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ORIGINAL ARTICLE

Nutritional management of young infants presenting with acute bronchiolitis in Belgium, France and Switzerland: survey of current practices and documentary search of national guidelines worldwide

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Abstract

Feeding difficulties are common in young infants presenting with acute bronchiolitis, but limited data is available to guide clinicians adapting nutritional management. We aimed to assess paediatricians' nutritional practices among Western Europe French speaking countries. A survey was disseminated to describe advice given to parents for at home nutritional support, in hospital nutritional management, and preferred methods for enteral nutrition and for intravenous fluid management. A documentary search of international guidelines was concomitantly conducted. Ninety-three (66%) contacted physicians responded. Feeding difficulties were a common indication for infants' admission. Written protocols were rarely available. Enteral nutrition was favoured most of the time when oral nutrition was insufficient and might be withheld in case of severe dyspnoea to decrease respiratory workload. Half of physicians were aware of hyponatremia risk and pathophysiology, and isotonic intravenous solutions were used in less than 15% of centres. International guideline search (23 countries) showed a lack of detailed nutritional management recommendations in most of them.

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Conclusion: practices were inconsistent among physicians. Guidelines detailed nutritional management poorly. Awareness of hyponatremia risk in relation to intravenous hypotonic fluids and of the safety of enteral hydration and nutrition is insufficient. New guidelines including detailed nutritional management recommendations are urgently needed.

What is Known?
- *Infants presenting with acute bronchiolitis face feeding difficulties.*
- *Underfeeding may promote undernutrition, and intravenous hydration with hypotonic fluids may induce hyponatremia.*

What is New?
- *Physicians' nutritional practices are inconsistent and awareness of hyponatremia risk and pathophysiology is insufficient among physicians.*
- *Awareness of hyponatremia risk and pathophysiology is insufficient among physicians.*
- *The reasons for enteral nutrition withholding in bronchiolitis infants are not evidence based, and national guidelines of acute bronchiolitis across the world are elusive regarding nutritional management.*
- *National guidelines of acute bronchiolitis across the world are elusive regarding nutritional management.*

Keywords Recommendation · Child · Nutrition · Bronchiolitis, clinical practice

Abbreviations

IV	Intravenous
NutriSIP	the French speaking paediatric intensive care nutrition group
PICU	paediatric intensive care units
SIADH	syndrome of inappropriate secretion of antidiuretic hormone

Introduction

Acute bronchiolitis is one of the most prevalent diseases in infants [21]. Young age is a risk factor for severity and hospital admission [3]. More than 20,000 bronchiolitis infants were admitted in French hospitals during the 2017–2018 bronchiolitis season. In 2009, the hospitalisation rate was 35.6 per 1000 French infants, with 13% requiring mechanical ventilation support [3]. Indeed, respiratory distress is one of the main symptoms of this disease, as a consequence of upper and lower airway obstruction with secretions or lower airways and alveolar inflammation. As a result, children presenting with bronchiolitis may present with feeding difficulties, which are frequent indications for admission. In severe bronchiolitis, these may even lead to underfeeding, faltering growth and dehydration. Poor oral intake with no nutritional support has been shown to be associated with longer hospital stays [35].

Surprisingly, nutritional support strategies for acute bronchiolitis have been inadequately studied. Practices are often based on common sense and experience. This consists of an increase of the number of feeds per day, combined with decreasing the amount of volume per feed, and/or of nasal suctioning prior to breast/bottle feeding and/or of formula thickening, as recommended in the European French speaking bronchiolitis guidelines published in 2001 [32]. Furthermore, these guidelines state that infants with acute bronchiolitis may require enteral nutrition via a naso-gastric tube or parenteral nutrition. A group from the western French region has updated the bronchiolitis guidelines in 2013 [33] and proposed a nutritional strategy based on the Wang modified severity score (mainly based on respiratory markers). Low Wang scores allowed for oral feeding, moderate scores for naso-gastric enteral feeding and high scores for intravenous hydration with close monitoring of serum sodium levels (hyponatremia) because of the risk of syndrome of inappropriate secretion of antidiuretic hormone (SIADH). Swiss guidelines similarly have highlighted the high risk of hyponatremia [1]. However, these nutritional support guidelines remain vague, while the benefit (or absence of) of other treatments are far much detailed (use of salbutamol, adrenalin, hypertonic saline nebulization, chest physiotherapy, antibiotics), based on plethora of literature.

