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Assessing the quality of health care in the management of bronchiolitis in Australian children: a population-based sample survey

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ABSTRACT

Background Bronchiolitis is the most common cause of respiratory hospitalisation in children aged <2 years. Clinical practice guidelines (CPGs) suggest only supportive management of bronchiolitis. However, the availability of CPGs do not guarantee that they are used appropriately and marked variation in the clinical management exists. We conducted an assessment of guideline adherence in the management of bronchiolitis in children at a subnationally representative level including inpatient and ambulatory services in Australia.

Methods We searched for national and international CPGs relating to management of bronchiolitis in children and identified 16 recommendations which were formatted into 40 medical record audit indicator questions. A retrospective medical record review assessing compliance with the CPGs was conducted across three types of healthcare setting: hospital inpatient admissions, emergency department (ED) presentations and general practice (GP) consultations in three Australian states for children aged <2 years receiving care in 2012 and 2013.

Results Purpose-trained surveyors conducted 13 979 eligible indicator assessments across 796 visits for bronchiolitis at 119 sites. Guideline adherence for management of bronchiolitis was 77.3% (95% CI 72.6 to 81.5) for children attending EDs, 81.6% (95% CI 78.0 to 84.9) for inpatients and 52.3% (95% CI 44.8 to 59.7) for children attending GP consultations. While adherence to some individual indicators was high, overall adherence to documentation of 10 indicators relating to history taking and examination was poorest and estimated at 2.7% (95% CI 1.5 to 4.4).

Conclusions The study is the first to assess guideline-adherence in both hospital (ED and inpatient) and GP settings. Our study demonstrated that while the quality of care for bronchiolitis was generally adherent to CPG indicators, specific aspects of management were deficient, especially documentation of history taking.

INTRODUCTION

Bronchiolitis is a respiratory infection in children aged less than 12 or 24 months, depending on the definition, that causes respiratory distress often associated with cough, wheeze or crackles and hypoxia.[1] Almost one-third of all children will develop bronchiolitis by their first birthday and 90% children will develop the disease by the second year of their lives.[2] It is the most common cause of hospitalisation in children in this age group.[3] Clinical practice guidelines (CPGs) suggest only supportive management without the need for bronchodilators,[4] epinephrine,[5] anticholinergic drugs[6] or corticosteroids.[7] There is no proven benefit for antivirals or antibiotics.[7] The availability of guidelines does not guarantee that they are used appropriately, and previous studies have demonstrated marked variation in the clinical management of bronchiolitis.[8–10] However, there is a dearth of information relating to the quality of clinical care in management of bronchiolitis in Australian children. Evaluation of the quality of clinical care and the extent to which it is adherent to guidelines can identify areas for improvement and help design interventions to improve quality of care.

CareTrack Kids (CTK) assessed the care delivered to Australian children aged 0–15 years, in 2012 and 2013, to estimate the proportion that received care in line with CPGs for 17 common conditions, including bronchiolitis.[11] Across the 17 conditions, indicator-adherent care was provided for an estimated average of 59.8% (95% CI 57.5 to 62.0) of indicators and at 59.3% (95% CI 54.6 to 63.9) for bronchiolitis indicators. This paper presents and discusses the CTK results for bronchiolitis care. While it has been documented that variation in clinical care exists, the primary aim of this study was

to document specific aspects of clinical care where variation exists across different healthcare settings including ambulatory and hospital settings, which is important for designing initiatives to improve quality of care.

MATERIALS AND METHODS

The CTK methods have been described in detail elsewhere.[11–13] Aspects specifically relevant to bronchiolitis are presented below.

Development of indicators

We searched for national and international CPGs relating to bronchiolitis in children.[13] Ten CPGs were found and 56 recommendations extracted. Five recommendations were excluded because they were guiding statements only with no actions; they used auxiliary verbs such as 'may', 'consider' and 'could' to indicate the recommendation's strength; there was a low likelihood of information being documented in the medical record; or they were out of scope for our purposes (such as structure-level measures).

