



Original Research

National survey conducted among Italian pediatricians examining the therapeutic management of croup

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ARTICLE INFO

Keywords:

Acute laryngotracheitis
 Betamethasone
 Budesonide
 Dexamethasone
 Nebulized epinephrine
 Westley croup score

ABSTRACT

Objectives: Practice-to-recommendations gaps exist in croup management and have not been critically investigated. This study examined the therapeutic management of croup among a national sample of Italian pediatric providers.

Methods: A survey was administered online to a sample of primary care and hospital-based pediatricians. Demographic data, perception regarding disease severity, treatment and knowledge of croup, choices of croup treatment medications, and knowledge of and adherence to treatment recommendations were compared between hospital and primary care pediatricians. Oral corticosteroids alone, oral corticosteroids with or without nebulized epinephrine and nebulized epinephrine plus oral or inhaled corticosteroids were considered the correct management in mild, moderate and severe croup, respectively. The determinants for correct management were examined using multivariate logistic regression analysis.

Results: Six hundred forty-nine pediatricians answered at least 50% of the survey questions and were included in the analysis. Providers reported extensive use of inhaled corticosteroids for mild and moderate croup. Recommended treatment for mild, moderate and severe croup was administered in 46/647 (7.1%), 181/645 (28.0%) and 263/643 (40.9%) participants, respectively. Provider's age and knowledge of Westley Croup Score were significant predictors for correct management of mild croup. Being a hospital pediatrician and perception of croup as a clinically relevant condition were significant for moderate croup.

Conclusions: Significant differences exist between recommended guidelines and clinical practice in croup management. This study suggests wide variability in both the treatment of croup and clinical decision making strategies among hospital and primary care pediatricians. Addressing this issue could lead to noteworthy clinical and economic benefits.

1. Introduction

Croup, which is also known as acute laryngitis (i.e., laryngo-tracheobronchitis), is one of the most common pediatric respiratory conditions affecting children mainly between 6 months and 3 years of age [1]. Although most children present with mild symptoms, the

clinical presentation may vary, ranging from mild cases to impending respiratory failure and in rare cases, death. Even in mild cases, which mostly resolve with minimal intervention, exacerbated symptoms at the onset may frighten caregivers, resulting in a high rate of pediatric emergency departments (PEDs) visits [2–4].

Currently, the best available evidence regarding therapeutic

Abbreviations: ED, emergency department; HP, hospital pediatricians; PCP, primary care pediatricians; PED, pediatric emergency department; WCS, westley croup score.

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<https://doi.org/10.1016/j.rmed.2024.107587>

Received 29 March 2023; Received in revised form 10 February 2024; Accepted 5 March 2024

Available online 24 March 2024

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management of croup is summarized in only a handful of clinical recommendations [5–7]. In general, many studies including systematic reviews agree on the use of Westley Croup Score (WCS) [8], however, there is no general consensus on its clinical utility and validity. This is coupled with provider consensus on the administration of corticosteroids as the cornerstone treatment for remediation of croup symptoms [8–11]. In most clinical practices, oral dexamethasone at the dosage of 0.3–0.6 mg/kg is the corticosteroid of choice, as it provides a longer-lasting and more effective treatment than other agents. In moderate and severe cases, nebulized epinephrine should be added [8, 11–14].

Although there is a large body of evidence and several systematic reviews supporting the proper management of croup, there is increasing evidence worldwide of substantial variability in croup management [15–17]. Most of the reported studies focused on management of inpatient croup and included different healthcare provider's types. Because croup is far more common in children, pediatric providers are expected to be more skilled and familiar with the management of this condition [17]. To date, no studies have been conducted assessing pediatricians' management of croup. The primary aim of the current study was to investigate the therapeutic management of croup among pediatricians through a national survey targeting hospital pediatricians (HP) and primary care pediatricians (PCP). Secondary aims included assessing adherence to existing therapeutic management recommendations and exploring the determinants of the possible divergence between recommendations and actual practice.

2. Materials and methods

2.1. Survey design

A questionnaire was developed in the IRCCS Azienda Ospedaliero-Universitaria di Bologna. Survey content was based on the Delphi method conducted among hospital experts, and using current guidelines and peer review studies addressing good clinical practice and croup management. After developing the questionnaire, the study group discussed the survey contents and provided feedback concerning content validity. Suggestions from the study group were then incorporated into the questionnaire. Subsequently, the survey was pilot tested with a convenience sample of 10 pediatricians and pediatric resident in Bologna to ensure clarity of questions and ease of administration. Further comments from this set of respondents were then incorporated into the final version of the questionnaire. The online Croupsurv survey included 32 questions (Survey S1) grouped into 4 different sections: a) demographics [1–8]: questions to characterize the sample, field of expertise, and workplace setting; b) clinical assessment [9–12]: questions assessing perceived severity of the disease and knowledge of the Westley Croup Score; c) treatment [13–29]: different therapeutic approaches used by pediatricians to manage croup in their clinical practice; d) adherence to recommendations/determinants [30–32]: knowledge and adherence to existing recommendations for treating croup and discrepancy with actual clinical practice. The survey contained multiple choice questions requiring a single answer with a few exceptions reported in the [Supplementary Appendix 1](#).

