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Emerging Issues in Managing Pediatric Parasitic Infections: An Assessment of Clinical and Epidemiological Knowledge of Giardiasis and Cryptosporidiosis

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Abstract

Background: We are not aware of any survey data that has assessed the general awareness by pediatricians of Giardia and/or Cryptosporidium infection, the most common causes of human intestinal parasitic infections in the United States. The aim of this survey was to evaluate pediatrician knowledge and perceptions on the treatment of parasitic infections in children 1-12 years of age.

Methods: A 44-question online survey was conducted from July 1 to July 14, 2014 among 1000 pediatricians.

Results: Almost all respondents identified viruses as the most likely cause of diarrhea (95.0%) in young patients and therefore reported treating with supportive therapy (82.4%). Approximately only 10% of respondents would suspect parasites if the diarrhea became persistent, with the duration of persistence generally considered as more than 1-2 weeks. If they considered parasites as the cause of diarrhea, they would most commonly test for both Cryptosporidium and Giardia, and initiate therapy after confirmation (70.9%). The drug of first choice for empiric therapy was most commonly metronidazole (78.4%) followed by paromomycin (10.4%) and nitazoxanide (6.4%). Notably, 72.0% of pediatricians considered the availability of nitazoxanide would change their potential treatment choice for diarrhea. Respondents preferred additional print materials (56.2%) followed by live events including web-based education (35.6%) to receive additional education concerning parasitic infection in children.

Conclusion: This survey supports the need to enhance efforts to provide education among pediatricians on how best to manage and treat childhood diarrhea caused by parasites such as Giardia and Cryptosporidium.

Keywords: Pediatric; Giardiasis; Cryptosporidiosis; Parasite; Diarrhea

Introduction

Giardia lamblia (also called Giardia intestinalis or duodenalis) is a flagellate protozoa that generally causes a self-limited, often persistent illness that is typified by diarrhea, flatulence, greasy/floating stools, bloating, abdominal cramps, dehydration, weight loss, and malabsorption [1]. It is the leading cause of human intestinal parasitic infection in the USA [2]. Although less frequently detected than giardiasis, cryptosporidiosis is a similar persistent diarrheal illness caused by protozoa of the genus Cryptosporidium [3]. Cryptosporidiosis is characterized by diarrhea (with or without crampy abdominal pain), which may be intermittent or continuous, and voluminous, and may include vomiting and low-grade fever [4,5]. Giardiasis and cryptosporidiosis are considered 'neglected diseases' by the World Health Organization [6]. Giardiasis is commonly treated with metronidazole or tinidazole; however, the tablet formulations can be difficult to administer in children because of pediatric dose requirements, possess an unpalatable metallic taste, and may cause adverse effects such as nausea [7,8]. In addition, resistance has been documented in G. lamblia [9-11]. Apart from nitazoxanide, there is no other commonly recommended specific treatment for cryptosporidiosis. Nitazoxanide has proven to be clinically effective in a short course (3 consecutive days) of therapy in both children (>1 year old) and adults who are otherwise healthy and is the only agent approved by the Food and Drug Administration (FDA) for the treatment of both giardiasis and cryptosporidiosis. Furthermore, with its availability as a pleasant-tasting, oral suspension, it is the only FDA-approved agent available to treat persistent diarrhea caused by these parasites in young children.

Pediatric infections with intestinal parasites such as G. lamblia and Cryptosporidium spp. in the US appear more frequent than commonly perceived and have been understudied [12]. It is therefore believed that general awareness of these persistent parasitic infections may be low. A recent Centers for Disease Control and Prevention survey of obstetrician-gynecologists on their clinical and epidemiologic knowledge of cryptosporidiosis in pregnancy found that only 44% of respondents reported that prolonged, intermittent diarrhea would lead them to consider cryptosporidiosis in a differential diagnosis [13]. In addition, questions about the availability of an FDA-approved treatment were the most frequently missed questions among the survey respondents. We are not aware of any similar survey data that assesses the general awareness of Giardia and/or Cryptosporidium in any other physician group, in particular pediatricians. We therefore conducted a survey of US pediatricians to evaluate their knowledge and perceptions

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on the treatment of these parasitic infections in children 1-12 years of age.

