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Assessing the appropriateness of the management of Upper Respiratory Tract Infection in Australian children: a population-based sample survey

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Abstract

Objective

To assess care of Australian children aged 0-15 years to estimate the proportion that received care in line with clinical practice guidelines (CPGs) for upper respiratory tract infections (URTIs).

Design

Retrospective medical record review using a multi-stage sampling strategy.

Setting

General Practices, hospital emergency departments and hospital inpatient service providers in three Australian states.

Participants

Children aged up to 15 years who received care for URTI in 2012 and 2013.

Primary and Secondary Outcome Measures

The primary assessment was estimated adherence with 14 indicators of appropriate care as documented in medical records. Indicators were extracted from national and international CPGs and ratified by experts. Secondary assessment was adherence to two bundles of indicators (diagnostic symptoms, and medical history taking), where all indicators must be adherent for the bundle to be scored as adherent.

Results

There were 1653 children with one or more assessments of URTI care to CPG adherence. Over half the children were under three years of age, with roughly equal numbers of males and females. Three indicators had fewer than 25 visits so were not reported. Overall adherence ranged from 0.5% for indicator URTI09 (documented advice around antibiotics) to 88.3% for URTI05 (documentation of medical history). Adherence with Bundle A (documentation of all three definitive symptoms) was 43.1% (95% CI: 32.8-54.0) and Package B (documentation of all four indicators of medical history) was 30.2% (95% CI: 20.9-40.9).

Conclusions

URTIs in children are common, usually self-limiting, conditions that are allocated considerable resources. The results suggest there may be a need for more thorough holistic assessment of the patient, and improved documentation. Since inappropriate prescription of antibiotics for URTIs is still a known problem in Australia, there is a need for consistent, clear communication around antibiotics' lack of impact on symptoms and high association with undesirable side effects.

Key words:

Upper respiratory tract infection; guideline adherence; health care quality indicators; paediatrics; child health

Article summary

Strengths and limitations of this study

- The study used a multi-stage representative sample across three Australian states, generalisable to the population
- Using medical records allowed assessment of guideline-adherence in real-world settings
- Lack of documentation of an action was interpreted as indicating the action did not occur
- Continuity of care was not assessed i.e., whether a patient was seeing the "usual" GP and therefore information such as comorbidities, medical history, current medications etc may be already known or recorded elsewhere in the medical record and did not need to be documented again
- Registered paediatric nurses familiar with childhood illnesses and management extracted data from medical records

Introduction

Upper respiratory tract infections (URTIs) are characterised by nasal congestion, rhinorrhoea, cough, sore throat and fever with a median duration of symptoms of eight days.[1] It is estimated that a normal child will experience five viral URTIs per year,[2] but more than 10% of children have 10 or more 'colds' per year.[1] It has been suggested that first-time parents may be surprised and concerned by this frequency, and misunderstand treatment options.[3]

URTIs are one of the most frequent problems managed by general practitioners (GPs) in Australia.[4] The Bettering the Evaluation And Care of Health (BEACH) study found that URTI presentations made up 3.3% of an Australian GP's workload, being third in frequency to hypertension and immunisations/vaccinations.[4] Children under 15 years old made up 31% of these patients and 17% are under 5 years old.[5] While URTIs are self-limiting, minor ailments, this represents a considerable use of time and resources. Other costs attributed to URTIs in children are mainly due to lost work time for carers.[6]

National clinical practice guidelines (CPGs) for assessment and management of childhood URTIs have been developed in a number of countries such as USA,[7-9] Sweden,[10] UK[11] and Australia.[12, 13] Most guidelines around assessment are consensus based as research on the clinical management on URTIs is scarce.[4] As URTIs are predominantly viral in origin and therefore mostly self-limiting, the clearest guidelines address the appropriate use of antibiotics, and assessment for complications such as peritonsillar abscess, bacterial sinusitis or pneumonia, or differential diagnoses such as pertussis. Other guidance addresses issues of care process, like ensuring past history and comorbidities are taken into account (e.g., neutropenia), and general advice to return if symptoms worsen or do not resolve.

Inappropriate management of URTIs in children can lead to overtreatment of a self-limiting condition, unnecessary antibiotic use leading to side effects and resistance of pathogenic bacteria, and increased burden for families. As one of the most frequent childhood illnesses, these considerations are significant.[11-13]

CareTrack Kids (CTK) assessed care of Australian children aged 0-15 years, in 2012 and 2013, to determine the proportion that received care in line with CPGs for 17 common conditions.[14] Across the 17 conditions, appropriate care per occasion of care was provided at an average of 59.8% (95% CI: 57.5-62.0), and at 53.2% (95% CI: 46.6-59.8) for URTI.[14] We present and discuss the CareTrack Kids results for URTI, at indicator level.