2.2. Ethical approval and data treatment

This study was approved by the local Ethics Committee of center Emilia area (Protocol number 1057/2020/Oss/AOUBo). Informed electronic consent was obtained prior to respondents accessing the online survey.

2.3. Survey sample and administration

The survey was administered to a sample of Italian pediatricians between February 1, 2021 and May 31, 2021, using the Qualtrics online

platform with a hyperlink sent to pediatricians by email [18].

The email addresses of hospital pediatricians were obtained from hospital websites by manually searching the Internet for pediatric wards', region by region. When the only available email address was that of the Department's Head of Pediatrics, he/she was asked to forward the invitation email to the senior consultants of the medical staff, with the project's original email as carbon copy (cc), in order to keep track of the number of pediatricians and their contacts. Primary care pediatricians email addresses were collected from the websites of local health services. Primary care pediatricians were asked to forward the email invitation to their primary care colleagues, adding a "cc" for the study team's email. Duplicate e-mails were removed from the master list maintained by the investigative team.

Inclusion criteria required that survey respondents were a licensed pediatrician currently practicing and have an Internet connection to access the survey. Only surveys with at least 50% completion rates were included in the final analysis. The survey was supported by the Italian Society of Pediatrics (SIP) and the Italian Society of Pediatric Emergency Medicine (SIMEUP). Both societies advertised the survey on their websites but members could receive a link to the survey only by contacting the study coordinator directly by email.

2.4. Statistics/data analysis

Summary descriptive statistics were reported as frequency and relative percentages. Survey responses from HP and PCP were compared by the χ^2 test. Community pediatricians and freelance pediatricians operating in the private sector were included in the PCP group. Analysis of the standardized residuals was performed in cases where the non-binomial χ^2 test was significant [19]. Variables with $p < 0.20$ in unadjusted analyses were considered for inclusion in the multivariable model. Multivariate analysis were conducted to examine potential determinants of proper management in the PED for different croup severity classes. Oral corticosteroids alone, oral corticosteroids with or without nebulized epinephrine, and nebulized epinephrine plus oral or inhaled corticosteroids were considered as the correct management in mild, moderate and severe croup, respectively [5–7]. Statistical significance was set at $p < 0.05$. Data analysis was performed with IBM SPSS Statistics (Version 26) [20].

3. Results

A total of 1849 qualified pediatricians were invited to respond to the survey. Of these, 711 pediatricians accessed the survey platform, and of these 649 answered at least 50% of the questions. The raw response rates were 58% (323/557) and 25.7% (326/1270) among HP and PCP, respectively ([Fig. 1a](#)).

3.1. Demographic data

[Table 1](#) contains the demographic characteristics of the respondents and [Fig. 1b](#) reports their geographical distribution. Among HP respondents, pediatric emergency medicine (60/313, 19.2%), general pediatrics (70/313, 22.4%) and pediatric pulmonology (16/313, 5.1%) were the most common subspecialties, respectively. Additionally, among the HPs, 261/313 (83.1%) work shifts in the PEDs.

3.2. Perception and knowledge of croup

[Table 2](#) shows differences between pediatrician type in the perceived frequency and severity of croup, concern about croup management as well as knowledge, use, and utility of the WCS. Among HPs, croup is much more likely to be regarded as a common and either not clinically significant or clinically significant disease (265/321, 82.6%), as opposed to PCPs (165/325, 50.8%; $p < 0.001$). In addition, PCPs were more likely to consider croup a clinically significant condition either