The 51 candidate recommendations were subjected to a three-round modified Delphi internal review by three clinicians (all paediatricians) involved in CTK, by email. The recommendations passing this process were subjected to further reviews and modifications by 12 paediatricians and two nurses, external to the project, again using a modified Delphi method. External reviewers were recruited via advertisements and communications in relevant medical colleges, and professional associations and networks. The reviews were undertaken on a customised wiki site. For both the internal and external reviews, a modified RAND-UCLA method was used.[14] Additionally, each clinician recorded whether each recommendation was acceptable and feasible to collect, and its level of clinical impact.[13]

During internal and external review, recommendations were excluded due to low acceptability, feasibility or impact; if the concept was covered in other recommendations(s); or rated with a low appropriateness score by reviewers. Of 51 recommendations, 35 were excluded during internal review, with 16 recommendations passed to external review, with all of these retained. These recommendations were re-formatted into 40 medical record audit indicator questions. For the purposes of this study, a clinical indicator was defined as a measurable component of a standard or guideline, with explicit criteria for inclusion, exclusion, time frame and practice setting. For example, a single recommendation that all infants presenting with acute bronchiolitis have six elements of history elicited and recorded (ie, duration and progression of symptoms, presence of apnoeas, etc) was re-formatted into six separate indicator questions (BRON01–BRON06). All indicator questions are shown, with additional details, in online appendix 1.

Sample size, sampling process and data collection

CTK targeted 400 medical records for bronchiolitis and 6000 medical records for 16 other conditions. We estimated that at least 384 medical records reviews are required to estimate the true proportion of medical records that document appropriate bronchiolitis care with 95% CI, 5% precision and assuming an infinite population. If any of the sampled medical records contained an occasion of care for bronchiolitis management, a separate assessment of adherence was made for each eligible indicator in each visit. For ED and inpatient medical records, we used International Disease Classification codes associated with bronchiolitis to identify all visits in children in 2012 and 2013. For EDs in New South Wales that we used Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT) to identify visits associated with bronchiolitis. Separate lists were generated for ED and inpatients. In the primary care setting, a subset of GPs used their systems to identify all visits for bronchiolitis (with the support of paediatric nurses/surveyors if needed). Once bronchiolitis cases were identified, the lists were randomly ordered and sampled until a site-specific quota was achieved.

Detail on the general sampling methods for the CTK study have been published,[11] with selected details specific to bronchiolitis in online appendix 2. The 16 other conditions were selected for sampling independently of the selection of bronchiolitis. The conditions were selected due to either high rates of healthcare utilisation or due to their high clinical relevance (eg, type 1 diabetes). The choice of conditions was not related to diagnostic terminology used in different settings.

Briefly, three healthcare settings were sampled: hospital inpatients and ED presentations, and consultations in general practices (GPs) in randomly selected health districts in Queensland (Hospital Health Services), New South Wales (Local Health Districts) and South Australia (Local Health Networks), for children aged ≤15 years receiving care in 2012 and 2013. Data were collected by nine experienced paediatric nurses (surveyors), trained to assess eligibility for indicator assessment and compliance with CPGs. Surveyors went to the setting and reviewed the selected medical records (1) identifying visits for any of the 17 selected conditions and (2) assessing compliance with each relevant indicator. Surveyors read all relevant parts of the medical record including correspondence and test results to determine indicator compliance. Figure 1 further illustrates assessments for bronchiolitis by state and healthcare provider type.

Analysis

Because a child could have multiple visits for management of bronchiolitis, age was calculated at the child's date of visit when there was only one, or as the midpoint of the age at first and last visit, when

