BMJ Paediatrics Open

# Treatment for acute bronchiolitis before and after implementation of new national guidelines: a retrospective observational study from primary and secondary care in Oslo, Norway

Nicolai Klem ,[1,2] Håvard Ove Skjerven,[3] Beate Nilsen,[2] Mette Brekke,[4] Odd Martin Vallersnes[1,2]

**To cite:** Klem N, Skjerven HO, Nilsen B, *et al*. Treatment for acute bronchiolitis before and after implementation of new national guidelines: a retrospective observational study from primary and secondary care in Oslo, Norway. *BMJ Paediatrics Open* 2021;**5**:e001111. doi:10.1136/bmjpo-2021-001111

Received 29 March 2021
Revised 30 April 2021
Accepted 7 May 2021



[1]Department of General Practice, University of Oslo, Oslo, Norway
[2]Department of Emergency General Practice, Oslo Accident and Emergency Outpatient Clinic, City of Oslo Health Agency, Oslo, Norway
[3]Department of Paediatrics, Oslo University Hospital, Oslo, Norway
[4]General Practice Research Unit, University of Oslo, Oslo, Norway

**Correspondence to**
Dr Nicolai Klem; nicolaiklem@gmail.com

## ABSTRACT

**Background** Acute bronchiolitis treatment guidelines changed in Norway in 2013, no longer recommending the use of nebulised epinephrine. We aimed to assess whether these changes were successfully implemented in both primary and secondary care. Secondary aims were to compare the difference in management of acute bronchiolitis patients in primary and secondary care between 2009 and 2017.

**Methods** We retrospectively registered data on demographics, clinical features and management from electronic medical records of all infants (<12 months of age) diagnosed with acute bronchiolitis at a primary care centre (Oslo Accident and Emergency Outpatient Clinic) and a secondary care centre (Oslo University Hospital) in Norway in 2009, 2014 and 2017. All patient records were individually reviewed to ensure data accuracy.

**Results** We included 680 (36.3%) patients from primary care and 1195 (63.7%) from secondary care. There was a reduction in the use of nebulised epinephrine from 2009 to 2017 from 66.9% to 16.1% of cases (p<0.001) in primary care and from 59.1% to 4.9% (p<0.001) in secondary care. In parallel, there was an increase in the use of nebulised saline treatment, from 0.8% to 53.8% (p<0.001) in primary care and from 39.3% to 65.3% (p<0.001) in secondary care. The decrease in the use of nebulised racemic epinephrine occurred earlier in secondary care than in primary care; 13.4% vs 56.1%, respectively, in 2014.

**Conclusions** Implementation of the new guidelines on the treatment of acute bronchiolitis was successfully implemented in both primary and secondary care.

### What is known about the subject?

- Treatment guidelines for acute bronchiolitis no longer recommend the use of nebulised epinephrine.
- Guidelines, often made by hospital specialists for hospital care, are often perceived not to fit the primary care population.

### What this study adds?

- The successful implementation of a new treatment guideline for acute bronchiolitis reduced the use of nebulised epinephrine both in primary and secondary care.
- An inverse rise in the use of nebulised saline was seen in both settings, though not specifically recommended.
- Use of antibiotics remained low.

## INTRODUCTION

Bronchiolitis is an acute viral lower respiratory tract infection affecting infants below 1 year of age.[1] Multiple treatment options have been recommended and used throughout different regions and time periods, including nebulised beta-2-agonists, nebulised racemic epinephrine, systemic corticosteroids, antibiotics and nebulised hypertonic saline.[1–4] Mecklin *et al* showed that all of these options were used in infants below 12 months of age with bronchiolitis between 2000 and 2015 in Tampere, Finland, with an increasing use of nebulised hypertonic saline.[5] In 2013, nebulised racemic epinephrine was removed from the Norwegian national acute bronchiolitis treatment guidelines[6] as a consequence of the Bronchiolitis All-Study SE Norway that found no difference in patient outcomes in children given nebulised racemic epinephrine versus children given nebulised saline.[2] In general, recently published guidelines from different regions recommend supportive care only and a minimal handling strategy in the treatment for acute bronchiolitis patients.[7–10]