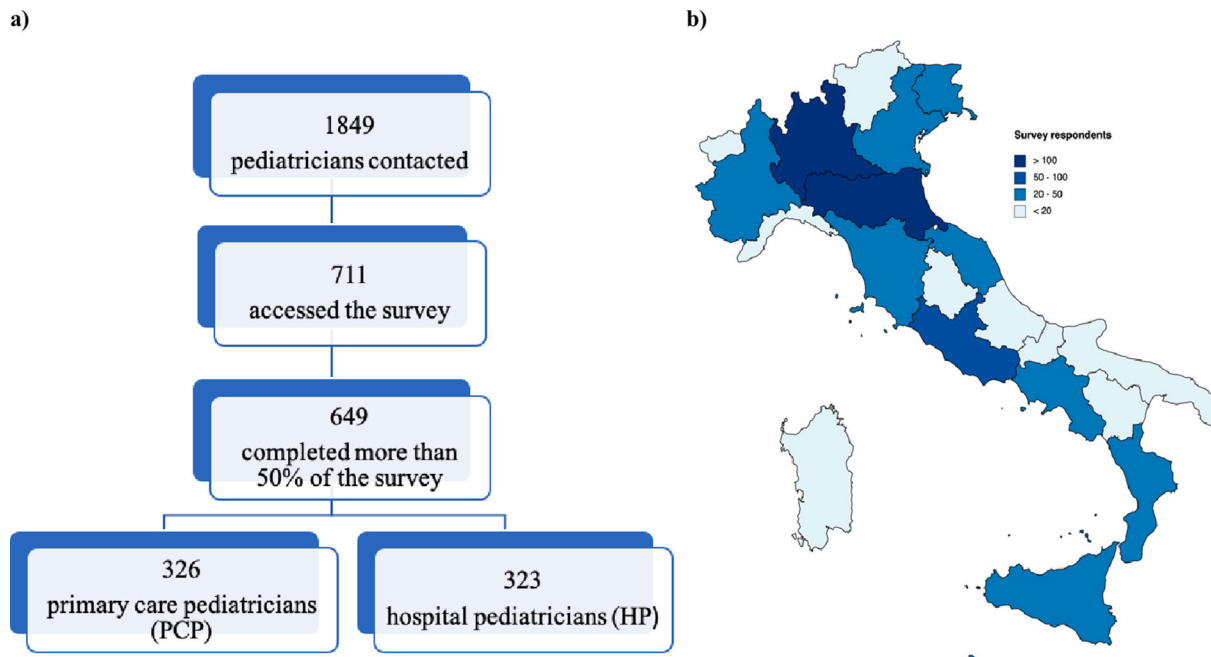


Fig. 1. Flow-chart (left, a) showing the sampling frame and respondent numbers for the pediatricians included in the survey and a heat-map (right, b) for the geographical distribution of the respondents.

Table 1
Demographic characteristics of the respondents.

	Total n (%)	HP n (%)	PCP n (%)	P
Sex, n (%)				<0.001
Participants	649	323	326	
Female	411 (63.3)	176 (54.5)	235 (72.1)	
Age, n (%)				<0.001
Participants	647	322	325	
<30 years	2 (0.3)	2 (0.6)	0 (0)	
30–39 years	120 (18.5)	106 (32.9)	14 (4.3)	
40–49 years	130 (20.1)	81 (25.2)	49 (15.1)	
50–59 years	168 (25.9)	61 (18.9)	107 (32.9)	
≥60 years	227 (35.1)	72 (22.4)	155 (47.7)	
Geographical region, n (%)				0.007
Participants	646	321	325	
North	402 (62.2)	220 (68.5)	182 (56.0)	
Centre	141 (21.8)	63 (19.6)	78 (24.0)	
South	62 (9.6)	23 (7.2)	39 (12.0)	
Islands	41 (6.3)	15 (4.7)	26 (8.0)	
Level of care, n (%)				
Participants		265		
Primary center		81 (30.6%)		
Secondary center		124 (46.8%)		
Tertiary center		53 (16.9%)		

Legend: HP = hospital pediatricians; PCP = primary care pediatricians.

common or uncommon condition (257/325, 79.1%) more than HPs (221/321, 68.8%; $P = 0.003$). A much greater proportion of PCPs had never heard of the WCS (197/326, 60.4%) compared to the HPs (82/319, 25.7%), albeit more of the HPs were aware of the WCS and use it frequently (75/319, 23.5% vs 13/326, 4% for HPs and PCPs, respectively).

Compared to PCPs (129/326, 39.6%), more of the HPs were aware of

the WCS (237/319, 74.3%; $P < 0.001$). However, among pediatricians who are aware of this score for management of croup, its regular use was relatively low and differed significantly between HP (75/237, 31.6%) and PCP (13/129, 10.1%, $P < 0.001$).

3.3. Croup management

Table 3 shows the between-group comparisons for croup management. A wide majority (88%) of the respondents claim to, “sometimes or always” tailor croup treatment based on severity. Fig. 2 depicts selected answers on questions assessing pharmaceutical approaches to treating croup.