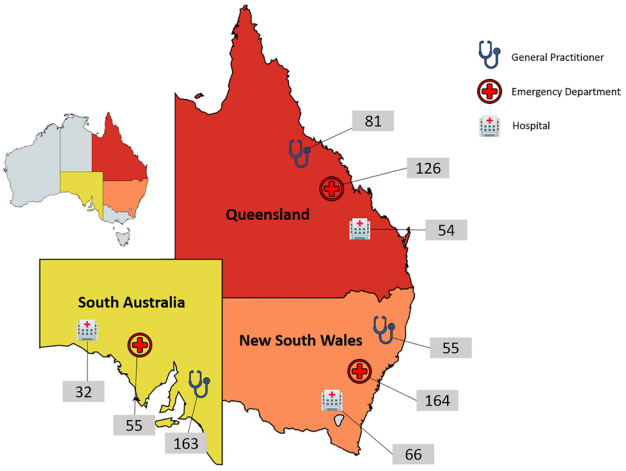

Figure 1 Bronchiolitis assessments by state and healthcare provider type. Total number of visits to emergency departments=345; total number of admissions to hospital=152; total number of visits to general practitioners=299. Total number of bronchiolitis assessments in New South Wales=285; Queensland=261; South Australia=250. Total number of visits assessed for care of bronchiolitis in sampling frame=796.

there were multiple visits. Each child represents one medical record, and each visit an episode of care. At indicator level, estimates of adherence were measured as the percentage of eligible indicators (ie, indicators answered either 'Yes' or 'No') which were scored as 'Yes'.

Adherence to some indicators were aggregated as bundles of care. Some of the indicators represented single CPG recommendations (ie, applying to a single category of patient) with multiple compliance criteria. These represented natural groups. As the indicators assessed each compliance criterion individually, we re-aggregated the indicators so that the bundle was only considered CPG-adherent if all the compliance criteria were met. All relevant indicator sets drawn from single CPGs were considered for re-grouping, and the research team selected a small number which were considered most likely to be of interest. Indicators BRON01–BRON10 all relate to the documentation of history and examinations of children who presented with bronchiolitis; all 10 of these indicators would have to be scored 'Yes' for the bundle (bundle A) to be scored as being compliant with the CPG. When assessing bundles, a visit was only included if there were responses for all component indicators.

Three other bundles were created and scored the same way. Bundle B was related to children diagnosed with acute mild/moderate bronchiolitis and assessed the provision of inappropriate tests/examinations. Bundle C, related to infants aged <12 months with severe bronchiolitis, and assessed the provision of appropriate prescription and monitoring/assessment. Bundle D, related to infants aged <12 months with bronchiolitis who were discharged, and assessed whether they met specific discharge criteria.

Weights were constructed as specified in online appendix 2 to adjust for oversampling of states and healthcare settings and for sampling within health districts. Weights were designed to represent the number of visits for bronchiolitis expected in each setting. The final weighted sample was equivalent to the total number of visits for bronchiolitis in hospital inpatient, ED and GP settings each state in 2012 and 2013. The weighted data were analysed in SAS V.9.4 (SAS Institute, Cary, North Carolina, USA), using the SurveyFreq procedure. Variance was estimated by Taylor series linearisation and the primary sampling unit (health district) was specified as the clustering unit. Stratification and, where appropriate, domain analyses were used (see online appendix 2). Exact 95% CIs were generated using the modified Clopper-Pearson method, except when the point estimate was 0% or 100%, where the unmodified Clopper-Pearson method was used.[15] Results were suppressed if there were <25 eligible visits.

Ethical considerations

We received primary ethics approval from relevant bodies including hospital networks and the Royal Australian College of General Practitioners (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68; NREEC 14-008), and site-specific approvals from 34 sites. Australian Human Research Ethics Committees can waive requirements for patient consent for external access to medical records if the study entails minimal risk to providers and patients[12]; all relevant bodies provided this approval. Ethics approvals included reporting by healthcare setting for condition-level data. Participants were protected from litigation by gaining statutory immunity for CTK as a quality assurance activity from the Federal Minister for Health under Part VC of the Health Insurance Act 1973 (Commonwealth of Australia).

RESULTS

Characteristics of the medical records and healthcare settings

For the broader CTK study, we sampled 6689 records (estimated sample size was 6400). The recruitment rate was 92% for hospitals and estimated to be 24% for GPs (see online appendix 2). Eligible bronchiolitis assessments were conducted in 56 GPs, 34 hospital EDs and 29 hospital inpatient service providers; a total of 119 sites.