Methods

The CTK methods have been described in detail elsewhere.[14-16] We describe some aspects specifically relevant to URTI, with a focus on indicator development.

Development of indicators

The RAND-UCLA method was modified and applied to develop indicators.[17] This study defined a clinical indicator as a measurable component of a standard or guideline, with explicit criteria for inclusion, exclusion, time frame and practice setting.[18]

Three CPGs were found following a systematic search for Australian and international CPGs for URTI relevant for the years 2012-2013. From these three, 20 recommendations were extracted. Recommendations were screened for eligibility and excluded if they: (1) contained indefinite wording (e.g., “may”, “could”); (2) had a low likelihood of being documented; (3) consisted of guiding statements without recommended actions; or (4) addressed aspects of care deemed out of scope of the CTK study such as “structure-level” recommendations. Thirteen recommendations were excluded, with the remaining seven passed to internal review.

Candidate recommendations were ratified by experts over a two-stage multi-round modified Delphi process, which comprised an email-based three-round internal review and a collaborative, online, wiki-based two-round external review, custom-designed for the study.[16] In total, ten experts (comprising nine paediatricians and one general practitioner) were recruited for the internal (n=3) and external review (n=7). An expert coordinator was appointed to lead the reviews for each

condition. Reviewers completed a Conflict of Interest declaration [16] and these were managed according to an established protocol.[19]

In the internal review, experts scored each recommendation against three criteria (acceptability, feasibility and impact),[16] and recommended inclusion or exclusion. External reviewers applied the same scoring criteria as internal reviewers and, in addition, used a nine-point Likert scale to score each indicator as representative of appropriate care delivered to children during 2012 and 2013.[16, 17] Internal and external reviewers completed their assignments independently to minimise group-think.[20] Four recommendations were ratified by this process and these were formatted into 14 medical record audit indicator questions. All indicator questions are shown in Appendix 1.

Sample size, sampling process and data collection

A minimum of 400 medical record reviews per condition was required to obtain national estimates with 95% CIs and precision of ±5%, without adjustment for design effects. CTK targeted 400 medical records for URTI and 6000 medical records for 16 other conditions. If any of the 6400 medical records we targeted and sampled contained a visit for URTI, a separate assessment of appropriateness was made for each occasion. Detail on the sampling methods have been published;[14] additional details specific to URTI can be found in Appendix 2. Briefly, we sampled three healthcare settings (hospital inpatients, Emergency Department (ED) presentations, and consultations with GPs) in health department administrative units (health districts) in Queensland, New South Wales and South Australia, for children aged ≤15 years receiving care in 2012 and 2013. For the broader CTK study, the recruitment rate was 92% for hospitals, and estimated to be 24% for GPs (see Appendix 2). Data were collected by nine experienced paediatric nurses, trained to assess eligibility for indicator assessment and adherence with CPGs. Medical records for selected visits in 2012 and 2013 were reviewed on-site at each participating facility during March–October 2016.

Analysis

At indicator level, estimates of adherence were measured as the percentage of eligible indicators (i.e., indicators answered either 'Yes' or 'No') which were scored as 'Yes'. Adherence results for some clinically-related indicators were aggregated as bundles of care. For example, indicators URTI01-URTI03 all relate to the documentation of symptoms of children who presented with URTI; all three of these indicators would have to be scored 'Yes' for the bundle to be scored as adhering to the CPG. When assessing bundles, a visit was only included if there were responses for all component indicators.

Sampling weights were constructed as specified in Appendix 2 to adjust for oversampling of states and healthcare settings and for sampling within health districts. The weighted data were analysed in SAS version 9.4 (SAS Institute Inc, 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 analysis were used (see 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.[21] In both indicator and bundle reports, results were suppressed if there were <25 eligible visits, as small sample sizes could lead to misleading estimates. Differences in adherence rates between settings were restricted to comparisons between GP and the two hospital settings; as hospitals records were not sampled independently, they were not compared statistically. Statistical significance, where calculated, was based on the F-test approximation of the Rao-Scott chi-square test, which adjusts for the design effect.

Ethical considerations

We received primary ethics approval from relevant bodies including hospital networks (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68) and the Royal Australian College of General Practitioners (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 healthcare providers and

patients;[15] all relevant bodies provided this waiver. 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). Ethical approvals included reporting by healthcare setting for URTI.

Patient and public involvement

This study did not involve patients or the public.

Results

There were 1653 children with one or more assessable CPG indicators for URTI, with the age and sex distribution shown in Table 1. Over half the children in the CTK sample were under three years of age, with roughly equal number of males and females. Of 38,290 possible indicator assessments, 11,831 (30.9%) were designated as not applicable or otherwise ineligible. The field team conducted 26,459 eligible indicator assessments grouped into 2,714 visits, at a median of 10 indicators per visit. Eligible URTI visits were assessed in 81 GP practices, 34 hospital EDs and 25 hospital inpatient service providers.