Methods

Survey design and conduct

The primary objective of this survey was to gain a greater understanding of the knowledge, attitudes, and practices in the diagnosis and treatment of parasitic diarrhea among pediatricians in addition to assessing their familiarity of and receptivity to current approved drug therapy. The final goal was to ensure that the results of this survey were made available to the medical community in an effort to highlight potential gaps in knowledge and awareness of causes and treatment of parasitic infection in children and to facilitate education to close this gap.

Nielsen Co. (New York, NY) was responsible for the execution and completion of the participant surveys, submission of the survey to potential participants, collecting survey data, tabulating results, and reporting final results to the sponsor (Lupin Pharmaceuticals Inc., Baltimore, MD). The online survey was conducted from July 1 to July 14, 2014, among 1000 pediatricians and pediatric sub-specialists regarding their awareness of the causes of diarrheal illnesses and available treatment options for children. Potential survey participants were identified from Nielsen's general pediatrician database (N = ~12,000) and 3286 were invited to participate via direct e-mail to achieve the target of 1000 respondents. Soft quotas included pediatric infectious disease specialists (n = 30) and pediatric gastroenterologists (n = 30), and the majority as general pediatricians (n = 940) (to a maximum of 1000 if soft quotas were not filled). Respondents were only included based on screening questions and had to be practicing in one of the target specialties (pediatrics, pediatrician gastroenterology, or pediatric infectious diseases), see ≥1 pediatric patient per week with diarrhea, and had been practicing clinical medicine for 2-30 years. Those who completed the survey were offered a modest honorarium ($25) for their time.

The survey was designed by Atom Strategic Consulting, LLC (Randolph, NJ) and Nielsen in collaboration with academic physicians with different specialty focus including pediatric infectious disease, pediatric gastroenterology, and epidemiology (The Persistent Diarrhea Working Group). Input on survey creation was also provided by staff from the Centers for Disease Control and Prevention (see Acknowledgments). Survey questions were organized such that general questions about diarrhea cause and treatment approach were asked first followed by specific questions about parasite awareness. This was followed by questions specific to familiarity with barriers to using nitazoxanide and then general parasite knowledge and treatment-related guideline questions. The survey concluded with a demographic assessment. There were a maximum of 44 survey questions that included four screening questions, five demographic questions, and 35 questions concerning diarrhea (on causes, definition, treatment, and parasite awareness) of which five had follow-up questions that would only require completion based on the response of the originating question. Survey questions and potential responses are detailed as Supplemental Data (see online).

Data analysis

Data were described descriptively as n (%) or mean ± SD for the total cohort of 1000 respondents and for pre-selected respondent subgroups defined by their particular response to survey questions (practice type, practice setting, duration in practice, cases of diarrhea seen weekly, persistent diarrhea changes suspicion of cause, caring for patients with recurrent/prolonged diarrhea, and familiarity with nitazoxanide). Statistical testing (IBM SPSS software) across subgroups was performed using the t-test with $P < 0.05$ considered as statistically significant.

Results

Respondent demographics

Table 1 shows the demographic breakdown of the survey respondents. Most were general pediatricians (95.8%), which is in line with the initially targeted population for the survey. A small percentage of respondents defined their specialty as pediatric gastroenterologists (2.7%), pediatric infectious disease specialists (1.4%), and pediatric surgeon (0.1%). Gender distribution was approximately equal. Their mean duration in practice was 16.7 ± 8.14 years (Table 1).

Survey analyses

Unless otherwise specified, the denominator for percentage calculations is based on the total of 1000 respondents.

Causes and Definition of Diarrhea

Results are summarized in Table 2. The majority of respondents (95.0%) identified viruses as the most likely cause of diarrhea; the next most likely cause was food intolerance (3.4%) and none selected

Table 1: Pediatrician Demographics.