From these sites, we sampled a total of 494 children who had one or more visits for bronchiolitis management; a little over half (56%) were male and the median age was 7 months (IQR 4–11 months). Each child was eligible for 1–9 bronchiolitis visits (median=1). Of 38 440 possible indicator assessments, 14 760 (38.4%) were automatically filtered by age or healthcare setting restrictions, and surveyors designated a further 9701 (25.2%) as not applicable or otherwise ineligible. The

field team conducted 13 979 eligible indicator assessments grouped into 796 visits, at a median of 20 indicator assessments per visit.

Adherence

The assessed adherence for each indicator is shown in table 1. Adherence is not reported for one of the 40 indicators because it had <25 assessments. For the 39 indicators where adherence was reported, compliance ranged from 10.3% for indicator BRON02 ("*Infants (aged <12 months) presenting with acute bronchiolitis had the presence of apnea recorded*") to 99.9% for BRON17 ("*Children aged <2 years diagnosed with acute mild/moderate bronchiolitis did not have chest physiotherapy*"), the latter being an indicator assessing inappropriate use of a non-recommended treatment. The IQR for adherence in the 39 indicators reported was 43.3% to 96.3%.

The overall guideline adherence for management of children with bronchiolitis was 77.3% for children attending EDs (95% CI 72.6 to 81.5), 81.6% for hospitalised children (95% CI 78.0 to 84.9) and 52.3% for those managed by GPs (95% CI 44.8 to 59.7) (table 2).

The assessed appropriateness of four bundles is shown in table 3. Bundle A assessed the documentation of 10 elements of history taking and examination in children presenting with bronchiolitis under 1 year of age, in all healthcare settings, and found 2.7% adherence (95% CI 1.5 to 4.4); the component indicator with the lowest compliance was documentation of the presence of apnoea (10.3%; BRON02). Bundle B covered four indicators relating to avoidance of inappropriate tests and examinations, in children aged <2 years across all healthcare settings and found 92.6% adherence (95% CI 87.5 to 96.1). Bundles C and D were restricted to ED presentations and inpatients under 1 year of age. Bundle C assessed appropriateness of treatment and monitoring/assessment of infants with severe bronchiolitis and found 72.3% adherence (95% CI 47.5 to 89.9) across four indicators. Bundle D comprised three indicators assessing the appropriateness of discharge and had adherence of 89.0% (95% CI 78.8 to 95.3). All bundles are reported separately by healthcare setting. Bundle A showed that GPs had the lowest compliance with recording of all 10 assessments (0.0% vs 11.5% for ED and 15.3% for inpatients), in keeping with the general pattern for adherence to be lowest in the GP setting. Contrary to this general pattern, Bundle B showed that GPs had higher compliance with guidelines limiting use of inappropriate tests and examinations.

DISCUSSION

Using indicators drawn from CPGs, we have shown that the guideline-adherent care for children with bronchiolitis ranges between 10% and almost 100%. Previous studies evaluating the appropriateness of care for bronchiolitis have focused on specific areas of its management in either an ambulatory or inpatient setting; a strength of the current study is that it assesses a broad range of different aspects of the clinical management of bronchiolitis across 119 different healthcare sites in three Australian States, covering three settings: GP, the ED and inpatient admissions. This comprehensive study suggests that management of bronchiolitis in Australia is largely adherent to CGPs.

Our results suggest that the lowest adherence across different healthcare settings was for indicators associated with documentation of history and clinical assessment in children aged <12 months with acute bronchiolitis. This variation was greatest within primary care settings. Appropriate recording of a diagnosis of mild, moderate and severe bronchiolitis (BRON11–13) was undertaken in less than a third of visits. Proper assessment of the severity of symptoms guides management pathways and determines the need for hospital admission and subsequent diagnostic and therapeutic procedures. Inadequate recording of medical diagnosis can also lead to an information gap especially when patients are transferred from the primary care setting to ED. Information gaps due to inadequate documentation have been associated with a longer patient stay in ED.[16] Additionally, inaccurate diagnosis is related to discrepancies in assignment of clinical codes. In Australia, healthcare financing is dependent on accurate clinical coding and inaccuracies may result in increased hospital revenues.[17] It was beyond the scope of the study to assess the factors associated with inadequate documentation which may be due to increased workload and limited resources. Converting paper-based records to an electronic record system which is currently being implemented across the Australian healthcare system may reduce missing information.[18]