Table 1: Characteristics of the eligible children with visits for URTI, 2012 - 2013

Characteristic	Children in the CTK Study
Age* - no. (%)	
< 3 months	46 (2.8)
3 - 11 months	262 (15.8)
1 - 2 years	568 (34.4)
3 - 5 years	363 (22.0)
6 - 12 years	350 (21.2)
13 - 15 years	64 (3.9)
Male - no. (%)	878 (53.1)

*The child's age was calculated as the age at visit where there was only one, or the midpoint of the child's age at her first and last URTI visit, where there was more than one.

Adherence

The assessed guideline adherence for each indicator is shown in Table 2, presented by healthcare setting and overall. Adherence is not reported for three of the 14 indicators, because they were assessed in fewer than 25 visits, and for some settings in the other 11 indicators. For the 11 reported indicators, overall adherence ranged from 0.5% (95% CI: 0.1-1.5) for indicator URTI09 ("*Parents of children with an URTI were advised against antibiotics as they may have side effects*") to 88.3% (95% CI: 79.3-94.4) for URTI05 ("*Children who presented with an URTI had their previous medical history documented*"). The interquartile range for overall adherence in the 11 indicators reported was 14.2% to 70.3%. Large confidence intervals on many of the indicators show substantial uncertainty in the estimates.

Table 2: Adherence by clinical indicator and by healthcare setting, 2012 - 2013

Indicator ID	Indicator Description	Healthcare Setting	No. of Children	No. of Visits	Proportion adherent, % (95% CI)
URTI01	Children who presented with URTI symptoms had the presence of a runny nose (rhinorrhea) documented.	GP	1197	2073	60.8 (49.0, 71.7)
		ED	423	530	77.5 (70.1, 83.8)*
		Inpatient	80	89	85.0 (68.0, 95.1)*
		Overall	1648	2692	61.4 (51.4, 70.8)
URTI02	Children who presented with URTI symptoms had the presence of a cough documented.	GP	1197	2073	70.1 (56.4, 81.6)
		ED	423	530	75.2 (60.9, 86.3)
		Inpatient	80	89	76.1 (57.5, 89.4)
		Overall	1648	2692	70.3 (58.6, 80.3)
URTI03	Children who presented with URTI symptoms had the presence of a fever documented.	GP	1196	2071	63.2 (52.0, 73.5)
		ED	422	529	85.2 (73.4, 93.2)*
		Inpatient	80	89	84.1 (59.8, 96.7)
		Overall	1646	2689	64.0 (54.3, 73.0)
URTI04	Children who presented with an URTI had their comorbidities documented.	GP	1178	2045	40.8 (28.9, 53.6)
		ED	417	518	78.8 (64.0, 89.6)*
		Inpatient	79	88	63.0 (32.6, 87.3)
		Overall	1623	2651	42.2 (32.0, 52.8)
URTI05	Children who presented with an URTI had their previous medical history documented.	GP	1201	2092	88.0 (77.3, 94.9)
		ED	423	530	95.8 (91.1, 98.4)
		Inpatient	80	89	98.2 (92.5, 99.9)*
		Overall	1652	2711	88.3 (79.3, 94.4)
URTI06	Children who presented with an URTI had their current medications documented.	GP	1198	2088	45.9 (37.2, 54.9)
		ED	422	529	82.9 (71.3, 91.2)*
		Inpatient	80	89	87.6 (74.5, 95.5)*
		Overall	1648	2706	47.3 (39.9, 54.7)
URTI07	Children who presented with an URTI had a physical examination.	GP	1200	2089	83.0 (71.7, 91.1)
		ED	422	529	94.8 (87.6, 98.4)
		Inpatient	80	89	100.0 (95.9, 100.0)*