Proper treatment for mild croup was chosen by 46/647 (7.1%) of the respondents, with no significant difference between HPs and PCPs (26/322, 8.1% vs 20/325, 6.2%, respectively). For moderate croup the recommended approach was selected by 181/645 respondents (28%; HP 107/321, 33.3%; PCP 74/324, 22.8%; $p = 0.003$). The recommended treatment for severe croup was selected by 263/643 (40.9%) participants, 138/322 (42.8%) HP and 125/321 (38.9%) PCP ($p = 0.312$). For further details about medications of choice and dosages see the Supplementary Appendix 2.

Table 4 contains the results of both the univariate and multivariate logistic regression assessing determinants of proper management of mild, moderate, and severe croup. In comparison to mild and moderate croup, none of the 9 predictors for correct management of severe croup were significant. Only age and knowledge of WCS were significant predictors for correct management of mild croup, whereas HP and perception of croup as a common and clinically relevant condition were significant for moderate croup.

Table 5 shows the results regarding PED discharge prescriptions. A majority of the participants (537/627, 85.7%) reported they routinely (always or often) prescribe medications for home therapy, reporting a high rate of prescribing inhaled corticosteroids (579/617, 93.8%).

In the management of mild croup, prescribing a post-ED discharge therapy was found to be more common among pediatricians who prefer inhaled over oral steroids (89% vs 11%, $p = 0.004$). This tendency was confirmed in moderate and severe cases (78.9% vs 21.1%, $p = 0.644$;

Table 2
General perception, level of concern about croup and knowledge of WCS.

	Total n (%)	HP n (%)	PCP n (%)	P
Perception of croup frequency and severity				<0.001
<i>Participants</i>	646	321	325	
Uncommon and not clinically significant	9 (1.4)	1 (0.3)	8 (2.5)	
Uncommon but clinically significant	207 (32.0)	55 (17.1)	152 (46.8)	
Common but not clinically significant	159 (24.6)	99 (30.8)	60 (18.5)	
Common and clinically significant	271 (41.9)	166 (51.7)	105 (32.3)	
Level of concern about croup management				0.232
<i>Participants</i>	647	321	326	
Low	31 (4.8)	16 (5.0)	15 (4.6)	
Medium	456 (70.5)	235 (73.2)	221 (67.8)	
High	160 (24.7)	70 (21.8)	90 (27.6)	
Knowledge and use of WCS				<0.001
<i>Participants</i>	645	319	326	
Never heard	279 (43.3)	82 (25.7)	197 (60.4)	
I'm aware of WCS but I don't use it	122 (18.9)	64 (20.1)	58 (17.8)	
I'm aware of WCS and I sometimes use it	156 (24.2)	98 (30.7)	58 (17.8)	
I'm aware of WCS and I often use it	88 (13.6)	75 (23.5)	13 (4.0)	
Perception of the utility of WCS				0.306
<i>Participants</i>	364	237	127	
Useless	2 (0.5)	1 (0.4)	1 (0.8)	
Not very useful	60 (16.5)	34 (14.3)	26 (20.5)	
Quite useful	224 (61.5)	146 (61.6)	78 (61.4)	
Very useful	78 (21.4)	56 (23.6)	22 (17.3)	
Reassessment of clinical improvement through WCS, 2–6 h after treatment				0.332
<i>Participants</i>	362	237	125	
Always	41 (11.3)	31 (13.1)	10 (8.0)	
Often	113 (31.2)	74 (31.2)	39 (31.2)	
Sometimes	154 (42.5)	101 (42.6)	53 (42.4)	
Never	54 (14.9)	31 (13.1)	23 (18.4)	

Legend: HP = hospital pediatricians; PCP = primary care pediatricians; WCS = Westley Croup Score.

57.4% vs 42.6%, $p = 0.705$, respectively), even though the differences were not statistically significant.

3.4. Knowledge and adherence to guidelines

Among the survey respondents, 75/309 (24.3%) of the HPs and 174/306 (56.9%) of the PCPs were unfamiliar with any guidelines for croup ($p < 0.001$). Among the existing recommendations, those developed by the United Kingdom's National Institute for Health and Care Excellence were the most commonly known by the respondents being better known by HPs than by PCPs (194/309, 62.8% vs 109/306, 35.6%; $p < 0.001$). High to full adherence to guidelines was indicated by 139/230 (60.4%) and 50/126 (39.7%) of the HPs and PCPs, respectively ($p < 0.001$). Inadequate adherence was mainly attributed to parental anxiety or request (94/181, 51.9%), professional experience (32/181, 17.7%) or habits (17/181, 9.4%).