Despite low adherence to diagnosis, and poor recording of all items relating to history and examination, adherence to appropriate symptomatic management of bronchiolitis including monitoring oxygen saturation, prescribing oxygen to maintain oxygen saturation at 93% or greater and ensuring frequent feeding either through nasogastric tube or intravenous fluid depending on the severity of symptoms (BRON20–22) was over 70%.[19] Though it was beyond the scope of this study to verify whether clinicians were unsure of the appropriate diagnosis of bronchiolitis, the documented discrepancy between diagnosis and management of bronchiolitis suggest that the documentation of diagnosis was incomplete.

The overall appropriateness of undertaking blood tests (BRON15) and chest X-rays (BRON14) in the management of mild/moderate bronchiolitis in children aged <2 years exceeded 90%. These were avoided for ~60% of the children aged <12 months with moderate bronchiolitis attending ED and requiring admission in the hospitals (BRON23). This

Table 1 Adherence of care, by clinical indicator, 2012–2013, Australia

Indicator ID	Indicator description	Number of children	Number of visits	Proportion adherent, % (95% CI)
BRON01	Infants (aged <12 months) presenting with acute bronchiolitis had the duration and progression of their symptoms recorded	404	646	79.3 (68.1 to 88.0)
BRON02	Infants (aged <12 months) presenting with acute bronchiolitis had the presence of apnoea recorded	403	645	10.3 (6.3 to 15.5)
BRON03	Infants (aged <12 months) presenting with acute bronchiolitis had their feeding history recorded	404	646	67.7 (57.2 to 77.1)
BRON04	Infants (aged <12 months) presenting with acute bronchiolitis had the presence of previous episodes of bronchiolitis recorded	402	642	42.5 (26.0 to 60.2)
BRON05	Infants (aged <12 months) presenting with acute bronchiolitis had their family history of atopy or asthma recorded	403	645	27.2 (20.1 to 35.2)
BRON06	Infants (aged <12 months) presenting with acute bronchiolitis had the presence of pre-existing conditions recorded	400	641	54.2 (37.9 to 69.8)
BRON07	Infants (aged <12 months) presenting with acute bronchiolitis had their general appearance and basic observations (Temp, RR, HR, SpO_2) examined	404	646	28.8 (22.0 to 36.4)
BRON08	Infants (aged <12 months) presenting with acute bronchiolitis had their hydration status reviewed	404	646	50.5 (38.3 to 62.6)
BRON09	Infants (aged <12 months) presenting with acute bronchiolitis received a respiratory examination (work of breathing, recession, auscultation)	404	646	74.5 (58.0 to 87.1)
BRON10	Infants (aged <12 months) presenting with acute bronchiolitis had their feeding (duration and volume, oxygen saturations while feeding) examined	400	635	13.1 (9.2 to 17.9)
BRON11	Infants (aged <12 months) who had any of the following signs/symptoms: * appear well * mild tachypnoea (RR<60/min) * normal or mildly increased work of breathing (WOB) that is, no nasal flaring/grunting * wheeze at end expiratory or crackles * no cyanosis * SaO_2>93% on air * no tachycardia * normal/slightly decreased feeding or may take longer to feed, intermittently stops feeding were diagnosed with mild acute bronchiolitis	322	437	12.5 (2.7 to 32.2)
BRON12	Infants (aged <12 months) who had two or more of the following signs/symptoms: * appear mildly unwell * moderate tachypnoea (RR>60/min) * mild to moderate WOB * no cyanosis * SaO_2 90%–95% on air * mild tachycardia * difficult feeding but able to take >50% of normal feed, frequent stops were diagnosed with moderate acute bronchiolitis	124	182	22.2 (10.8 to 37.8)
BRON13	Infants (aged <12 months) who had two or more of the following signs: * appear unwell (lethargic, restless) * severe tachypnoea>70 * bradypnoea<30 * moderate to severe WOB * may be cyanosed or pale * SaO_2<90% on air, <92% on oxygen * tachycardia >180 * difficult feeding taking <50% of normal feed, not interested * poor capillary refill >3 s were diagnosed with severe/life-threatening acute bronchiolitis	25	30	33.0 (9.5 to 65.3)
BRON14	Children diagnosed with acute mild/moderate bronchiolitis did not have a chest X-ray	333	503	93.6 (89.3 to 96.6)
BRON15	Children diagnosed with acute mild/moderate bronchiolitis did not have routine blood tests	333	507	97.7 (95.6 to 98.9)
BRON16	Children diagnosed with acute mild/moderate bronchiolitis did not have an ABG	333	508	99.2 (98.0 to 99.8)
BRON17	Children diagnosed with acute mild/moderate bronchiolitis did not have chest physiotherapy	335	510	99.9 (99.0 to 100)
BRON18	Infants (aged less than 12 months) with mild bronchiolitis did not receive prescribed oxygen	328	447	99.4 (98.1 to 99.9)
BRON19	Infants (aged less than 12 months) with mild bronchiolitis did not receive further investigations (ie, blood tests, chest X-ray)	327	448	97.1 (95.1 to 98.5)
BRON20	Infants (aged <12 months) with moderate bronchiolitis were prescribed oxygen to maintain saturation levels of greater than or equal to 93%	90	140	73.5 (60.2 to 84.2)
BRON21	Infants (aged <12 months) with moderate bronchiolitis were provided with frequent feeds or NG feeds were considered	99	155	82.3 (75.4 to 88.0)
BRON22	Infants (aged <12 months) with moderate bronchiolitis and prescribed oxygen had continuous saturation monitoring and hourly observations	66	100	96.6 (90.9 to 99.2)
BRON23	Infants (aged <12 months) with moderate bronchiolitis did not have further investigations performed (ie, blood tests, chest X-ray)	95	146	59.4 (47.1 to 71.0)