Adherence to clinical guidelines in general practice has room for improvements.[11] One plausible explanation is that guidelines are often made by secondary care specialists for

specific conditions that do not necessarily fit the primary care population.[12] The Norwegian guidelines for acute bronchiolitis are made by paediatricians for secondary care, but parts of the guidelines have been used also in Norwegian primary care.[6] To the best of our knowledge, no studies have compared how the same changes in a clinical guideline have been implemented in both primary and secondary care.

### Aims

The primary aim of the study was to determine whether the new national treatment guidelines for acute bronchiolitis in Norway, published in 2013, were implemented in primary and secondary care. Secondary aims were to compare the difference in management of acute bronchiolitis patients in primary and secondary care between 2009 and 2017.

## METHODS

### Study design

A retrospective observational study of children <12 months of age presenting with acute bronchiolitis at the Oslo Accident and Emergency Outpatient Clinic (OAEOC) or at the Oslo University Hospital (OUH), Division of Paediatric and Adolescent Medicine, in Oslo, Norway, in 2009, 2014 and 2017.

### Settings

The Norwegian healthcare system is two-tiered, with primary care holding a gate-keeping function for secondary care. Unless triaged directly for hospital treatment by the ambulance service, patients at all ages are assessed in primary care, usually by local family physicians during office hours, or at primary care emergency outpatient clinics at weekends and nights. If the primary care doctor decides that the patient needs secondary care, the patient is transferred to hospital.

In Oslo, the main primary care emergency clinic is the OAEOC, open 24 hours a day, 365 days a year. Diagnostic and treatment resources include chest X-rays, point-of-care blood tests and nebuliser treatment. Oslo is the capital city of Norway and had 666 759 inhabitants as per 1 January 2017.[13] The paediatric population (children <18 years of age) in the OAEOC catchment area was 137 233 as per 1 January 2017, while the OUH catchment area, covering 12 of 15 city districts, encompassed 110 958.[13]

### Participants

We included all patients below the age of 12 months diagnosed with bronchiolitis at the OAEOC or the OUH from 1 January to 31 December of the 3 years 2009, 2014 and 2017.

At the OAEOC, eligible patients were identified from the patient registration lists in the electronic medical records. If the triage nurse had described airway illness, or symptoms associated with airway illness, as the presenting complaint in a child below the age of 12 months, the case notes were reviewed by study personnel and the patient included if given a bronchiolitis diagnosis (R78 in the International Classification of Primary Care, second edition (ICPC-2))[14] or treated for bronchiolitis with relevant bronchiolitis symptoms noted. At the OUH, all contacts involving patients below the age of 12 months with a diagnosis of bronchiolitis (J21 in the International Classification of Diseases and Related Health Problems (ICD-10))[15] were identified through an electronic search in the medical records. Electronic patient records for each acute admission were reviewed. In both settings, patients were included case by case, while planned follow-up contacts were excluded. Hence, one patient could be included several times as different cases.

We reviewed 5233 patient records at the OAEOC and 1520 at the OUH, yielding 680 included cases from the OAEOC and 1195 from the OUH.

### Variables

We registered demographic data (gender, age), vital signs (heart rate, oxygen saturation, respiratory rate, temperature) and clinical signs of respiratory distress (retractions, cyanosis). Furthermore, we registered treatment given, including nebulised medication (racemic epinephrine, saline, salbutamol), oxygen, high-flow nasal oxygen, ventilatory support (continuous positive airway pressure (CPAP), bilevel positive airway pressure (BPAP), respirator), nasogastric tube feeding, antipyretics, steroids and antibiotics. Supplementary investigations were also registered, including C reactive protein (CRP), nasopharyngeal swabs for virus and atypical bacterial agents, and chest X-rays. At the OAEOC, a CRP point-of-care test was used, not measuring values <5 mg/L, while the OUH used a laboratory CRP test. Finally, we registered length of stay, whether the patient was transferred to hospital from the OAEOC, whether nebuliser home treatment was initiated, and whether the patient re-presented to the clinic within 48 hours.