Bronchiolitis nutritional practices in European French speaking countries have not yet been examined, nor has their compliance with existing guidelines. Recent emphasis on the hyponatremia risk in bronchiolitis infants may impact on the nutritional strategy, regarding the hydration/nutrition route (intravenous versus enteral) and regarding solution types (iso- versus hypo-tonic fluids). Indeed, hyponatremia (caused by both anti-diuretic hormone secretion and renin-angiotensin-aldosterone system activation [16]) is also worsened by the use of intravenous hypotonic solution [19].

In this study, we aimed to describe nutritional practices among general paediatrics units in European French speaking countries (especially focusing on enteral versus parenteral route use, on formula and solution type use and on nutritional goals), to assess their compliance with international nutritional bronchiolitis guidelines and to locate national guidance around bronchiolitis management across the World.

Material and methods

A 23-item cross-sectional survey was constructed by the NutriSIP (the French speaking paediatric intensive care nutrition group) members (as no validated pre-existing tool matching our objectives existed) with all closed

ended questions. The survey was pilot-tested on six physicians to assess clarity of questions and establish face validity and was modified slightly. The survey items were selected as they corresponded to the main nutritional issues identified by the NutriSIP, in order to assess nutritional care of young infants presenting with acute bronchiolitis: advice given to parents for at home nutritional support, in hospital nutritional management, preferred methods for enteral nutrition and preferred methods for intravenous fluid management. The focus was on acute bronchiolitis, excluding infants with chronic respiratory failure, congenital heart disease or history of prematurity. Infants presenting with asthma were outside the scope of the survey. Young infants were defined as children younger than 3 months of age.

This survey is presented in supplemental digital content 1 in its original French version which was sent to invited responders (an English translation is provided in supplemental digital content 2). The electronic survey was disseminated online in spring 2018 via Survey-Monkey® software (San Mateo, California, USA) within the NutriSIP network. Every paediatric unit of local or university hospitals, admitting young infants presenting with acute bronchiolitis, was contacted to participate to the survey, in six different areas of French-speaking western Europe countries (Belgium, France and Switzerland), corresponding to the recruitment area of university paediatric intensive care units (PICUs) where a NutriSIP member is working: Auvergne-Rhône-Alpes area, Languedoc-Roussillon area, French Grand-Ouest area, Provence-Côte d'Azur area and French speaking parts of Belgium and Switzerland. In each unit, one only physician working in a general paediatric ward or a paediatric emergency department was asked to answer the survey (intermediate care and PICU physicians were excluded from the survey). The survey was accompanied by an information letter with instructions clarifying the setting and how to answer the questionnaire, insisting on the fact that answers should describe local current practices rather than ideal practices (see supplemental digital contents 1 and 2). We aimed for a response rate at 70%, so two reminder e-mails were sent in case of no response.

In addition to the survey, a focused documentary search and analysis of international bronchiolitis guidelines were conducted (published either in English, French, German, Spanish, Portuguese, Dutch, Swedish, Norwegian, Danish or Italian), on Pubmed and Google Scholar (using Mesh terms: "bronchiolitis, "nutrition", and using the filter "consensus development conference") from 2000 to 2018. NutriSIP members contacted physicians involved in bronchiolitis management worldwide through their personal networks, in order to access national guidelines stored on national platforms or published in national non-referenced journals or websites.

Statistical analysis

Data are expressed as mean and standard deviation (SD) for normally distributed continuous variables, or as median and inter-quartiles (IQR) for non-normally distributed variables and frequency and proportions for categorical variables. The country where responders were working (i.e., Belgium, France or Switzerland) was considered as a factor which we hypothesised could impact nutritional practices and was analysed using Chi-square or Fisher's exact test for categorical variables. Statistical significance threshold was set at 5%. Statistical analyses were conducted using IBM SPSS® Statistics version 24.0 (IBM® Armonk, NY, USA).