Continued

Table 1 Continued

Indicator ID	Indicator description	Number of children	Number of visits	Proportion adherent, % (95% CI)
BRON24	Infants (aged <12 months) with moderate bronchiolitis had 2 hourly observations performed	98	154	91.7 (83.7 to 96.5)
BRON25	Infants (aged <12 months) with mild to moderate bronchiolitis caused by a viral infection were not prescribed antibiotics	334	484	86.1 (74.8 to 93.7)
BRON26	Infants (aged <12 months) with severe bronchiolitis were prescribed oxygen to maintain saturation levels of greater than or equal to 93%	24	31	96.3 (82.6 to 99.9)
BRON27	Infants (aged <12 months) with severe bronchiolitis were prescribed intravenous fluids and nil by mouth	23	31	89.4 (73.1 to 97.5)
BRON28	Infants (aged <12 months) with severe bronchiolitis had their blood glucose assessed at least once during this presentation/admission	23	31	78.1 (54.3 to 93.2)
BRON29	Infants (aged <12 months) with severe bronchiolitis had continuous cardiorespiratory and saturation monitoring and hourly observations	23	31	98.3 (85.7 to 100)
BRON30	Infants (aged <12 months) who presented to the ED with acute bronchiolitis and any of the following: * lethargy * presence of nasal flaring and/or grunting * oxygen saturation <95% on air * uncertainty regarding diagnosis were reviewed within 30 min	94	107	97.7 (90.9 to 99.8)
BRON31	Infants (aged <12 months) who presented to the ED with acute bronchiolitis and any of the following: * respiratory rate >60/min or <30/min * presence of nasal flaring and/or grunting * SpO_2 <92% on air * severe chest wall recession * cyanosis were reviewed immediately	32	36	84.8 (60.0 to 97.1)
BRON32	Infants (aged <12 months) with acute bronchiolitis were not prescribed any of the following medications: * nebulised epinephrine * bronchodilators (if aged <6 months) * corticosteroid medication (unless asthma or chronic neonatal lung disease) * ipratropium bromide (possible asthma or chronic neonatal lung disease) * ribavirin (antiviral) unless there is significant immunosuppression	391	614	78.4 (69.0 to 86.0)
BRON33	Parents of infants (aged <12 months) with mild bronchiolitis received advice to provide small frequent feeds	335	450	24.0 (16.4 to 33.1)
BRON34	Parents of infants (aged <12 months) with mild bronchiolitis were provided written information prior to discharge	156	198	43.3 (31.8 to 55.4)
BRON35	Parents of infants (aged <12 months) with mild bronchiolitis were advised to follow-up with a health professional within 24 hours	155	200	53.8 (42.8 to 64.5)
BRON36	Infants (aged <12 months) who presented to the GP with acute bronchiolitis and two of the following: * poor feeding (<50% of usual fluid intake in preceding 24 hours) * lethargy * history of apnoea * respiratory rate >60/min OR <30/min * presence of nasal flaring and/or grunting * severe chest wall recession or tracheal tug * cyanosis * oxygen saturation <95% on air * uncertainty regarding diagnosis were referred to hospital	15	15	Insufficient data
BRON37	Infants (aged <12 months) with bronchiolitis who were discharged had minimal respiratory distress	202	266	99.2 (97.3 to 99.9)
BRON38	Infants (aged <12 months) with bronchiolitis who were discharged maintained an adequate daily oral intake (>75% of usual intake)	196	256	90.7 (82.2 to 96.0)
BRON39	Infants (aged <12 months) with bronchiolitis who were discharged had oxygen saturations which were greater than or equal to 92% on room air (including during sleep periods)	198	261	95.8 (88.7 to 99.0)
BRON40	Parents/carers of infants (aged <12 months) with bronchiolitis who were discharged were provided: * education and written information * support and follow-up arrangements	200	263	59.6 (49.3 to 69.3)