### Statistical methods

All data were analysed in IBM SPSS V.26 (IBM Corp). Pearson's $\chi^2$ test was used to compare frequencies. For continuous data, one-way analysis of variance was used. Kruskal-Wallis test was used for the CRP data, which did not follow the normal distribution. The significance level was set to 5%. Imputation for missing data was not performed.

### Patient and public involvement

Patients were not involved in designing the study, but will be involved in disseminating the results to the wider patient community.

## RESULTS

We included 680 cases from primary care and 1195 cases from secondary care. Mean age was higher in primary

Table 1 Demographics and clinical features of children treated for acute bronchiolitis in primary care and at hospital in Oslo, Norway, before and after introduction of new treatment guidelines in 2013

| | Primary care* | | | Hospital* | | |
|---|---|---|---|---|---|---|
| | 2009 | 2014 | 2017 | 2009 | 2014 | 2017 |
| | n=242 | n=239 | n=199 | n=435 | n=374 | n=386 |
| Gender | | | | | | |
| Girls (n (%)) | 99 (41.0) | 91 (38.1) | 76 (38.2) | 180 (41.4) | 142 (38.0) | 145 (37.6) |
| Boys (n (%)) | 143 (59.0) | 148 (61.9) | 123 (61.8) | 255 (58.6) | 232 (62.0) | 241 (62.4) |
| Age (months, mean±SD) | 6.4±3.3 | 6.2±3.4 | 5.7±3.3 | 4.9±3.1 | 5.0±3.4 | 4.6±3.2 |
| Heart rate (per minute, mean±SD) | 152.6±22.3 | 151.5±37.4 | 155.0±21,0 | 147.7±19.4 | 148.1±21.6 | 151.4±19.1** |
| Respiratory rate (per minute, mean±SD) | 50.0±12.0 | 49.2±11.7 | 51.9±11.3 | 50.7±11.4 | 50.0±11.1 | 48.4±10.4* |
| Oxygen saturation (%, mean±SD) | 96.5±3.0 | 96.0±5.0 | 96.4±2.8 | 97.1±3 | 96.8±3.9 | 97.1±2.7 |
| Retractions (n (%)) | 126 (52.1) | 163 (68.2) | 136 (68.3)* | 253 (58.2) | 197 (52.7) | 237 (61.4)* |
| Cyanosis (n (%)) | 2 (0.8) | 2 (0.8) | 3 (1.5) | 4 (0.9) | 4 (1.1) | 4 (1.0) |
| Temperature (°C, mean±SD) | 37.5±0.9 | 37.4±0.9 | 37.4±0.9 | 37.7±0.8 | 37.6±0.8 | 37.5±0.8* |
| CRP (mg/L, median (IQR))† | 10 (5–14) | 6 (5–18.5) | 5 (5–11.5)** | 7.0 (1.5–17.6) | 7.8 (1.7–20.6) | 7.0 (1.4–18) |

Comparisons were done across all three years at each setting: *p<0.05, **p<0.01, ***p<0.001.
*Except for two statistically significant changes in vital signs among the hospital patients; a rise in heart rate from 2009 to 2017; 147.7±19.4 to 151.4±19.1 (p<0.01), and a fall in respiratory rate in the same time period; 50.7±11.4 to 48.4±10.4 (p<0.05), there were no significant differences in vital signs or symptoms between the patient populations in the two settings, nor across the years at each setting.
†CRP test used in primary care setting did not specify values <5 mg/L. Values <5 mg/L are set as 5.
CRP, C reactive protein.

care than in secondary care, 6.1 months vs 4.8 months (p<0.001). The gender distribution was similar, with 60.9% boys in both settings. Clinical characteristics are shown in table 1.