Indicator ID	Indicator Description	Healthcare Setting	No. of Children	No. of Visits	Proportion adherent, % (95% CI)
		Overall	1650	2707	83.4 (73.9, 90.5)
URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	GP	1162	2013	11.0 (3.7, 23.8)
		ED	308	386	9.4 (4.7, 16.4)
		Inpatient	63	71	3.1 (0.1, 15.6)
		Overall	1491	2470	11.0 (4.3, 21.8)
URTI09	Parents of children with an URTI were advised against antibiotics as they may have side effects.	GP	1152	1993	0.4 (0.0, 1.7)
		ED	303	381	3.6 (0.9, 9.1)*
		Inpatient	63	71	0.0 (0.0, 5.1)
		Overall	1475	2445	0.5 (0.1, 1.5)
URTI10	Children with an URTI and pneumonia were prescribed antibiotics.	GP	39	41	12.0 (3.9, 25.9)
		ED	15	16	Insufficient data
		Inpatient	4	4	Insufficient data
		Overall	57	61	14.2 (6.6, 25.5)
URTI11	Children with an URTI and a peritonsillar abscess were prescribed antibiotics.	GP	8	8	Insufficient data
		ED	2	2	Insufficient data
		Inpatient	0	0	Insufficient data
		Overall	10	10	Insufficient data
URTI12	Children with an URTI and bordetella pertussis were prescribed antibiotics.	GP	9	9	Insufficient data
		ED	6	6	Insufficient data
		Inpatient	1	1	Insufficient data
		Overall	15	16	Insufficient data
URTI13	Children with an URTI and acute moderate/severe bacterial sinusitis were prescribed antibiotics.	GP	18	20	Insufficient data
		ED	1	1	Insufficient data
		Inpatient	3	3	Insufficient data
		Overall	21	24	Insufficient data
URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	GP	1183	2054	54.8 (46.8, 62.7)
		ED	368	451	78.4 (71.1, 84.5)*
		Inpatient	71	80	64.5 (47.0, 79.6)
		Overall	1603	2585	55.6 (48.7, 62.2)

Legend: GP=General Practitioner; ED=Emergency Department

* ED/Inpatient adherence statistically significantly higher than GP adherence at $p<0.05$.

By healthcare setting, estimated adherence in ED and inpatient settings was generally higher than in GP settings. As shown in Table 2, adherence in the GP setting was statistically significantly lower than in the ED setting for six indicators (URTI01, URTI03-04, URTI06, URTI09, URTI14), and in the inpatient setting for four indicators (URTI01, URTI05-07).

The assessed adherence for two bundles of care is shown in Table 3, for all three settings and overall. Bundle A assessed the documentation of three symptoms (runny nose, cough and fever), and found 43.1% overall adherence (95% CI: 32.8-54.0); the component indicator with the lowest

adherence was documentation of the presence of a runny nose (61.4%, 95% CI: 51.4-70.8; URTI01). Bundle B covered four indicators relating to the documentation of medical history and found 30.2% adherence (95% CI: 20.9-40.9); the component indicator with the lowest adherence was documentation of comorbidities (42.2%, 95% CI: 32.0-52.8; URTI04).

Table 3: Adherence by bundle of care and healthcare setting, 2012 – 2013

Bundle ID	Bundle Description	Indicator IDs*	Healthcare Setting	No. of Children	No. of Visits	No. of Indicator Assessments	Proportion Adherent, % (95% CI)
A	Children who presented with URTI symptoms had the presence of symptoms documented.	01 - 03	GP	1196	2071	6213	42.5 (30.5, 55.2)
			ED	422	529	1587	59.1 (46.5, 70.9)
			Inpatient	80	89	267	60.4 (44.1, 75.2)
			Overall	1646	2689	8067	43.1 (32.8, 54.0)
B	Children who presented with an URTI had medical history documented.	04 - 07	GP	1175	2039	8156	28.8 (17.8, 41.9)
			ED	415	516	2064	68.2 (51.4, 82.1)
			Inpatient	79	88	352	55.6 (29.8, 79.4)
			Overall	1618	2643	10572	30.2 (20.9, 40.9)

Legend: GP=General Practitioner; ED=Emergency Department

* In Table 2, the indicator ID was preceded by 'URTI'.

Discussion

This study assessed the guideline adherence of care for URTI provided to children aged 0-15 years in GP practices, EDs and inpatient services. Overall, guideline adherence was found to be suboptimal and inconsistent with indicator scores ranging from 88.3% (URTI05) to 0.5% (URTI09).

Children under three months of age were included in the study and accounted for 2.8% of the cohort. We acknowledge that it is difficult at that age to differentiate URTI from early bronchiolitis.

Documentation of past medical history scored the highest of the indicators at 88.3% (URTI05) but is only one aspect of a holistic assessment required to make appropriate management decisions; i.e.,

to rule out more serious underlying disease (e.g., cystic fibrosis) and to limit exacerbation of chronic conditions (e.g., asthma).[3] The second package of care measured documentation of past medical history, comorbidities, current medications and a physical examination. All four aspects were documented in only 30.2% of patient encounters, indicating that one or more important aspects of assessment were potentially being overlooked. It could be argued that children who were seeing their usual GP or were regular presenters at the ED (for example, a well-known patient with asthma or cystic fibrosis) may not have had these co-morbidities documented at each individual episode of care. Auditors had access to the whole medical record and were instructed to consider this when determining whether indicators were eligible for scoring.