ABG, arterial blood gas; ED, emergency department; GP, general practice; HR, heart rate; NG, nasogastric; RR, respiratory rate; SaO2, arterial oxygen saturation; Temp, temperature.

latter figure is comparable with the use of chest X-ray and blood investigation in Canadian children (42% and 15%, respectively)[20 21] and in children in the USA attending ED with bronchiolitis, where 15%–40% underwent chest X-ray.[22] The available data do not support the use of chest X-ray in management of bronchiolitis.[23] The overuse of chest X-rays does not comply with paediatric patient safety initiatives and also wastes healthcare resources.[22] In our study, while adherence to CPG's recommendations to minimise laboratory investigation in children with bronchiolitis aged <2 years was high, there was overuse of chest X-rays particularly in children aged <12 months. Physicians often recommend chest X-rays in children with wheeze who are aged <6 months or who require hospitalisations, which do not have any beneficial

Table 2 Adherence of care, by healthcare setting, 2012–2013, Australia

Healthcare setting	Number of children	Number of visits	Number of indicators	Proportion adherent, % (95% CI)
General practice	223	299	4153	52.3 (44.8 to 59.7)
Emergency department	259	345	6696	77.3 (72.6 to 81.5)
Hospital	126	152	3130	81.6 (78.0 to 84.9)

impact on clinical management.[24] CPGs highlighting specific criteria for use of chest X-rays and other laboratory investigations in management of bronchiolitis may reduce such unwarranted variation in clinical practice. Studies have suggested that interventions that lead to providers pledging to minimise overuse of investigations not supported by CPGs including chest X-rays may also lead to reduction in use.[25]

The inappropriate use of different medications such as nebulised epinephrine, bronchodilators and corticosteroid in managing the acute phase of bronchiolitis was assessed to be ~22% (BRON32); lower than rates documented in studies conducted in Spain (64%) and Turkey (>50%).[26] CPGs recommend only symptomatic management of bronchiolitis without the need for any medication. The rate of use of antibiotics for viral bronchiolitis (BRON25) was ~14%; this was comparable with studies from other developed countries.[27 28] This is a particularly important finding given that, in high-income countries, where antibiotics are not available without a prescription, antibiotics for respiratory tract infections are commonly prescribed in primary care settings.[29] Despite the wealth of evidence suggesting no benefit of use of antibiotic in viral bronchiolitis, inappropriate use of antibiotics remains a problem as it leads to wastage of resources[30] and is also associated with emergence of antimicrobial resistance, a well-known global public health problem.[29] The use of antibiotics in children with acute bronchiolitis have not demonstrated improved clinical outcomes[31]; on the contrary, they have been associated with adverse events.[32] Studies suggest that making evidence-based guidelines more accessible at the point of care can reduce use of antibiotics in children with bronchiolitis.[33] However, implementation of guidelines in primary practice requires complex interventions.[34 35]