There was a reduction in the use of nebulised racemic epinephrine treatment from 2009 to 2017; from 66.9% (162/242) of cases to 16.1% (32/199) (p<0.001) in primary care and from 59.1% (257/435) to 4.9% (19/386) (p<0.001) in secondary care (table 2). Simultaneously, there was an increase in the use of nebulised saline treatment; from 0.8% (2/242) to 53.8% (107/199) (p<0.001) in primary care and from 39.3% (171/435) to 65.3% (252/386) (p<0.001) in secondary care. The decrease in the use of nebulised racemic epinephrine occurred earlier in secondary care (13.4% (50/374) in 2014) than in primary care (56.1% (134/239) in 2014).

In secondary care, there was also a reduction from 2009 to 2017 in the use of nebulised salbutamol from 14.5% (63/435) of cases to 6.5% (25/386) (p=0.001), an increase in the use of oxygen supplement from 9.9% (43/435) to 19.4% (75/386) (p<0.001) and of antipyretics from 6.2% (27/435) to 13.0% (50/386) (p=0.004) (table 2). In-hospital antibiotic use was low throughout the study period; 1.9% in 2009, 2.7% in 2014 and 4.3% in 2017 (p=0.136). Antibiotic home treatment initiated from the hospital was reduced from 4.6% (20/435) to 2.8% (11/386) (p=0.047).

Furthermore, there was a decrease in the use of chest X-ray as a diagnostic tool, from 4.1% (10/242) to none (p<0.001) in primary care and from 31.0% (135/435) to 19.2% (74/386) (p<0.001) in secondary care (table 2). At the hospital, microbiological tests were performed in 72.6% (867/1195) of the children. Respiratory syncytial virus (RS-virus) was the main agent throughout, found in 69.3% (601/867) of the samples (table 3).

## DISCUSSION

In accordance with the guidelines published in 2013, the use of nebulised racemic epinephrine was substantially reduced from 2009 to 2017 in both primary and secondary care. The change occurred earlier (2014) in secondary than in primary care. In the same period, the use of nebulised saline increased and antibiotics decreased in both settings. In hospital, the use of oxygen and antipyretics increased.

The new treatment guidelines were implemented already in 2014 in secondary care and well implemented in primary care in 2017. One can argue that this was fairly successful, as implementation of guidelines is known to

**Table 2** Management of children with acute bronchiolitis in primary care and at hospital in Oslo, Norway, before and after introduction of new treatment guidelines in 2013

| | Primary care | | | Hospital | | |
|---|---|---|---|---|---|---|
| | 2009 | 2014 | 2017 | 2009 | 2014 | 2017 |
| | n=242 | n=239 | n=199 | n=435 | n=374 | n=386 |
| Nebulised racemic epinephrine (n (%)) | 162 (66.9) | 134 (56.1) | 32 (16.1)*** | 257 (59.1) | 50 (13.4) | 19 (4.9)*** |
| Nebulised saline (n (%)) | 2 (0.8) | 52 (21.8) | 107 (53.8)*** | 171 (39.3) | 278 (74.3) | 252 (65.3)*** |
| Nebulised salbutamol (n (%)) | 5 (2.1) | 9 (3.8) | 4 (2.0) | 63 (14.5) | 36 (9.6) | 25 (6.5)** |
| Oxygen supplement (n (%)) | 5 (2.1) | 4 (1.7) | 4 (2.0) | 43 (9.9) | 86 (23.0) | 75 (19.4)*** |
| Betamethasone (n (%)) | 16 (6.6) | 13 (5.4) | 9 (4.5) | 29 (6.7) | 16 (4.3) | 14 (3.6) |
| Antipyretics (n (%)) | 7 (2.9) | 20 (8.4) | 5 (2.5)** | 27 (6.2) | 34 (9.1) | 50 (13.0)*** |
| Chest X-ray (n (%)) | 10 (4.1) | 0 (0.0) | 0 (0.0)*** | 135 (31.0) | 67 (17.9) | 74 (19.2)*** |
| Referral to hospital (n (%)) | 93 (38.4) | 107 (44.8) | 79 (39.7) | Not applicable | | |
| Hospitalisation days (mean±SD) | | | | 2.7±3.8 | 2.7±3.0 | 2.2±2.4 |
| Hospitalised less than 24 hours (n (%)) | | | | 217 (49.9) | 197 (52.7) | 237 (61.4)** |
| Highflow nasal oxygen (n (%)) | | | | 0 (0.0) | 20 (5.3) | 38 (9.8)*** |
| CPAP/BPAP (n (%)) | | | | 19 (4.4) | 27 (7.2) | 23 (6.0) |
| Respirator/mechanical ventilation (n (%)) | Not applicable | | | 6 (1.4) | 7 (1.9) | 7 (1.8) |
| Nasogastric tube (n (%)) | | | | 40 (9.2) | 43 (11.5) | 56 (14.5) |
| Microbiological nasopharyngeal testing | | | | 303 (69.7) | 278 (74.3) | 286 (74.1) |
| Antibiotics in hospital (n (%)) | | | | 8 (1.9) | 10 (2.7) | 16 (4.3) |
| Antibiotics home treatment (n (%)) | 4 (1.7) | 1 (0.4) | 1 (0.5) | 20 (4.6) | 6 (1.6) | 11 (2.8)* |
| Nebulisation home treatment (n (%)) | Not applicable | | | 227 (52.2) | 231 (61.8) | 238 (61.7)** |
| Recontact within 48 hours (n (%)) | 39 (16.1) | 35 (14.6) | 32 (16.1) | 37 (8.5) | 39 (10.4) | 50 (13.0) |