Antibiotics are not indicated for uncomplicated viral URTI presentations, and their inappropriate use may contribute to the major problem of antibiotic resistance,[11] and put children at risk of side effects. Other studies investigating this issue have measured inappropriate prescribing rates of 20.2% for children under 5 years of age with uncomplicated URTIs,[22] and 46% of patients of all ages with URTI in Australian general practice.[23] Prescribing for non-specific URTI increased fourfold in the UK between 1996 and 2006.[24] Pressure from parents to receive a prescription for antibiotics is a frequently mentioned issue affecting physicians' prescribing practice.[e.g., 23, 25, 26, 27] A study in South East Wales suggested that parents of pre-school children were being influenced to inappropriately seek antibiotics by the policy and social pressure exerted by day care providers, contrary to the evidence on URTI treatment.[28] A Canadian cluster-randomised trial which trained family physicians to engage parents in shared decision-making around treatment options demonstrated that it is possible to reduce the rate of inappropriate antibiotic use in children with acute respiratory infections by 60%.[29]

Two indicators were included in our study that relate to explaining to parents why antibiotics are not indicated (URTI08 - 09) to address this social pressure, and ensure engagement with, and education of parents. These indicators were guided by the National Institute for Health and Care Excellence (NICE) 2008 guidelines which recommend: "*When the "no antibiotic prescribing*

strategy" is adopted, patients should be offered reassurance that antibiotics are not needed immediately because they are likely to make little difference to symptoms and may have side effects, for example, diarrhoea, vomiting and rash." Our indicators reflect this advice yet seem infrequently given to parents in our study or were not documented. Indicator URTI09 ("*Parents of children with an URTI were advised against antibiotics as they may have side effects*") showed the lowest level of adherence across the indicators (0.5%) with indicator URTI08 ("*Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms*") scoring second lowest with 11%. There may be several reasons for this: the advice may have been given but not documented; antibiotics may have been (inappropriately) prescribed; or pressure for antibiotic prescription may not have been an issue needing to be addressed. Alternatively, discussions around the inappropriateness of antibiotics to treat an uncomplicated URTI may have been framed in a different way that auditors did not judge as equivalent; e.g., focussing instead on the viral nature of URTIs and how antibiotics are only effective against bacterial infections.

Our study did assess circumstances in which antibiotic prescription was appropriate. Appropriateness of antibiotic prescription for children with concurrent pneumonia (URTI10) was only 14.2% in the aggregated data and on breakdown by setting, only GPs had a large enough number of presentations to report. GPs for this indicator scored 12.0% (95% CI: 3.9-25.9), which is surprisingly low. The BEACH study[22] measured antibiotic prescription rates for children under five years diagnosed with pneumonia as 65.6%. Given that 85% of children with URTI and pneumonia in our study were under five years of age, it is not clear why our results differ. The BEACH study relies on physician documentation of a special form, while our study examined what was documented in the medical record. As early as 2005, we have Australian survey evidence of a high level of penetration of electronic medical record use by GPs (~90%), with 98% of users 'mostly' using the inbuilt prescribing tool, so under-documentation seems unlikely to be the source of the discrepant results, at least for this setting.[30] It remains possible that the relatively small number of occasions of care surveyed (n=61), has by chance led to an unrepresentative result.

Another reason may have been the lack of specificity of URTI10 which did not differentiate between bacterial and viral pneumonia.

Strengths of the study include the large sample of Australian children: 1,653 children with one or more eligible indicator assessments were analysed. The use of paediatric registered nurses who underwent five days of training and assessment in auditing the indicators, and who are familiar with childhood illnesses and management, to collect data was another strength. This increased the likelihood that records were correctly interpreted, and data recorded accurately. A weakness of the study is the use of documentation to assess actual practice; i.e., if it was not documented, it was assumed it did not occur. We note, however that from a litigation, insurance and auditing point of view, documentation is an accepted proxy measure for action and has been shown to be acceptably correlated with actual practice.[31, 32]

Clinically, this study suggests the need for more thorough holistic assessment of the patient including consideration of all four aspects included in the indicators here (comorbidities, past medical history, current medications and physical examination). Since inappropriate prescription of antibiotics for URTIs is still known to be a problem in Australia,[22] there is a need for consistent clear communication and patient education around antibiotics' lack of impact on symptoms and the risks of undesirable side effects.

Conclusion

Uncomplicated URTIs are a common condition of childhood, with considerable time and resources expended in assessing and managing them.[4] This study has shown that appropriate care may not be delivered consistently and there is room for improvement. Guideline adherence for bundles of care, that require all component indicators to be addressed, was low: documentation of all three common diagnostic symptoms was only adhered to in an estimated 43.1% of visits, and holistic assessment of the patient using four indicators was only adhered to in 30.2% of visits. In a context where

pressure from parents still drives inappropriate antibiotic use for children with URTI, advice to parents was infrequently reported (0.5 and 11%).

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Ethics Statement

Primary ethics approval was received from hospital networks (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68) and the Royal Australian College of General Practitioners (NREEC 14-008), and site-specific approvals from 34 sites.