Results

Ninety-three (66% response rate) physicians working in general paediatric and/or paediatric emergency wards completed the online survey, out of the 141 physicians (one only per unit) that were contacted (16 from Belgium, 73 from France, 4 from Switzerland: the list of responding centres is displayed in the acknowledgment section). Ninety-seven percent of them were paediatricians, with 67% working in a local hospital and 33% in university hospitals; physicians had been working in paediatric wards for a median of 14 years (IQR 7–20) and the median number of beds in the unit was 20 (IQR 15–27). Survey completion ratio was high, with missing data rare (< 4%).

Main results are presented in Tables 1, 2, 3 and 4. Detailed results are presented in supplemental digital content 2. (1) *Regarding home discharge nutritional information*, written documentation was given to parents in less than 25% of the units, and an increase number of feeds a day with pre-feed nasal suctioning was advised by about 80% physicians (Table 1). (2) *Regarding enteral* versus *parenteral choice strategy*, enteral nutrition was withheld at admission in 24% of the centres and in case of severe forms of bronchiolitis in 65.6%. This aimed to reduce respiratory workload for 87.8% of the responders (Table 2). (3) *Regarding enteral nutrition*, usual milk (breast feeding was favoured by a vast majority of physicians) was administered by bolus method in 72% of the units. Nurses and parents were more reluctant to perform naso-gastric tube insertion (42.1% and 38.6%, respectively), compared to physicians (12.1%; $p < 0.00$) (Table 3). (4) *Regarding parenteral management*, isotonic fluids were used in 13.4% of the units, while easy availability of intravenous (IV) fluid solution was the major factor influencing the physicians' prescription. About one fourth admitted insufficient knowledge about hyponatremia risk and pathophysiology (Table 4).

The use of isotonic IV solution was more frequent in Belgium and Switzerland, compared with France but the

Table 1 Physicians' main answers: Advice given to parents for home nutritional management of young infants with acute bronchiolitis

Questions (in bold font) and answers	Number (%)
Q7. Do you give parents any documentation/written information about nutrition if a child with acute bronchiolitis is discharged home from the emergency department?	*N* = 89
Yes	24 (27.0%)
Q8. Do you give parents any documentation/written information about nutrition when a child with acute bronchiolitis is discharged home after hospital admission?	*N* = 90
Yes	14 (15.6%)
Q10. Which advice about nutrition do you give parents when a child with acute bronchiolitis is discharged home from the emergency department?	*N* = 90
To increase the number of feeds a day	85 (94.4%)
Promote breast feeding without any change	46 (51.1%)
Daily weighing if younger than 1 month old	18 (20.0%)
Formula thickening, switching to a pre-thickened formula	26 (28.9%)
Formula thickening, adding thickeners	23 (25.6%)
Nasal suctioning prior to bottle/breast feeding	79 (97.8%)
No limitation of feeding duration	26 (28.9%)
Limit the maximum feeding duration to 30 min	17 (18.9%)
Consult with a doctor in case of oral intake decreasing to < 50% of normal intakes for 2 days	66 (73.3%)

difference was not significant. No other differences were found between countries.

The guideline search found Western Europe guidelines ($n = 13$), and other developed country guidelines ($n = 8$). Detailed nutritional care was not part of the guidelines in half of the countries. In others, nutritional support guidance provided varied widely depending on the country, as presented in Supplemental material 3. Oral feeding ability was a common criterion for hospitalisation, but thresholds (if mentioned) varied by country. Clear guidance around enteral or parenteral support was available in 6 (29%) in favour of enteral nutrition in 5 (80%) and indication when to withhold enteral nutrition poorly detailed. Type of fluid solutions to be used in case of intravenous hydration (isotonic solution) was clearly detailed in 5 (24%), and hyponatremia occurrence risk was mentioned in 12 (57%). Scarcity of and inconsistency between international guidelines did not allow for practices/guidelines concordance analysis.