Parameter	Total (N=1000)
Medical specialty	
General pediatrics	958 (95.8)
Pediatric gastroenterology	27 (2.7)
Pediatric infectious diseases	14 (1.4)
Pediatric surgeon	1 (0.1)
Pediatric patients seen per week	
>100	295 (29.5)
50–100	521 (52.1)
10–49	167 (16.7)
<10	17 (1.7)
Cases of diarrhea seen per week	
>25	109 (10.9)
15–25	282 (28.2)
5–14	499 (49.9)
<5	110 (11.0)
Gender	
Male	506 (50.6)
Female	494 (49.4)
Practice type	
Solo	120 (12.0)
Group	644 (64.4)
Multispecialty	211 (21.1)
Other	25 (2.5)
Practice location	
Urban	299 (29.9)
Suburban	609 (60.9)
Rural	91 (9.1)
Other	1 (0.1)
Years in practice	
21–30	340 (34.0)
11–20	393 (39.3)
2–10	167 (16.7)
Data are presented as n (%).	

parasites. The most likely approach to treatment was reported as empirical treatment with supportive therapy alone (82.0%). The majority of respondents defined 'persistent' diarrhea as lasting either >1 (39.6%) or >2 (41.2%) weeks. According to the respondent's definition of persistent diarrhea, 94.0% stated that their suspicion of the cause of diarrhea would change; among the respondents who replied yes (n = 940), the most frequent suspected causes were bacteria (39.5%), food intolerance (27.6%), and parasites (11.3%). Further, respondents who currently prescribe nitazoxanide (n = 21) were significantly (P<0.05) more likely to suspect parasites compared to those who had never heard of nitazoxanide (n = 33) [20.6% vs. 10.1%] or those who had heard of nitazoxanide but never prescribed it (n = 34) [20.6% vs. 9.5%]. The majority of respondents (82.7%) considered that there was a difference clinically between diarrhea that is ongoing compared to diarrhea that gets better but then recurs. Among those who considered there was a difference between ongoing and recurrent diarrhea (n = 827), the majority (89.8%) stated that their treatment approach would be different. Those who had been in practice for 21-30 years (n = 246) were significantly (P < 0.05) less likely to change their treatment approach compared to those who had been in practice for 2-10 years (n = 210) [85.7% vs. 92.5%] or 11-20 years (n = 287) [85.7% vs. 91.7%]. The majority of respondents stated they cared for patients with recurrent or persistent diarrhea 3-10 (17.6%), 1-2 (51.3%), or <1 times a month (28.3%). Respondents who prescribed nitazoxanide currently or in the past (n = 268) were significantly (P < 0.05) more likely to see a higher number of patients with persistent or prolonged diarrhea each month compared to those who were unfamiliar with nitazoxanide (n = 732): 32.1% vs. 15.6%, respectively, saw ≥3 patients a month (Table 2).

Questions/answers	No. of respondents (%)
In general, when a young patients (≥1 year old) presents with diarrhea, what in your experience is the most likely cause? (N=1000)	
Viruses	950 (95.0)
Food intolerance	34 (3.4)
All other answers combined	16 (1.6)
How do you approach medical management in a young patient (>1 year old)? (N=1000)	
Treat empirically with supportive therapy	824 (82.4)
Watch and wait	90 (9.0)
Treat empirically with drug and/or supportive therapy based on test results	66 (6.6)
Treat empirically with drug and supportive therapy	20 (2.0)
How do you define of 'persistent' diarrhea? (N =1000)	
>2 weeks	412 (41.2)
>1 week	396 (39.6)
4–6 days	146 (14.6)
<3 days	46 (4.6)
If the diarrhea is persistent by the respondent's definition, does your suspicion about what may be causing diarrhea change? (N=1000)	
Yes	940 (94.0)
No	60 (6.0)
Suspected cause of persistent diarrhea if yes to previous question (N =940)	
Bacteria	371 (39.5)
Food intolerance	259 (27.6)
Parasites	106 (11.3)
Viruses	83 (8.8)
Metabolic disorder such as celiac disease	56 (6.0)
All other answers combined	65 (6.9)
Is there a difference clinically in your opinion between ongoing and recurrent diarrhea? (N=1000)	
Yes	827 (82.7)
No	99 (9.9)
Do not know	74 (7.4)
Would your treatment approach be different for ongoing vs. recurrent diarrhea if yes to previous question? (N=827)	
Yes	743 (89.8)
No	51 (6.2)
Do not know	33 (4.0)
How often do you care for patients with recurrent and/or prolonged diarrhea? (N=1000)	
>10 times a month	24 (2.4)
3–10 times a month	176 (17.6)
1–2 times a month	513 (51.3)
<1 time a month	283 (28.3)
Never/do not know	4 (0.4)
Note: Some percentages do not add up to 100% exactly due to rounding.	