Data sharing statement

All additional data are provided in the Appendices.

Competing interests

All authors declare that they have no conflicts of interest.

Authors' contributions

JB, PH designed the overall study. SJ, HW contributed to design of URTI study. JB, PH, GA, HPT, CM carried out the collection and statistical analysis of the data. JCL drafted the manuscript and was responsible for coordination of all aspects of the work. KC, LAE reviewed and made

substantial contributions to earlier drafts. All authors contributed to the interpretation of results and the final manuscript.

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Appendix 1: Characteristics of clinical indicators, 2012 - 2013

			No. of Sites					
Indicator ID	**Indicator Description**	**Age Inclusion Criteria**	**GP**	**ED**	**IP**	**Level of Evidence or Strength of recommendation#**	**Phase of Care**	**Quality Type***
URTI01	Children who presented with URTI symptoms had the presence of a runny nose (rhinorrhea) documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI02	Children who presented with URTI symptoms had the presence of a cough documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI03	Children who presented with URTI symptoms had the presence of a fever documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI04	Children who presented with an URTI had their comorbidities documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI05	Children who presented with an URTI had their previous medical history documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI06	Children who presented with an URTI had their current medications documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI07	Children who presented with an URTI had a physical examination.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	0 - 15 years	81	31	22	Consensus-based recommendation	Treatment	Underuse
URTI09	Parents of children with an URTI were advised against antibiotics as they may have side effects.	0 - 15 years	81	30	22	Consensus-based recommendation	Treatment	Underuse
URTI10	Children with an URTI and pneumonia were prescribed antibiotics.	0 - 15 years	24	12	4	Consensus-based recommendation	Treatment	Underuse
URTI11	Children with an URTI and a peritonsillar abscess were prescribed antibiotics.	0 - 15 years	7	2	0	Consensus-based recommendation	Treatment	Underuse
URTI12	Children with an URTI and bordetella pertussis were prescribed antibiotics.	0 - 15 years	8	5	1	Consensus-based recommendation	Treatment	Underuse
URTI13	Children with an URTI and acute moderate/severe bacterial sinusitis were prescribed antibiotics.	0 - 15 years	14	1	3	Consensus-based recommendation	Treatment	Underuse

			No. of Sites					
Indicator ID	**Indicator Description**	**Age Inclusion Criteria**	**GP**	**ED**	**IP**	**Level of Evidence or Strength of recommendation[#]**	**Phase of Care**	**Quality Type***
URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	0 - 15 years	81	34	24	Consensus-based recommendation	Ongoing management	Underuse

Legend: ID=Identifier; GP=General Practitioner; ED=Emergency Department; IP=Inpatient.

[#] Strength of recommendation as reported in individual CPGs. CPGs used a variety of classification schemes for allocating Strength of Recommendation in 'Grades' or Level of Evidence in 'Levels'. If strength of recommendation, or level of evidence, were not specified in the CPG, the term "Consensus-based recommendation" was assigned.

* The type of quality of care assessed was classified as underuse or overuse: underuse refers to actions which are recommended, but not undertaken; overuse refers to actions which are not indicated, or are contraindicated, in the context of the indicator's inclusion criteria.

Appendix 2: Additional details relating to study methods

The report of top-level CareTrack Kids (CTK) results[1] and its associated online appendix, detail the methods of the larger study, which generated the data reported in this paper. Selected methods specifically relevant to URTI are described below.

Sample size

A visit was defined as an occasion of admitted inpatient care, an Emergency Department (ED) presentation or a consultation with a General Practitioner (GP). Without adjustment for the design effect, a minimum of 400 surveys per condition was required to obtain national estimates with 95% Confidence Interval (CI) and precision of +/- 5% at condition level, conservatively assuming only one eligible indicator per visit. It was anticipated that loss of precision due to design effects would be largely offset by multiple eligible indicators per visit and additional surveys generated by the secondary sampling (multiple visits for care of URTI for each medical record identified for sampling of URTI, and visits for care of URTI incidentally found in medical records identified for sampling other conditions).

Sampling Process

A multistage stratified random sampling process was implemented. For logistical efficiency, sampling was targeted at three states, Queensland (QLD), New South Wales (NSW) and South Australia (SA), which together comprise 60.0% of the estimated Australian population aged 15 years or younger in the 2012 and 2013 calendar years. All six paediatric tertiary hospitals (two in QLD, three in NSW, and one in SA) were targeted as they have state-wide coverage. State Departments of Health organize care within administrative units ('health districts'): Hospital Health Services in QLD, Local Health Districts in NSW, and Local Health Networks in SA. For QLD, we targeted five health districts (two metropolitan, three

regional), in NSW four health districts (two metropolitan, two regional), and in SA three health districts (two metropolitan, one regional).