Comparisons were done across all 3 years at each setting: *p<0.05, **p<0.01, ***p<0.001.
BPAP, Bilevel positive airway pressure; CPAP, continuous positive airway pressure.

**Table 3** Microbiological results from nasopharynx swabs in children with acute bronchiolitis treated at hospital in Oslo, Norway, before and after introduction of new treatment guidelines in 2013

| | 2009 | 2014 | 2017 |
|---|---|---|---|
| | n=303 | n=278 | n=286 |
| RS-virus (n (%)) | 181 (59.7) | 206 (74.1) | 214 (74.8) |
| Rhinovirus (n (%)) | * | 126 (45.3) | 117 (40.9) |
| Other viruses (n (%)) | 63 (20.8) | 78 (28.1) | 73 (25.5) |
| Bacteria (n (%)) | 5 (1.7) | 0 (0.0) | 4 (1.4) |
| Two or more agents (n (%)) | 11 (3.6)* | 79 (28.4) | 56 (19.6) |
| Negative results (n (%)) | 87 (28.7)* | 16 (5.8) | 12 (4.2) |

*Rhinovirus was not tested for in 2009.
RS-virus, respiratory syncytial virus.

take time.[16 17] Our results show slower adaption to the guidelines in primary care than in secondary care. There is research suggesting lower adherence to guidelines in primary care,[11] which would support our findings. Primary care physicians experience several barriers for adherence to guidelines, where lack of awareness and lack of familiarity are the two most commonly reported.[18 19] As physicians in primary care manage patients of all ages with a wide spectrum of illnesses, the implementation of guidelines for specific illnesses might not get general attention.[12] The Bronchiolitis All-Study SE was conducted at the OUH previously to the guideline implementation, directly involving most doctors and nurses attending the acute ward.[2 20] This would suggest a higher awareness and familiarity to the new guidelines at the hospital, leading to faster adaptation. We consider full time employees and internal education programmes at both clinics crucial for successful implementation.

Apart from the primary care delay in implementing the new guidelines, we found similar changes in the initial treatment of patients with acute bronchiolitis in primary and secondary care. The increase in nebulised saline use is not evidence based and not recommended by national guidelines. Overtreatment is an acknowledged challenge in medicine,[21] and there is a possibility that the increasing use of nebulised saline is a consequence of the urge of healthcare personnel to do something, by providing any specific therapy rather than what is evidence based management.