Table 3
Preferred therapy for mild, moderate and severe croup.

	Total n (%)	HP n (%)	PCP n (%)	P
Differentiated treatment based on croup severity				<0.001
<i>Participants</i>	641	320	321	
Never	37 (5.8)	7 (2.2)	30 (9.3)	
Rarely	40 (6.2)	11 (3.4)	29 (9.0)	
Sometimes	139 (21.7)	61 (19.1)	78 (24.3)	
Always	425 (66.3)	241 (75.3)	184 (57.3)	
Preferred therapy for mild croup				
<i>Participants</i>	647	322	325	
No therapy	44 (6.8)	15 (4.7)	29 (8.9)	0.031
Inhaled CS	572 (88.4)	285 (88.5)	287 (88.3)	0.936
Oral CS	106 (16.4)	56 (17.4)	50 (15.4)	0.490
Parenteral CS	0 (0)	0 (0)	0 (0)	–
Nebulized epinephrine	15 (2.3)	11 (3.4)	4 (1.2)	0.065
Preferred therapy for moderate croup				
<i>Participants</i>	645	321	324	
No therapy	2 (0.3)	1 (0.3)	1 (0.3)	1.000
Inhaled CS	507 (78.6)	255 (79.4)	252 (77.8)	0.607
Oral CS	483 (74.9)	227 (70.7)	256 (79.0)	0.015
Parenteral CS	26 (4.0)	22 (6.9)	4 (1.2)	<0.001
Nebulized epinephrine	169 (26.2)	129 (40.2)	40 (12.3)	<0.001
Preferred therapy for severe croup				
<i>Participants</i>	643	322	321	
No therapy	1 (0.2)	0 (0)	1 (0.3)	0.499
Inhaled CS	370 (57.5)	189 (58.7)	181 (56.4)	0.554
Oral CS	337 (52.4)	139 (43.2)	198 (61.7)	<0.001
Parenteral CS	231 (35.9)	157 (48.8)	74 (23.1)	<0.001
Nebulized epinephrine	524 (81.5)	307 (95.3)	217 (67.6)	<0.001

Legend: HP = hospital pediatricians; PCP = primary care pediatricians; CS = corticosteroids.

4. Discussion

To our knowledge, this study is one of the first to examine clinical decision making by pediatricians in the treatment of croup. The study included different provider types (HPs and PCPs) operating in different workplace settings (PED and the out-of-hospital), thus increasing exposure to uniquely different clinical settings for croup treatment. Gathering this type of information is critically important given there are far ranging medical views toward the management of croup in children and a lack of concerted and well supported guidelines for providers to follow. In this respect, an important finding of this study is that, in a very common clinical condition such as croup, a majority of HPs and PCPs appear to be unfamiliar with its proper management according to international recommendations, particularly regarding techniques to assess severity and therapeutic choices. Indeed, an important finding emerging from this study is the relatively poor application of the WCS to assess disease severity. Only a very small percentage of the total sample routinely applied the WCS as a part of their clinical practice and this percentage was notably higher among HPs than PCPs. Moreover, a relatively higher percentage of PCPs compared to HPs claimed to be completely unaware of the WCS. Conceivably, these differences arise because caregivers often take their children to the hospital PED. For instance, more HPs compared to PCPs reported that croup is a common disease, perhaps given the larger number of patients they see presenting with croup. In addition, HPs may be more confident in using scoring systems, given evidence of their use and documented validity in ED

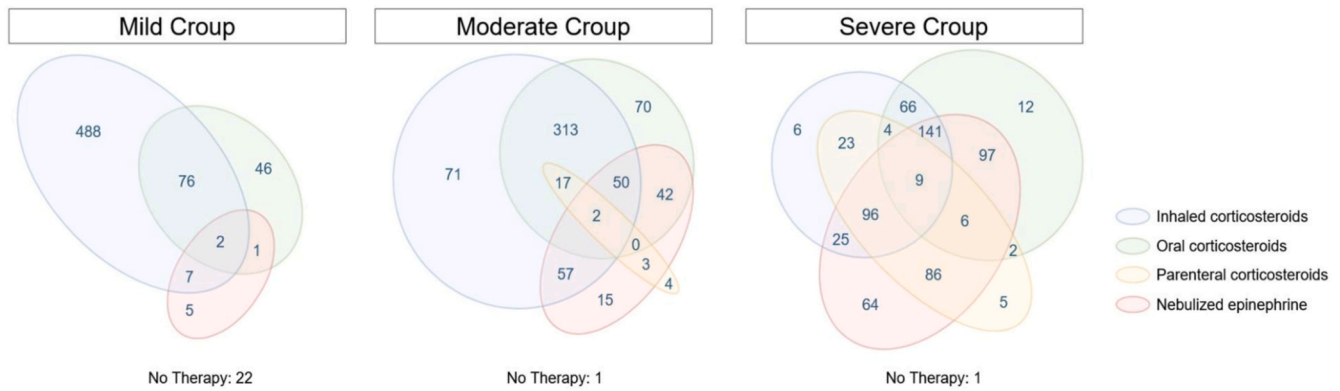


Fig. 2. Venn diagrams depicting indicated approaches on multiple choice questions regarding pharmaceutical approaches to mild, moderate, and severe croup.