Recruitment of health care providers

Within the selected health districts, we approached all public hospitals, or private hospitals providing public services under contract, that had patient volumes of ≥2,000 ED presentations and ≥500 paediatric separations per year; we also advertised the study to GPs and approached all the providers we could identify through internet searches, and via personal contacts. Within the selected sites, we sampled medical records for each condition targeted at that setting.

Recruitment of GPs was decentralized. Administrative details for refusal rates, from cold-calling or direct contact by clinicians who facilitated recruitment of their peers, were maintained on project laptops. At the end of recruitment all computers were decommissioned and cleaned, with the files archived on a USB drive. Unfortunately, the USB drives created during laptop decommissioning were misplaced and have not been able to be located. This did not affect the indicator adherence data, as the database was remotely located and updated regularly via the internet. We have therefore sought to estimate the recruitment rates based on recruitment spreadsheets emailed to the administrative staff.

For GPs, we were only able to locate emailed spreadsheets with late stage records for one state, South Australia. Based on this spreadsheet, we approached 114 GPs and recruited 27 of them, giving a recruitment rate of 23.7%; an additional GP, not listed on the available spreadsheet, was recruited subsequently and was not added to either the numerator or the denominator, for this estimate. The spreadsheet did not have clear information on eligibility, so it is likely that an unknown number of the 114 approached were ineligible because: 1) they were not open during the whole 2012-2013 survey period; 2) they saw no or few children; or

3) they were not confident in their ability to generate full listings of children with the target conditions, or they did not use one of the four practice software systems our surveyors were trained to search. Our estimate of 23.7% is therefore likely to be an underestimate of the actual recruitment rate.

Self-selection of GPs could lead to bias in the estimated guideline adherence. It is plausible that self-selected practices were more confident of their guideline adherence, potentially leading to overestimation of guideline-adherence in the CareTrack Kids study.

Allocation of surveys to sampling units

The number of URTI records targeted at each site was determined by a nominal allocation of the 400 records targeted, informed by data available at the time, supplemented by expert opinion, with planned over-sampling of settings where fewer occasions of care were expected.[1, 2] For hospitals, a fixed number was targeted at each site; for GPs, different combinations of conditions were targeted at each site, to simplify the logistics of sampling.

Data collection

Nine experienced paediatric nurses were employed across the three states, with all nine assessing occasions of care for URTI. The surveyors undertook a one-week training program, prior to data collection. A surveyor manual was developed which included instructions, condition-specific definitions, inclusion and exclusion criteria, and guidance for assessing eligibility of each encounter for relevant indicators. Mock records were assessed during the surveying task for 6 of the 9 surveyors (2 had already terminated employment and 1 was excluded as their assessments may not have been made independently) and their results compared. A good level of agreement was found; $\kappa = 0.76$ (95%CI, 0.75-0.77; n = 1895) for

the child's eligibility for indicator assessment, and κ = 0.71 (95% CI, 0.69-0.73; n = 1009) for indicator assessment.[1]

A web-based tool, originally developed for the CareTrack Adults study[3, 4], was designed to enter data during medical record review. Surveyors undertook criterion-based medical record reviews using the data collection tool. Medical records for selected visits in 2012 and 2013 were reviewed on-site at each participating facility during March–October 2016. The surveyors responded to each indicator as 'Yes' (care provided during the encounter was consistent with the indicator), 'No', or 'Not Applicable' (NA; the indicator was not eligible for assessment). For example, a surveyor assessing an occasion of care for a child with URTI, but without pneumonia, would record 'NA' to indicator URTI10.

Analysis

Survey or register-derived data were used to estimate the proportion of occasions of care for URTI in each setting.[5-10] The number of occasions of healthcare for each condition was thereby estimated for each hospital or, for GPs, each health district, and sampling weights were calculated using the methods detailed in eAppendix 4 of the report of the top-line CTK results (this Appendix can be accessed by request via the corresponding author, if required).[1]

Differences in adherence rates between settings were restricted to comparisons between GP and the two hospital settings, as hospitals records were not sampled independently, they were not compared statistically. Statistical significance was based on the F-test approximation of the Rao-Scott chi-square test, which adjusts for the design effect; a modified Rao-Scott chi-square test was used when the design correction was negative.

A variety of stratifications, and sometimes domain analysis,[11, 12] were necessary to ensure accuracy of the confidence interval estimates. These are detailed in eTable 1, below.

eTable 1: Domain analysis and stratifications for different estimates presented in the manuscript.

Location	Sub-section/Area	Domain analysis[11, 12]	Strata
Table 2	Indicator x healthcare setting estimates	Yes	State
	Overall Indicator estimates	Yes	State and healthcare setting
Table 3	Bundle x healthcare setting estimates	Yes	State
	Overall estimate for bundle	Yes	State and healthcare setting

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Assessing the appropriateness of the management of Upper Respiratory Tract Infection in Australian children: a population-based sample survey

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Abstract

Objective

To assess the proportion of Australian children aged 0-15 years that received care in line with clinical practice guidelines (CPGs) for upper respiratory tract infections (URTIs).