The reduction in the use of nebulised beta-2-agonists is supported by new guidelines and research,[2 9 22–25] and is a focus across the world.[24 25] Antibiotic treatment is not recommended for acute bronchiolitis,[9 26 27] and overuse is a known problem.[28–30] Our results showed a very low use of antibiotics, consistently below 5%, compared with other countries, where rates in the range of 3.5%–11.1% are reported.[28]

We found a steady rise in the use of highflow oxygen in the hospital setting. Recent research has not clearly shown that this is beneficial for acute bronchiolitis treatment.[31 32] Hospital length of stay did not change during the study time period. However, there was an increase in the proportion of patients discharged within 24 hours, from 49.9% to 61.4%, signifying that a majority of hospital bronchiolitis patients only need a short period of supportive care.

No more than 40% of the bronchiolitis patients at the OAEOC were sent on to secondary care. This contribution to reducing hospital emergency department crowding is an advantage of a gate keeping primary care emergency health service. The availability of nebuliser treatment and short-term observation gives the OAEOC the capacity to treat and observe children with a wide variety of airway symptoms, and hence better to identify the patients in need of hospital treatment.

The main agent causing bronchiolitis is known to be RS-virus,[33 34] as was the case in our study, with rhinovirus the second most common agent. Two or more agents were found in more than one out of four children, less frequently than the 61% co-infections found by Skjerven *et al* in their review from 2016.[35] A relationship between viral findings and the severity of respiratory disease in infants with acute bronchiolitis has not been established, though it has been suggested that high genomic load can lead to longer hospital stay and more use of oxygen and ventilatory support.[35 36]

## Strengths and limitations

Our study included a large patient population from both primary and secondary care. Encompassing the two largest emergency departments for children in Oslo, our study population is representative of the city population. Though patients were not included if managed at other smaller primary care clinics, or referred by them or the ambulance service directly to the neighbouring paediatric hospital covering the remaining 3 of 15 city districts, this number is probably small and the population is most likely similar to ours. We therefore consider our results to be representative for the population of children with acute bronchiolitis needing primary and/or hospital care in Norway.

The medical journal of every study subject was thoroughly examined by the first author, ensuring as complete and accurate data as possible. Clinical signs, diagnostic investigations or treatments not mentioned in the patient records were considered not present or not performed. This may have resulted in some under-reporting, though not enough to have an impact on our conclusions.

Eligible patients were found retrospectively, and we sought to limit selection bias by having clear and strict inclusion criteria. Still, some interpretation was necessary in the primary care setting in cases where bronchiolitis had not been set as the main diagnosis and the patient was included based on the case notes. Only the first author reviewed the patient records. This secured a more consistent inclusion of patients, but at the same time carried the risk of increased selection bias.

Since the inclusion of some patients was based on strict criteria from case notes, we may have missed some patients in the primary care group receiving ICPC-2 symptoms diagnoses rather than the specific diagnosis of acute bronchiolitis. However, the patient records of all individuals with related symptom diagnoses were manually screened to identify signs and symptoms in order to identify acute bronchiolitis. This may also partly explain why the number of included patients was lower at the OAEOC than the OUH. Furthermore, the ambulance service brings severely sick patients directly to hospital, hence bypassing the OAEOC.

## Conclusion

There was a large and highly significant reduction in the use of nebulised racemic epinephrine treatment after the introduction of new national guidelines in 2013, both in primary and secondary healthcare. Simultaneously, there was an increase in the use of nebulised saline. Implementation of the new guidelines occurred earlier in the hospital setting than in primary care.

**Acknowledgements** We thank the Department of Microbiology at the Oslo University Hospital for making the microbiological data available to us.

**Contributors** NK conceived and designed the study, collected and analysed the data, and drafted and revised the manuscript. HOS, MB and BN contributed to designing the study and revised the manuscript. OMV contributed to designing the study, revised the manuscript and supervised the project.