Table 4
 Predictors of proper management for mild, moderate and severe croup.

	Univariate analysis			Multivariate analysis		
	OR	95% CI	p	OR	95% CI	p
Mild croup						
HP	1.340	0.732-2.452	0.343			
PED shifts	0.697	0.381-1.272	0.239			
Male sex	1.508	0.777-2.926	0.224			
Age >40 years	0.402	0.212-0.765	0.005	0.248	0.093-0.660	0.005
Perception of croup as a common and clinically relevant condition	1.288	0.707-2.350	0.408			
Level of concern about croup	1.532	0.804-2.918	0.194	1.752	0.604-5.084	0.302
WCS: knowledge and regular use	1.286	1.012-1.634	0.040	1.597	1.171-2.177	0.003
Different treatment based on croup severity	0.948	0.771-1.167	0.617			
Adherence to guidelines	3.421	0.700-16.727	0.129	3.364	0.575-19.677	0.178
Moderate croup						
HP	0.746	0.495-1.125	0.162	0.554	0.310-0.989	0.046
PED shifts	1.240	0.819-1.878	0.309			
Male sex	0.918	0.604-1.397	0.691			
Age >40 years	0.885	0.532-1.470	0.636			
Perception of croup as a common and clinically relevant condition	1.386	0.919-2.089	0.119	2.102	1.182-3.738	0.011
Level of concern about croup	1.160	0.730-1.844	0.530			
WCS: knowledge and regular use	1.030	0.847-1.251	0.770			
Different treatment based on croup severity	0.907	0.787-1.045	0.176	0.912	0.743-1.120	0.381
Adherence to guidelines	2.303	0.672-7.894	0.184	2.560	0.719-9.118	0.147
Severe croup						
HP	1.176	0.858-1.611	0.313			
PED Shifts	1.160	0.775-1.736	0.471			
Male sex	0.908	0.605-1.363	0.643			
Age >40 years	1.444	0.838-2.490	0.186	1.463	0.846-2.530	0.173
Perception of croup as a common and clinically relevant condition	1.284	0.863-1.910	0.218			
Level of concern about croup	0.885	0.555-1.410	0.606			
WCS: knowledge and regular use	1.010	0.835-1.222	0.915			
Different treatment based on croup severity	1.122	0.969-1.299	0.124	1.131	0.977-1.311	0.100
Adherence to guidelines	2.067	0.604-7.069	0.247			

Legend: HP = hospital pediatricians; PED = Pediatric emergency department; WCS = Westley Croup Score.

settings [21–23].

Along with its limited application, the WCS was considered of modest utility by the majority of the pediatricians in this study. This finding requires further examination to learn more about why most pediatricians don't rely on WCS, what drives their clinical judgment, and precisely what information they use in selecting an appropriate treatment, especially if they are not using current recommendations. Nonetheless, the findings from the current study comport with the literature, which describes how the WCS is still poorly implemented in clinical practice despite demonstrating adequate reliability [10,24]. The dissemination and implementation of the WCS might provide a means to standardize croup severity assessment across different healthcare delivery settings, and as a result, guide its proper management.

Moreover, in the current study most of the providers claimed to tailor croup treatment based on a severity assessment, despite limited, in some cases, application of the WCS. This also comes in light of the wide gap

that has been found between recommended treatment and prescribed therapies. Indeed, while a high proportion of the pediatricians claimed high adherence to diagnosis, treatment, and management guidelines, only a few of them selected the recommended treatments for mild, moderate, and severe croup. Notably, we reported a common trend towards non-recommended prescriptions, including a relevant use of inhaled corticosteroids for mild and moderate cases, parenteral steroids for moderate and severe croup, and nebulized epinephrine for mild cases, showing low adherence to recommendations, particularly regarding corticosteroid administration [15].

Our findings confirm, at least for Italy on a national scale, what we previously reported in a single metropolitan area [16]. Similarly, an Australian study assessed the appropriateness of the management and adherence to national guidelines through 26 commonly used clinical indicators, in a review of 982 children's medical records [15]. The authors reported high levels of adherence to proper management in most

Table 5
Home therapy prescriptions (molecule of choice and length of therapy).