Discussion

A wide range of practices was found regarding the assessment and management of nutritional care for acute bronchiolitis in young infants, among general paediatric physicians. Practices and reasons for the withholding of oral and enteral nutrition were not consistent. An awareness of hyponatremia occurrence risk was present, but its pathophysiology and relation to hypotonic solution infusion was insufficiently known. Most international guidelines were vague about nutrition care.

Prescribing practices for enteral or parenteral hydration and nutrition were not consistent amongst physicians. This could partly be explained by the paucity of details regarding nutritional management found in the guidelines [1, 33]. Previous studies which assessed physicians' compliance with bronchiolitis guidelines found that change in physicians' practices prior to and after guideline publication varied depending on the education program proposed at the same time, but limited data regarding nutritional support or hydration was collected [2, 4]. Dissemination of and incorporation of guidelines into daily clinical practice remain challenging.

Parental advice for home nutritional management and in-hospital management of moderate forms of bronchiolitis were not consistent amongst physicians, apart from the importance to perform nasal suctioning prior to oral feeding, and to increase the number of feeds a day whilst maintaining a normal daily total amount of feeds. Formula thickening was also proposed, as per Khoshoo et al. study [14]. Most international guidelines refer to the child's capacity to sustain adequate feeding and hydration as a disease severity indicator and potential criteria for hospital admission. However, the precise threshold (from guidelines and in our survey) is rarely set. It is also a commonly recommended criterion for hospital discharge. These are

Table 2 Physicians' main answers: nutritional strategy for young infants admitted for acute bronchiolitis

Questions (in bold font) and answers	Number (%)
Q9. Do you have local written guidelines or a protocol about how to feed acute bronchiolitis children during their admission?	*N* = 85
Yes	26 (30.6%)
Q11. How would you manage a child admitted to your unit and presenting with an acute bronchiolitis, with mild dyspnea and hypoxia requiring oxygen? (the parents report that the infant requires 1.5 times more time to feed; no weight loss)	*N* = 90
I prescribe the exact same diet as at home	17 (18.9%)
I increase the number of feeds a day	78 (86.7%)
I promote breast feeding and add conditional supplemental formula bottles	30 (33.3%)
I order formula thickening, switching for a pre-thickened formula	28 (31.1%)
I recommend nasal suctioning prior to bottle/breast feeding	72 (80.0%)
I prescribe gastric feeding for what is left after bottle feed, if > 50% of total volume	31 (34.4%)
Q12. How would you manage in the 12 first hours a child admitted to your unit and presenting with an acute bronchiolitis, with moderate dyspnea and no hypoxia, no hypercarbia, no acidosis? (the child eats about 65% of normal amounts a day)	*N* = 87
Oral feeding only	27 (31.0%)
Oral feeding + gastric feeding of what is not orally taken	40 (46.0%)
Oral nutrition + IV fluids	8 (9.2%)
Q13. How would you manage in the 12 first hours a child admitted to your unit and presenting with an acute bronchiolitis, with moderate dyspnea and no hypoxia, no hypercarbia, no acidosis? (The child eats about 15% of normal amounts a day).	N = 89
Oral feeding + gastric feeding of what is not orally taken	23 (25.8%)
Enteral nutrition (via gastric tube) only	44 (49.5%)
Q14. In a child admitted for acute bronchiolitis and significant respiratory distress, when would you withhold or decrease oral or enteral nutrition?	*N* = 90
Systematically at admission (IV fluids are initiated), reassessment a few hours after	22 (24.4%)
According to a subjective assessment of respiratory distress	34 (37.8%)
In case of significant hypercarbia	26 (28.9%)
In case of need for high flow nasal cannula	35 (38.9%)
More systematically if apnoea occurrence	32 (35.6%)
More systematically if respiratory distress or exhaustion	59 (65.6%)
In case of the need for transfer to high dependency care or intensive care unit	50 (55.6%)
Q15. What benefits do you expect from oral feed withholding, in acute bronchiolitis children admitted for significant respiratory distress?	*N* = 90
Decrease of respiratory workload	79 (87.8%)
As a security measure (fasting) in case of the need for potential intubation	31 (34.4%)
To prevent stomach distention, and thus to allow for good lung expansion	43 (47.8%)
To prevent regurgitation, vomiting, aspiration	36 (40.0%)
Q16. What benefits do you expect from enteral feed withholding, in acute bronchiolitis children admitted for significant respiratory distress?	*N* = 88
Decrease of respiratory workload	37 (42.0%)
As a security measure (fasting) in case of the need for potential intubation	49 (55.7%)
To prevent stomach distention, to allow for good lung expansion	42 (47.7%)
To prevent regurgitation, vomiting, aspiration	37 (42.0%)