**Funding** NK received 6 months scholarship from the Norwegian Committee on Research in General Practice (Allmennmedisinsk Forskningsutvalg (AFU)), a committee of the Norwegian College of General Practitioners.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** The study was a quality improvement study, as per the Norwegian Law on Health Personnel §26, retrospectively collecting anonymous data already registered in patient records. Accordingly, the need for approval from

an ethics committee was waived, as was the need to obtain consent to participate. The study was approved by the Oslo University Hospital Information Security and Privacy Office, and by the director of the Department of Emergency General Practice at the City of Oslo Health Agency.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. Data are currently not available for sharing. Several manuscripts based on the data set are in preparation. Requests concerning the data may be sent to the corresponding author.



**ORCID iD**

Nicolai Klem http://orcid.org/0000-0002-6906-6871

## REFERENCES

1 Gadomski AM, Scribani MB. Bronchodilators for bronchiolitis. *Cochrane Database Syst Rev* 2014:CD001266.
2 Skjerven HO, Hunderi JOG, Brügmann-Pieper SK, *et al*. Racemic adrenaline and inhalation strategies in acute bronchiolitis. *N Engl J Med* 2013;368:2286–93.
3 Zorc JJ, Hall CB. Bronchiolitis: recent evidence on diagnosis and management. *Pediatrics* 2010;125:342–9.
4 Fernandes RM, Bialy LM, Vandermeer B, *et al*. Glucocorticoids for acute viral bronchiolitis in infants and young children. *Cochrane Database Syst Rev* 2013;6:CD004878.
5 Mecklin M, Heikkilä P, Korppi M. The change in management of bronchiolitis in the intensive care unit between 2000 and 2015. *Eur J Pediatr* 2018;177:1131–7.
6 Norsk barnelegeforening. Akuttveileder I pediatri. Available: http://www.helsebiblioteket.no/retningslinjer/akuttveileder-i-pediatri/forside [Accessed 11 May 2017].
7 McNaughten B, Hart C, Shields M. Management of bronchiolitis in infants: key clinical questions. *Paediatr Child Health* 2017;27:324–7.
8 Everard ML, Hind D, Ugonna K, *et al*. Saline in acute bronchiolitis RCT and economic evaluation: hypertonic saline in acute bronchiolitis - randomised controlled trial and systematic review. *Health Technol Assess* 2015;19:1–130.
9 Ralston SL, Lieberthal AS, Meissner HC, *et al*. Clinical practice guideline: the diagnosis, management, and prevention of bronchiolitis. *Pediatrics* 2014;134:e1474–502.
10 National Institute of Health and Care Excellence. Nice guidelines 2015. bronchiolitis in children diagnosis and management, 2015. Available: https://www.nice.org.uk/guidance/ng9 [Accessed 11 May 2017].
11 Lugtenberg M, Burgers JS, Han D, *et al*. General practitioners' preferences for interventions to improve guideline adherence. *J Eval Clin Pract* 2014;20:820–6.
12 Austad B, Hetlevik I, Mjølstad BP, *et al*. Applying clinical guidelines in general practice: a qualitative study of potential complications. *BMC Fam Pract* 2016;17:92.
13 Oslo Municipality statistics database, 2017. Available: http://statistikkbanken.oslo.kommune.no/webview/index.jsp?catalog=http%3A%2F%2Fstatistikkbanken.oslo.kommune.no%3A80%2Fobj%2FfCatalog%2FCatalog48&submode=catalog&mode=documentation&top=yes [Accessed 11 Apr 2019].
14 World Health Organization. *International classification of primary care (ICPC-2)*. 2nd ed. Geneva: World Health Organization, 2003. http://www.who.int/classifications/icd/adaptations/icpc2/en/
15 World Health Organization. The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines. Geneva, 1992. Available: https://www.who.int/classifications/icd/en/bluebook.pdf [Accessed 11 May 2019].