Table 2: Causes and Definition of Pediatric Diarrhea.

Consideration of Parasitic Infection

Results are summarized in Table 3. The majority of respondents would consider a parasite-induced infection after either 1 (43.3%) or 2 (44.9%) weeks with diarrhea. History and physical examination (83.9%), and duration of diarrhea (74.2%) were the primary factors for respondents to consider parasitic-induced infection. If they considered parasites as the cause of diarrhea, they would most commonly test for both Cryptosporidium spp. and Giardia spp. and initiate therapy after confirmation (70.9%). Most commonly, they would consider testing for parasites when diarrhea is considered persistent according to their definition (83.0%). Almost without exception, all had tested a child with diarrhea for parasites (98.7%). Routine fecal ova and parasite testing was most commonly used for diagnosing patients with cryptosporidiosis (89.2%) or giardiasis (82.3%). Approximately, half of respondents (54.3%) considered that a negative test for Cryptosporidium spp. was not 100% accurate (Table 3).

Treatment of Diarrhea

Results are summarized in Table 4 and Figure 1. Almost all survey respondents (97.4%) had currently or previously prescribed metronidazole to treat pediatric parasite-induced diarrhea, with considerably lower percentages of respondents being familiar with nitazoxanide (26.8%), tinidazole (16.3%), or paromomycin (13.5%) (Figure 1). The drug of first choice when considering empiric therapy was most commonly metronidazole (78.4%) with other agents being infrequently considered (paromomycin (10.4%), nitazoxanide (6.4%), and tinidazole (1.6%)). Only 18.4% of respondents knew that nitazoxanide was approved for the treatment of cryptosporidiosis and/or giardiasis in patients ≥1 years of age. The main barrier to treating patients with nitazoxanide was a lack of awareness of nitazoxanide (59.6%). A majority of respondents (72.0%) considered that the availability of a liquid formulation of nitazoxanide would change their potential treatment choice for pediatric diarrhea (Table 4).

Parasite Awareness

Results are summarized in Table 5. Only 43.0% of respondents correctly identified Centers of Disease Control and Prevention/American Academy of Pediatrics recommendation that pediatric patients with cryptosporidiosis should abstain from swimming until 2 weeks after their diarrhea had completely resolved. One-third (33.3%) of respondents correctly identified that alcohol-based hand gels and sanitizers did not inactive either Giardia spp. or Cryptosporidium spp., with the majority not knowing (38.0%) or being incorrect (38.7%). The predominant reason given by the respondents for concern over