consensual recommendations and practices but are mainly based on experience and common sense, rather than on evidence.

For hospital care, physicians differed regarding their use of oral, enteral and parenteral hydration/nutrition. Oral and enteral support was favoured, but not in all centres, and IV management was often proposed in severe bronchiolitis. The main reason to withhold oral nutrition was its impact on respiratory work load, as described by Pinnington et al. [28], and to prevent aspiration [13]. More surprisingly, this was also a reason to withhold enteral tube feeding in one third of the units, even when no sucking/swallowing effort was involved.

Table 3 Physicians' main answers: use of enteral nutrition in young infants admitted for acute bronchiolitis

Questions (in bold font) and answers	Number (%)
Q17. What is your preferred method of enteral nutrition administration in a child admitted for acute bronchiolitis?	*N* = 90
Bolus feeding most of the time	65 (72.2%)
Continuous feeding most of the time	23 (25.6%)
Q18. What is your preferred type of milk/formula in this setting (apart from thickening)?	*N* = 90
Child's normal milk/formula	65 (72.2%)
Mothers milk, with no additions	69 (76.7%)
Q22. While inserting a gastric tube, which parameters may influence your choice?	*N* = 90
I don t know of which material gastric tube are made of	45 (50.0%)
Naso-gastric insertion most of the time	72 (80.0%)
I don t know the size of the gastric tubes that are inserted in my unit	39 (43.3%)
Q23. What would limit the use/insertion of gastric tube for acute bronchiolitis children in your unit?	*N* = 83
The nursing team is reluctant	35 (42.1%)
Physicians are reluctant	10 (12.1%)
Parents are reluctant	32 (38.6%)
Naso-gastric tube obstructs one nostril and compromises breathing	27 (32.6%)
Oro-gastric tube insertion often causes regurgitation/vomiting	27 (32.6%)

Similarly, half of the physicians mentioned that withholding enteral nutrition could prevent the impact of gastric overdistention on ventilation, but continuous feeding which may limit this side effect compared to bolus feeding was prescribed by less than 25%. Finally, withholding feeds to keep an empty stomach was also mentioned as a reason in anticipation of the potential need for intubation to prevent aspiration. Yet, the very low rate of intubation required in bronchiolitis should question this perceived fear. Indeed, recent reviews of bronchiolitis hospital admissions found that 6.7% to 16.0% of hospitalised infants required PICU admission for respiratory support, but only 1.2% to 4.1% required intubation [26, 27]. In most international guidelines, nutrition management is described vaguely, especially regarding the optimal feeding method to implement (oral, versus enteral, versus intravenous) and regarding the type of feeds to administer. When mentioned, breast milk remains the recommended formula. Oral/enteral feeding is generally recommended as a first-line nutritional strategy, but often, no clear benefit is highlighted in the guidelines in comparison to IV fluids. Yet, studies conducted in bronchiolitis infants have compared IV and enteral hydration and nutrition showing no significant difference on tolerance. Oakley et al. found no difference in length of stay and side effects while comparing gastric tube hydration (oral hydration solution) and intravenous hydration (hypotonic solution); however, the success rate of gastric tube insertion was higher than peripheral venous catheter insertion, and gastric hydration was also cost-saving [23–25]. Srinivasan et al. also found similar rates of aspiration while comparing IV hydration to gastric hydration [31]. Kugelman et al. compared IV hydration (hypotonic fluid) to gastric nutrition (breast milk or infant formula) and found no difference in outcomes [15]. There is ongoing debate around the optimal respiratory support method [8, 20], but nasal high flow and non-invasive ventilation does not seem to impact feeding tolerance: in infants receiving high flow nasal cannula support, feed related complications (emesis and respiratory distress) were not dependent on feeding/hydration mode [29, 30]. Finally, while enteral nutrition may be associated with respiratory failure progression in adults on non-invasive ventilation, complications related to enteral feeding in children were rare [17]. Unfortunately, the impact on nutritional status was not assessed as an outcome in these studies comparing intravenous to enteral routes. Enteral nutrition may be safer than originally thought by physicians.