One of the main limitations of the study is that it was based on review of medical records and it is possible that there were discrepancies between documented care and the actual care provided. However, this method of assessing appropriateness of care has been used previously for adults in Australia and the USA,[36 37] and it has been estimated that such methodology to assess quality of care may lead to a 10% point underestimate of adherence.[37] The low recruitment rates for GPs in the broader CTK study, around 24%, creates the possibility of bias due to self-selection; for example, participating providers could be more likely to provide guideline-adherent care. However, we had a large sampling frame covering 60% of the Australian paediatric population which provided an overall assessment of guideline adherence. We did not investigate providers' familiarity with, or knowledge of, existing guidelines and we did not assess which guidelines, if any, were used in different healthcare settings.

To our knowledge, this is the first comprehensive study documenting clinical practices in management of paediatric bronchiolitis across different healthcare settings allowing comparison across different

Table 3 Adherence of care, by bundle of care, 2012–2013, Australia

Bundle ID	Bundle description	Indicator IDs*	Healthcare setting	Number of children	Number of visits	Proportion adherent, % (95% CI)
A	Infants aged <12 months presenting with acute bronchiolitis have appropriate history and examinations recorded	01–10	GP	168	217	0.0 (0.0 to 1.7)
			ED	213	281	11.5 (6.1 to 19.4)
			Inpatient	106	126	15.3 (8.2 to 25.0)
			Overall	392	624	2.7 (1.5 to 4.4)
B	Children diagnosed with acute mild/moderate bronchiolitis did not receive inappropriate tests/examinations	14–17	GP	124	169	98.6 (92.8 to 100.0)
			ED	193	247	81.7 (74.1 to 87.9)
			Inpatient	75	85	75.1 (56.2 to 88.8)
			Overall	331	501	92.6 (87.5 to 96.1)
C	Infants aged <12 months with severe bronchiolitis received appropriate prescription and monitoring/assessment	26–29	ED	13	13	Insufficient data
			Inpatient	14	16	Insufficient data
			Overall	22	29	72.3 (47.5 to 89.9)
D	Infants aged <12 months with bronchiolitis who were discharged met specific criteria	37–39	ED	104	126	81.2 (64.4 to 92.4)
			Inpatient	107	125	98.6 (94.6 to 99.9)
			Overall	194	251	89.0 (78.8 to 95.3)

*In table 1, the indicator ID was preceded by 'BRON'.
ED, emergency department; GP, general practice.

providers and helping to prioritise specific areas for improvement. While our study has demonstrated that guideline adherence was high across most indicators, there are opportunities to improve specific areas in management of bronchiolitis including more judicious use of laboratory investigations and antibiotics which may reduce unnecessary healthcare resource utilisation and add value to healthcare.

Undertaking these types of studies is expensive and logistically difficult with barriers to access, including ethics and privacy requirements, geographical distances and disruption to clinical staff. These issues mean that it is likely to be prohibitively expensive to use the current unstructured medical records to assess quality of care on an ongoing basis. However, the data from our study can be used to target area for improving quality of care. Studies have suggested initiatives to improve quality of care including educational programmes to improve awareness about bronchiolitis CPGs,[38] easy online access to CPGs and availability of CPGs at point-of-care[33 39] may improve quality of care. Implementation of evidence-based interventions to improve adherence to CPGs may reduce unwarranted variation in clinical care of bronchiolitis in Australian children. When interventions are implemented, the data from our study can also be used by clinicians and policy-makers as baseline information to evaluate the performance of the interventions over time.

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