Questions/answers	No. of respondents (%)
In what time course in a child do you consider a possible parasite-induced infection? (N=1000)	
After 14 days	449 (44.9)
After 7 days	433 (43.3)
After 3 days	53 (5.3)
All other answers combined	65 (6.5)
When you think of parasites causing diarrhea in children, what do you typically see in your practice? (N=1000)	
Giardia	809 (80.9)
Cryptosporidium	277 (27.7)
Other parasites	120 (12.0)
Do not see parasites	98 (9.8)
What would prompt you to consider a parasite-induced infection as the cause of diarrhea in a young patient 1–12 years of age? (N=1000)*	
History and physical exam	839 (83.9)
Duration of diarrhea at presentation	742 (74.2)
Type of diarrhea at presentation	428 (42.8)
All other possible causes are ruled out	362 (36.2)
Based on travel history	28 (2.8)
If you are considering parasites as the cause of diarrhea, how do you approach treatment and diagnosis? (N=1000)	
Test for both Cryptosporidium and Giardia and initiate drug therapy after confirmation	709 (70.9)
Test for Giardia and initiate drug therapy after confirmation	121 (12.1)
Test for both Cryptosporidium and Giardia but do not initiate drug therapy after confirmation (watch and wait)	96 (9.6)
All other answers combined	74 (7.4)
When would you consider testing for parasites? (N=1000)	
When diarrhea is persistent by my definition	830 (83.0)
When my initial treatment is not effective	139 (13.9)
All other answers combined	31 (3.1)
Have you ever tested a child with diarrhea for parasites? (N=1000)	
Yes	987 (98.7)
No	13 (1.3)
Which of the following would you consider to be a valid concern with regard to parasite-induced infection in a child? (N=1000)†	
It can lead to delayed recognition and treatment	833 (83.3)
It can result in prolonged morbidity for the child	735 (73.5)
It can lead to lost productivity and general inconvenience for caregivers	702 (70.2)
It can result in transmission to others due to delayed or lack of treatment	655 (65.5)
Which tests have you requested for diagnosing patients with cryptosporidiosis in the past? (N=1000)*	
Routine fecal ova and parasite test	892 (89.2)
Specific cryptosporidiosis testing such as PCR or other DNA-based testing	309 (30.9)
Immunochromatographic card/rapid card test	60 (6.0)
Not applicable (have not ordered cryptosporidiosis testing in the past)	26 (2.6)
In your experience is a negative test for Cryptosporidium always 100% accurate? (N=1000)	
No	543 (54.3)
Do not know	380 (38.0)
Yes	77 (7.7)
Is cryptosporidiosis a reportable disease in your state? (N=1000)	
Yes	333 (33.3)
No	119 (11.9)
Do not know	551 (55.1)
Which tests have you requested for diagnosing patients with Giardia in the past? (N=1000)*	
Routine fecal ova and parasite test	823 (82.3)
Antigen testing for Giardia	435 (43.5)
Specific Giardia testing such as PCR or other DNA-based testing	269 (26.9)
Not applicable (have not ordered giardiasis testing in the past)	16 (1.6)
Is giardiasis a reportable disease in your state? (N=1000)	
Yes	280 (28.0)
No	253 (25.3)
Do not know	467 (46.7)

*Multiple choice response. All other responses ≤1%.
†Multiple choice response.
PCR, polymerase chain reaction.

Table 3: Consideration of Parasitic Infection.

Questions/answers	No. of respondents (%)
When considering empiric drug therapy for parasite-induced diarrhea in a child, which medication would be your first choice (N=1000)	
Metronidazole	784 (78.4)
Nitazoxanide	64 (6.4)
Tinidazole	16 (1.6)
Albendazole	9 (0.9)
Paromomycin	104 (10.4)
I tend to 'watch and wait'	20 (2.0)
All other answers combined	23 (2.3)
The FDA has approved nitazoxanide for the treatment of cryptosporidiosis and/or giardiasis in patients of which age range? (N=1000)	
Do not know	632 (63.2)
≥1 years	184 (18.4)
≥12 years	67 (6.7)
1–11 years of age	62 (6.2)
All other age groups	55 (5.5)
What are the main barriers to treating patients with nitazoxanide in your opinion? (N=1000)*	
There is little awareness of nitazoxanide in my practice	596 (59.6)
Cost of the medication	342 (34.2)
Challenges finding a pharmacy that provides oral suspension of nitazoxanide	236 (23.6)
No barriers	139 (13.9)
Has the availability of nitazoxanide impacted the frequently with which you order diagnostic testing for suspected cryptosporidiosis or giardiasis? (N=1000)	
No	878 (87.8)
Not sure	167 (16.7)
Yes	113 (11.3)
Does the availability of a liquid formulation of nitazoxanide change your potential treatment choice for diarrhea? (N=1000)	
Yes	720 (72.0)
No	99 (9.9)
Do not know	74 (7.4)
*Multiple choice responses. FDA, Food and Drug Administration.	

Table 4: Diarrhea Treatment.