	Total n (%)	HP n (%)	PCP n (%)	P
Home therapy prescription				0.066
<i>Participants</i>	627	316	311	
Always	361 (57.6)	168 (53.2)	193 (62.1)	
Often	176 (28.1)	99 (31.3)	77 (24.8)	
Sometimes	83 (13.2)	47 (14.9)	36 (11.6)	
Never	7 (1.1)	2 (0.6)	5 (11.6)	
Home therapy				0.211
<i>Participants</i>	617	314	303	
Inhaled CS alone	362 (58.7)	194 (61.8)	168 (55.4)	
Oral CS alone	38 (6.2)	20 (6.4)	18 (5.9)	
Inhaled + oral CS	217 (35.2)	100 (31.8)	117 (38.6)	
Preferred inhaled CS for home therapy				0.015
<i>Participants</i>	573	292	281	
Budesonide	490 (85.5)	261 (89.4)	229 (81.5)	
Beclomethasone	81 (14.1)	31 (10.6)	50 (17.8)	
Flunisolide	2 (0.3)	0 (0.0)	2 (0.7)	
Inhaled CS home therapy: aerosols per day				0.278
<i>Participants</i>	573	292	281	
1-2	263 (45.9)	140 (47.9)	123 (43.8)	
3-4	298 (52.0)	144 (49.3)	154 (54.8)	
>4	12 (2.1)	8 (2.7)	4 (1.4)	
Inhaled CS home therapy: length of therapy in days				<0.001
<i>Participants</i>	575	293	282	
≤3	271 (47.1)	169 (57.7)	102 (36.2)	
4-5	275 (47.8)	120 (41.0)	155 (55.0)	
≥6	29 (5.0)	4 (1.4)	25 (8.9)	
Preferred oral CS for home therapy				0.977
<i>Participants</i>	141	51	90	
Betamethasone	129 (91.5)	47 (92.2)	82 (91.1)	
Prednisone	6 (4.2)	2 (3.9)	4 (4.4)	
Dexamethasone	6 (4.2)	2 (3.9)	4 (4.4)	
Oral CS home therapy: length of therapy in days				0.886
<i>Participants</i>	141	51	90	
1-2	51 (36.2)	19 (37.3)	32 (35.6)	
3-4	86 (61.0)	31 (60.8)	55 (61.1)	
≥5	4 (2.8)	1 (2.0)	3 (3.3)	

Legend: HP = hospital pediatricians; PCP = primary care pediatricians; CS = corticosteroids.

cases, with the exception of corticosteroid administration, which was somewhat lower. Overall, rates of compliance in the Australian study were somewhat higher than those obtained in the current study. This misalignment with recommendations may reflect the lack of evidence about the best type, route of administration, and dosage of corticosteroids. This was recently underscored by an updated 2023 Cochrane systematic review and meta-analysis on croup management, which called for additional trials assessing the effectiveness of dexamethasone and budesonide compared to placebo [6,8].

We also reported an extensive use of nebulized epinephrine, even in mild croup, especially by HPs. According to international recommendations, epinephrine should be administered in combination with steroids, in severe or moderate croup [5–7]. The current findings suggest

that there is still high proportion of pediatricians who rely on nebulized epinephrine alone for the management of severe croup despite the well-known efficacy of corticosteroids in treating croup, regardless of its severity [15]. This choice could be partially explained by its fast onset of action, quick symptom abatement, and reduction of respiratory distress [25]. Inappropriate use of epinephrine reflects the low adherence of pediatricians to croup recommendations together with the inconsistent use of the WCS. Hence, regular use of the WCS could help providers select cases with mild croup where epinephrine administration is not recommended.

Given the high variability in croup management evidenced by survey respondents, we examined potential predictors of selecting the correct treatment approach for mild, moderate, and severe croup. The multivariate regression results show that knowledge and regular use of the WCS supports the correct management of mild but not moderate or severe croup. Younger providers were also more likely to correctly manage mild croup. The vital role of provider's age in treating mild croup is a novel finding. This may be linked to the inverse relationship between a clinician's years of experience and their adherence to recommendations [26]. Older providers may rely more on intuition and clinical experience whereas younger providers may resort to published guidelines, which remain fresh on their minds from their medical education. Correct treatment and management of moderate croup was more likely to occur when croup is perceived as a common and clinically significant disease but was hindered by being a HP. None of the relevant variables in the model predicted correct management of severe croup, suggesting there is widespread recognition of the correct management when a child presents with advanced respiratory distress. Although very few studies have examined determinants of adherence to international recommendations for croup management, several studies have investigated compliance for the management of other pediatric illnesses [27,28]. Zerr et al. conducted a survey among US physicians to investigate factors that may play a role influencing clinical decision-making in the management of febrile infants. Variability in the approach was found to be usually based on the specialty background of the clinician and influenced by both their experience and confidence in the diagnosis [29]. Moreover, clinical presentation and illness severity have been already documented as determinants for practice variability in other pediatric emergency settings [30].