When IV hydration was used, only 13% of surveyed physicians prescribed isotonic solutions. More than 40% of physicians were not aware of the hyponatremia risk in bronchiolitis infants. In various studies, hyponatremia was present at PICU admission in 16 to 22% of infants with bronchiolitis (this rate may increase to 57% depending on the measurement technique) and was associated with severity of illness and length of stay [10, 18, 22]. Lavagno et al. have recently published a reappraisal of the pathophysiology of hyponatremia occurring in children with acute respiratory infections [16]. Hyponatremia is more likely to be the consequence of a volume-dependent activation of the renin-angiotensin-aldosterone system,

Table 4 Physicians' main answers: intra venous fluid management of young infants admitted for acute bronchiolitis

Questions (in bold font) and answers	Number (%)
Q19. When you order IV fluids in a 6-week-old bronchiolitis infant (4.4 kg) without any electrolytic disturbance, what kind of solution would choose as a first line?	*N* = 89
Ready to use hypotonic solutions	55 (47.2%)
Hypotonic solutions "Holliday and Segar type formula" (reconstitution by nurses)	11 (12.4%)
Ready to use isotonic solution:	2 (2.3%)
Other isotonic solution (reconstitution by nurses)	10 (11.2%)
Q20. Considering hyponatremia occurring in children admitted for acute bronchiolitis, which of the following sounds right to you?	*N* = 89
Hyponatremia is classic complication, but rare in my experience	48 (53.9%)
Its potential occurrence requires systematic sodium monitoring, whichever the age	26 (29.2%)
It is the consequence of an anti-diuretic hormone inappropriate secretion syndrome	55 (61.5%)
It can be worsened by the use of a hypotonic solution infusion	41 (46.1%)
It can be worsened by the use of a hyperosmolar solution infusion	23 (25.8%)
It can lead to seizures	58 (65.2%)
I don t know some answers of this question	23 (25.8%)
Q21. While ordering IV fluids on a peripheral line (apart from fluid bolus), in a child admitted for acute bronchiolitis, which parameters guide your choice?	*N* = 90
IV fluid glucose concentration	31 (34.4%)
IV fluid solution tonicity	21 (23.3%)
IV fluid solution osmolarity	26 (28.9%)
IV fluid solution easiness to use (ready to use versus nurse reconstitution)	60 (66.7%)
Local guidelines	36 (40.0%)

combined with an appropriate anti diuretic hormone secretion which may also be inappropriately triggered by a volume-independent stimulus. Guidelines referring to "SIADH related hyponatremia" may not reflect its true pathophysiology and lead to inappropriate fluid/sodium management. However, bronchiolitis-related hyponatremia may be worsened by the use of IV hypotonic solutions [19]: Hanna et al. found that 3 out of 4 infants admitted to PICU with hyponatremic seizures had received hypotonic IV solutions prior to admission [9]. Moreover, only half of the bronchiolitis guidelines available highlighted this hyponatremia risk despite the plethora of literature on the topic [7, 34], and French, Belgian and Swiss guidelines remain vague on the harm caused by hypotonic solutions [1, 32, 33]. Isotonic solution use should be standard practice [19, 34]. However, a majority of physicians based their choice on the availability of ready-to-use solutions. The absence of a ready-to-use isotonic solution designed for infants (containing sufficient amount of glucose, e.g., 'Glucose 5%–NaCl 0.9%') with a French marketing authorization may prevent physicians prescribing such a solution. Belgian and Swiss physicians were more likely to use these isotonic solutions, as these are available in their respective countries. Finally, it would also be useful to include hyponatremia as an outcome in the future studies assessing enteral nutrition support to confirm their safety regarding this issue.