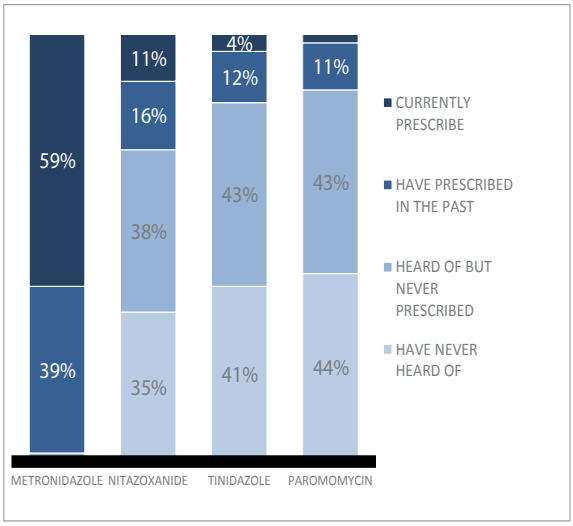

Figure 1: Familiarity of respondents (N=1000) with various prescription drugs to treat.

parasite transmission was transmission between the patient and caregiver/other family member (89.3%), with 36.5% citing pet-to-patient transmission. Approximately half of respondents thought that burden of caring factored into their decision to treat persistent pediatric diarrhea (54.7%) and that children affected by persistent diarrhea would be fairly/very/extremely distressed by their condition (45.7%). Approximately half of respondents (56.2%) considered that print material would be the most appropriate medium for additional educational opportunity concerning parasitic infections followed by live events including web-based education (35.6%) - only 19.8% did not require additional education on this topic (Table 5).

Discussion

Until the present survey, there has been little published information on the knowledge, attitudes, and approach to diagnosis and treatment of parasitic diarrhea among pediatricians in general practice. The number of survey respondents (N=1000) was sufficiently large to provide a representative sample of the target pediatrician population. Respondents had to have treated at ≥1 child ages 1-12 years every week and be in practice for 2-30 years. A potential limitation was responder bias in that only about one-third of pediatricians responded to the e-mail survey.

Almost all pediatricians (95.0%) think of viruses as the most likely cause of diarrhea in young patients on initial presentation and therefore treat empirically with supportive therapy (82.4%). However, if diarrhea is persistent, they are more likely to suspect bacteria (39.5%) or food intolerance (27.6%), with one in ten suspecting parasites (11.3%). They were split evenly in their definition of diarrhea persistence between >1 and >2 weeks (41.2% and 39.6%, respectively). Approximately three-quarters of pediatricians (71.3%) reported caring for ≥1 patient per month with recurrent and/or persistent diarrhea, with about one in five (20.0%) reporting ≥3 patients monthly. Almost all pediatricians would consider a parasite-induced infection after about >1 or >2 weeks (44.9% and 43.3%, respectively), while ~5% cited that they do not usually think about parasitic infection. History and physical

Questions/answers	No. of respondents (%)
The CDC and AAP recommend that patients diagnosed with cryptosporidiosis abstain from swimming until when? (N=1000)	
Their diarrhea has completely resolved	432 (43.2)
Two weeks after their diarrhea has completely resolved	430 (43.0)
They complete a 3-day treatment course of nitazoxanide	96 (9.6)
Do not know	38 (3.8)
All other answers combined	4 (0.4)
Alcohol-based hand gels and sanitizers effectively inactivate? (N=1000)	
Do not know	380 (38.0)
Neither	333 (33.3)
Both	232 (23.2)
Giardia	45 (4.5)
Cryptosporidium	10 (1.0)
Do you feel that transmission of parasites is of concern for…? (N=1000)*	
Patient to caregiver or other family member transmission	893 (89.3)
Pet to patients transmission	365 (36.5)
Patient to pet transmission	160 (16.0)
I feel such transmission risk is low and do not worry about it	58 (5.8)
Does the burden of caring for a patient with persistent diarrhea factor into your decision to treat? (N=1000)	
Yes	547 (54.7)
No	321 (32.1)
I do not think about this issue	132 (13.2)
How distressed would you say children are when they experience persistent diarrhea? (N=1000)	
Somewhat distressed	511 (51.1)
Distressed or fairly distressed	329 (32.9)
Very distressed	113 (11.3)
Very distressed	32 (3.2)
Extremely distressed	15 (1.5)
What additional educational opportunity would you like available concerning parasitic infections? (N=1000)*	
Additional print material	562 (56.2)
Additional live events including web-based education	356 (35.6)
More interaction with a sales representative to obtain information	274 (27.4)
I do not require additional education on this topic	198 (19.8)
*Multiple choice response. AAP, American Academy of Pediatrics; CDC, Centers for Disease Control and Prevention.	