Finally, the current findings suggest there is a national tendency towards the prescription of medications following ED discharge, as previously reported on a smaller scale [16]. Adherence to croup recommendations implies no need for post-ED discharge medications, as there are no studies supporting any advantages to this strategy [8,31,32]. Home therapy prescriptions, as we previously suggested, account for the likely overtreatment of croup patients. The main reasons behind this choice of prescribing medications after PED discharge remain unfounded.

Based on the current study, pediatricians who prescribe inhaled steroids for croup are more likely to prescribe a course of daily oral or inhaled corticosteroids at discharge. This choice could be related to the shorter half-life of budesonide as compared to oral corticosteroids. Moreover the perceived pressure from parents/caregivers, as reported in several studies and indicated by our respondents, could influence prescription decisions [33–35]. Home therapy prescription may result in a placebo effect on caregivers with perceived enhanced safety, reducing return to care visits [16].

Our study has some limitations. First, there is the potential for selection bias because personal interest or relevant expertise in the topic may have motivated participants to complete the survey. Moreover, survey data was analyzed if the respondent answered at least 50% of total questions. We are aware that a 90% cut-off would have been ideal methodologically speaking, however, we used a lower cut-off because many questions were branching and dependent on answers to earlier presented questions. Thus, using a 90% cut-off would not be possible, given the survey design.

Furthermore, the Italian National Health Service structure can influence the generalizability of these findings. Since the clinical presentation of croup may distress parents, PCPs may refer patients to the ED even if the case is mild. The relatively higher number of patients presenting with more variable forms of croup in the pediatric ED could contribute to the relatively higher confidence of HPs than PCPs with regard to croup management.

Finally, our results bring to the forefront the challenging issue of translating evidence-to-practice interventions in both EDs and out-of-hospital settings. Further studies are needed to investigate the possible factors influencing the low adherence to recommendations and implementation strategies that could alter clinical decision making and be widely adopted.

5. Conclusions

Our findings suggest that the gap between practice and recommendations in croup management needs to be filled. The divergence in clinical practice seems to be more pronounced in the management of mild and moderate cases with a relevant burden of inappropriate corticosteroid management. Overall, the approach followed by HPs is more likely concordant to the recommendations compared to the clinical course of action chosen by PCPs. Moreover, awareness and systematic application of the WCS efficiently predicted the correct management of mild forms of croup. Hence, greater deployment of the WCS together with the development and implementation of specific national guidelines, could help improve croup management, with relevant clinical and economic benefits.

Funding

No funding was secured for this study.

6. Contributors statement

Dr. Luca Pierantoni conceptualized the study. Dr. Elena Balduini was responsible for data curation and the initial analyses. Drs. Luca Pierantoni and Laura Andreozzi were responsible for formal data analysis, methodology, review and editing of the manuscript. Drs. Giacomo Stera and Gaia Toschi Vespasiani prepared the first draft of the manuscript. Dr. Carlotta Biagi and Dr. Daniele Zama contributed to the review and editing of the manuscript. Dr. Lawrence Matthew Scheier critically reviewed and revised the manuscript for important intellectual content. Prof Marcello Lanari critically reviewed and revised the manuscript and supervised the work. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

CRedit authorship contribution statement

Luca Pierantoni: Conceptualization, Formal analysis, Methodology, Writing – review & editing. **Laura Andreozzi:** Formal analysis, Methodology, Writing – review & editing. **Giacomo Stera:** Writing – original draft. **Gaia Toschi Vespasiani:** Writing – original draft. **Carlotta Biagi:** Writing – review & editing. **Daniele Zama:** Writing – review & editing. **Elena Balduini:** Data curation. **Lawrence Matthew Scheier:** Writing – review & editing. **Marcello Lanari:** Supervision, Writing – review & editing.

Declaration of competing interest

none.

Acknowledgements

We acknowledge the Italian Society of Pediatrics (SIP) and the Italian Society of Pediatric Emergency Medicine (SIMEUP) that supported the

study, advertising the survey on their websites.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.rmed.2024.107587>.

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