16 Austad B, Hetlevik I, Bugten V, *et al*. Implementing guidelines for follow-up after surgery with ventilation tube in the tympanic membrane in Norway: a retrospective study. *BMC Ear Nose Throat Disord* 2013;13:5.
17 Aftab RA, Khan AH, Syed Sulaiman SA, *et al*. Does guideline knowledge affect treatment compliance among emergency doctors? *Am J Med Sci* 2014;348:357–61.
18 Lugtenberg M, Zegers-van Schaick JM, Westert GP, *et al*. Why don't physicians adhere to guideline recommendations in practice? An analysis of barriers among Dutch general practitioners. *Implement Sci* 2009;4:54.
19 Cabana MD, Rand CS, Powe NR, *et al*. Why Don't Physicians Follow Clinical Practice Guidelines? *JAMA* 1999;282:1458–65.
20 Øymar K, Skjerven HO, Mikalsen IB. Acute bronchiolitis in infants, a review. *Scand J Trauma Resusc Emerg Med* 2014;22:23.
21 Armstrong N. Overdiagnosis and overtreatment as a quality problem: insights from healthcare improvement research. *BMJ Qual Saf* 2018;27:571–5.
22 Hartling L, Fernandes RM, Bialy L, *et al*. Steroids and bronchodilators for acute bronchiolitis in the first two years of life: systematic review and meta-analysis. *BMJ* 2011;342:d1714.
23 Meissner HC. Viral bronchiolitis in children. *N Engl J Med* 2016;374:62–72.
24 Montejo M, Paniagua N, Saiz-Hernando C, *et al*. Initiatives to reduce treatments in bronchiolitis in the emergency department and primary care. *Arch Dis Child* 2021;106:294–300.
25 Oakley E, Brys T, Borland M, *et al*. Medication use in infants admitted with bronchiolitis. *Emerg Med Australas* 2018;30:389–97.
26 Friis B, Andersen P, Brenøe E, *et al*. Antibiotic treatment of pneumonia and bronchiolitis. A prospective randomised study. *Arch Dis Child* 1984;59:1038–45.
27 Hall CB, Powell KR, Schnabel KC, *et al*. Risk of secondary bacterial infection in infants hospitalized with respiratory syncytial viral infection. *J Pediatr* 1988;113:266–71.
28 Zipursky A, Kuppermann N, Finkelstein Y, *et al*. International practice patterns of antibiotic therapy and laboratory testing in bronchiolitis. *Pediatrics* 2020;146:e20193684.
29 Lopez AA, Aslanova R, Bridger N, *et al*. Antibiotic use for inpatient bronchiolitis: did national guidelines impact practice at a pediatric hospital? *Hosp Pediatr* 2020;10:147–52.
30 Papenburg J, Fontela PS, Freitas RR, *et al*. Inappropriate antibiotic prescribing for acute bronchiolitis in US emergency departments, 2007-2015. *J Pediatric Infect Dis Soc* 2019;8:567–70.
31 Franklin D, Babl FE, Schlapbach LJ, *et al*. A randomized trial of high-flow oxygen therapy in infants with bronchiolitis. *N Engl J Med* 2018;378:1121–31.
32 Lin J, Zhang Y, Xiong L, *et al*. High-flow nasal cannula therapy for children with bronchiolitis: a systematic review and meta-analysis. *Arch Dis Child* 2019;104:564–76.
33 Miron D, Srugo I, Kra-Oz Z, *et al*. Sole pathogen in acute bronchiolitis: is there a role for other organisms apart from respiratory syncytial virus? *Pediatr Infect Dis J* 2010;29:e7–10.
34 Carlsen KH, Ørstavik I, Halvorsen K. Viral infections of the respiratory tract in hospitalized children. A study from Oslo during a 90 months' period. *Acta Paediatr Scand* 1983;72:53–8.
35 Skjerven HO, Megremis S, Papadopoulos NG, *et al*. Virus type and genomic load in acute bronchiolitis: severity and treatment response with inhaled adrenaline. *J Infect Dis* 2016;213:915–21.
36 Wishaupt JO, van der Ploeg T, de Groot R, *et al*. Single- and multiple viral respiratory infections in children: disease and management cannot be related to a specific pathogen. *BMC Infect Dis* 2017;17:62.