Table 5: Parasite Awareness.

exam (83.9%) and duration of diarrhea (74.4%) were the primary considerations for parasitic-induced infection, with about one-third (36.2%) only considering parasites when all other possible causes had been ruled out. Delayed recognition and treatment (83.3%), prolonged morbidity (73.5%), lost productivity and general inconvenience to caregivers (70.2%), and transmission to others (65.5%) were concerns for most pediatricians. Giardia (80.9%) was the most frequent parasite seen in their pediatric practice followed by Cryptosporidium (27.7%) and other parasites (12.0%), with about one in ten (9.8%) not seeing parasites. If considering parasites as the cause of diarrhea, most test for Giardia and Cryptosporidium (70.9%) or Giardia alone (12.1%) and initiate drug therapy after confirmation. Routine fecal ova and parasite testing for Giardia (82.3%) and Cryptosporidium (89.2%) was the most common test used for diagnosis.

Given these findings with respect to the causes and definition of pediatric diarrhea and consideration of parasitic infection in children, it is important to bear in mind recent reports of the potential for long-term complications from parasitic infections [14,15]. Six years after a waterborne Giardia outbreak, [15] the prevalence of irritable bowel syndrome (39.4%) and chronic fatigue (30.8%) were elevated and significantly increased (relative risk approximately 3-fold higher) compared to matched controls. Compared to results 3 years previously, [14] the prevalence of both conditions decreased over time. Thus, Giardia infection may elicit very long-term, but slowly self-limiting, complications. Prompt, appropriate treatment of parasite-induced diarrhea is therefore important to minimize the potential for any long-term morbidity and may be an underestimated concern for some pediatricians.

Metronidazole was the first choice among survey responders for empiric drug therapy for parasite-induced infections (78.4%) followed by paromomycin (10.4%) and nitazoxanide (6.4%). This was despite the general recognition that metronidazole is difficult to administer in children: it generally needs to be administered as 3-times daily for 10 days and has a bitter metallic taste, particularly when tablets have to be divided as no standard oral pediatric liquid formulation is available [7,8]. Metronidazole also induces adverse effects and resistance occurs in G. lamblia [8-11]. Notably, about three-quarters (72.0%) of pediatricians considered that the availability of a liquid formulation of nitazoxanide would change their potential treatment choice for diarrhea. Nitazoxanide is available as a pleasant-tasting pediatric oral suspension for administration using a twice-daily regimen for 3 days. There was poor awareness of the age range for which nitazoxanide is approved by the FDA as approximately two-thirds (63.2%) of respondents did not know; in actuality, the pediatric formulation is approved for children ages 1-11 years and as tablets for those ages >12 years. Furthermore, nitazoxanide is the only medication that is FDA-

approved for the treatment of both Giardia and Cryptosporidium infection.

Just less than half of pediatricians (43.0%) correctly recognized Centers for Disease Control and Prevention/American Academy of Pediatrics recommendations that patients diagnosed with cryptosporidiosis should abstain from swimming until at least 2 weeks after their diarrhea has completely resolved. Transmission of Cryptosporidium and Giardia via recreational water activity (e.g. swimming in public pools, recreational parks, rivers, lakes, rivers) appears relatively frequently and is associated with seasonal peaks in infections during the summer [16-18]. One-third (33.3%) of pediatricians correctly identified that alcohol-based hand gels and sanitizers do not effectively inactivate either Giardia or Cryptosporidium, while 38.0% did not know. To receive additional education concerning parasitic infections, respondents preferred additional print materials (56.2%) followed by live events including web-based education (35.6%).

In conclusion, the results of this survey supports the need to enhance efforts to provide education among general pediatricians on how best to manage and effectively treat childhood diarrhea caused by parasites such as Giardia and Cryptosporidium.

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