonists per dose/round?*
7. What is the maximum number of β-agonist puffs per round that you allow?
8. What protocol do you follow for administering ipratropium bromide?
9. Which oral corticosteroid do you use?
10. What oral corticosteroid dose do you use?
11. What is the maximum oral corticosteroid dose you use?
12. Do you administer oral corticosteroids to children under 5 years with moderate asthma exacerbation?
13. Do you consider atopic traits, allergies, or family history of asthma when deciding whether to administer corticosteroids to children under 5 years with wheezing?
14. Do you initiate inhaled corticosteroids to help control the crisis?
15. What second-line medication do you use for asthma attacks? Do you use intravenous magnesium sulfate?* Do you use high-flow oxygen in asthma management in the ED? Do you use continuous nebulized salbutamol? Do you use intravenous salbutamol? Do you use intravenous aminophylline?

C. HOME TREATMENT
16. How do you calculate the number of puffs per round recommended for home treatment?
17. What oral corticosteroid regimen (drug, dose, and duration) do you prescribe for home use, and to whom?
18. If the patient presents persistent asthma symptoms, do you initiate or modify maintenance therapy?*
19. What scale or tool do you use to identify persistent symptoms?*
20. Do you use educational handouts for asthma management? From which source?*

*Questions included in the 2012 GPR-SEUP survey.

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