As for energy targets, the vast majority of physicians surveyed stated that they prescribed or advised normal total amounts of feeds per day. No recommendations could be found worldwide to guide clinicians. A recent study which assessed resting energy expenditure (REE) by indirect calorimetry in infants (2- to 11-month-old), presenting with mild bronchiolitis (no oxygen requirements) found that most children were hyper or hypo metabolic [6]. Schofield equations failed to accurately predict REE. No data were presented regarding more severely ill infants. This makes the adaptation of feeds to energy requirements challenging. Finally, one study conducted in critically ill bronchiolitis infants has suggested that higher intakes of energy and protein improved anabolism, but no impact on clinical outcomes was assessed [5]. Yet, dyspnoea and bronchiolitis have been shown to be associated with increased risk for weight loss during admission in an intermediate care unit [11]. The impact on outcome of each specific macronutrient (i.e., proteins, lipids, carbohydrates) is poorly studied in the literature, and the questionnaire sent to clinicians did not intend to highlight this issue. Therefore, it is urgent to appropriately determine the optimal nutritional strategy in this setting. Finally, breast milk was favoured by most responders. Immunologic benefits of breast feeding to prevent bronchiolitis have been highlighted by Kaur et al. [12]; maintaining breast feeding

may also have beneficial impact on total intakes and immune response to viral aggression.

This study has some limitations, inherent to its design. Responders may give answers reflecting their own beliefs rather than their local team practices; subjectivity of responses is present in survey design and may introduce a bias in the result interpretation; no previous validated survey to assess nutritional practices in bronchiolitis infants was found in the literature, which did not allow increasing responder objectivity. Questions based on short clinical cases describing at a precise time point the respiratory status and children' feeding capability did not take into account the rapid changes that bronchiolitis patients experience, which may limit the interpretation of answers. This is often reflected in guidelines that focus on static rather than dynamic parameters to guide patients' care. The survey was not designed to outline a generic management profile of each responding unit, which did not allow comparing centres; the absence of clinical data collection did not allow comparing practices to clinical outcomes. The survey did not assess clinicians' practices regarding quantitative aspects of hydration, which may also play a significant role in hyponatremia occurrence. The limited number of answers from Belgium and Switzerland compared to France did not allow comparing practices between these countries appropriately. Analysis of concordance of practices with guidelines was not possible due to recommendations being inconsistent and not detailed enough regarding nutrition management of bronchiolitis.

Conclusion

There is an urgent need to update bronchiolitis recommendations and to include a detailed hydration and nutrition support strategy, based on the available evidence, especially regarding hydration issues. Paediatric isotonic solutions should be available in all units (and in all countries), and used when oral/enteral nutrition is not indicated. Further research is required to provide robust evidence regarding nutrition optimal practices in this setting (energy and protein goals, optimal feeding routes, and feed types, etc.). More active and effective dissemination of available guidelines is crucial, with suggested implementation strategies and re-assessment of these practices is required regularly to assess the impact of this guidance.

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Authors' contributions FVV, BGLR, CFC and LNT conceived the idea for this paper, undertook the literature search and worked on the review and manuscript. LNT edited the English wording.

PD, SR, CM, JC, CM, RP tested the survey, disseminated the survey and helped analysing the results.

FB and NP critically reviewed the results and the manuscript.

Compliance with ethical standards

Ethical approval was obtained for the study (Hospices Civils de Lyon ethical committee 18/07/2017).

This paper complies with ethical standards.

Informed consent was implicit for surveyed physicians upon response to the survey.

Conflict of interest The authors declare that they have no conflict of interest.

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