Design

Retrospective medical record review using a multi-stage sampling strategy.

Setting

General Practices, hospital emergency departments and hospital inpatient service providers in three Australian states.

Participants

Children aged up to 15 years who received care for URTI in 2012 and 2013.

Primary and Secondary Outcome Measures

The primary assessment was estimated adherence with 14 indicators of appropriate care as documented in medical records. Indicators were extracted from national and international CPGs and ratified by experts. Secondary assessment was adherence to two bundles of indicators (diagnostic symptoms, and medical history taking), where all indicators must be adherent for the bundle to be scored as adherent.

Results

There were 1653 children with one or more assessments of URTI care to CPG adherence. Over half the children were under three years of age, with roughly equal numbers of males and females. Three indicators had fewer than 25 visits so were not reported. Overall adherence ranged from 0.5% for "documented advice around antibiotics" to 88.3% for "documentation of medical history". Adherence with Bundle A (documentation of all three definitive symptoms) was 43.1% (95% CI: 32.8-54.0) and Bundle B (documentation of all four indicators of medical history) was 30.2% (95% CI: 20.9-40.9).

Conclusions

URTIs in children are common, usually self-limiting, conditions that are allocated considerable resources. The results suggest there may be a need for more thorough holistic assessment of the patient, and improved documentation. Since inappropriate prescription of antibiotics for URTIs is still a known problem in Australia, there is a need for consistent, clear communication around antibiotics' lack of impact on symptoms and high association with undesirable side effects.

Key words:

Upper respiratory tract infection; guideline adherence; health care quality indicators; paediatrics; child health

Article summary

Strengths and limitations of this study

- The study used a multi-stage representative sample across three Australian states, generalisable to the population
- Using medical records allowed assessment of guideline-adherence in real-world settings
- Lack of documentation of an action was interpreted as indicating the action did not occur
- Registered paediatric nurses familiar with childhood illnesses and management extracted data from medical records
- The patient's whole medical record was available to nurses extracting data not just the occasion of care

Introduction

Upper respiratory tract infections (URTIs) are characterised by nasal congestion, rhinorrhoea, cough, sore throat and fever with a median duration of symptoms of eight days.[1] It is estimated that a normal child will experience five viral URTIs per year,[2] but more than 10% of children have 10 or more 'colds' per year.[1] It has been suggested that first-time parents may be surprised and concerned by this frequency, and misunderstand treatment options.[3]

URTIs are one of the most frequent problems managed by general practitioners (GPs) in Australia.[4] The Bettering the Evaluation And Care of Health (BEACH) study found that URTI presentations made up 3.3% of an Australian GP's workload, being third in frequency to hypertension and immunisations/vaccinations.[4] Children under 15 years old made up 31% of these patients and 17% are under 5 years old.[5] While URTIs are self-limiting, minor ailments, this represents a considerable use of time and resources. Other costs attributed to URTIs in children are mainly due to lost work time for carers.[6]

National clinical practice guidelines (CPGs) for assessment and management of childhood URTIs have been developed in a number of countries such as USA,[7-9] Sweden,[10] UK[11] and Australia.[12, 13] Most guidelines around assessment are consensus based as research on the clinical management on URTIs is scarce.[4] As URTIs are predominantly viral in origin and therefore mostly self-limiting, the clearest guidelines address the appropriate use of antibiotics, and assessment for complications such as peritonsillar abscess, bacterial sinusitis or pneumonia, or differential diagnoses such as pertussis. Other guidance addresses issues of care process, like ensuring past history and comorbidities are taken into account (e.g., neutropenia), and general advice to return if symptoms worsen or do not resolve.

Inappropriate management of URTIs in children can lead to overtreatment of a self-limiting condition, unnecessary antibiotic use leading to side effects and resistance of pathogenic bacteria, and increased burden for families. As one of the most frequent childhood illnesses, these considerations are significant.[11-13]

CareTrack Kids (CTK) assessed care of Australian children aged 0-15 years, in 2012 and 2013, to determine the proportion that received care in line with CPGs for 17 common conditions.[14] Across the 17 conditions, appropriate care per occasion of care was provided at an average of 59.8% (95% CI: 57.5-62.0), and at 53.2% (95% CI: 46.6-59.8) for URTI.[14] We present and discuss the CareTrack Kids results for URTI, at indicator level.

Methods

The CTK methods have been described in detail elsewhere.[14-16] We describe some aspects specifically relevant to URTI, with a focus on indicator development.

Development of indicators

The RAND-UCLA method was modified and applied to develop indicators.[17] This study defined a clinical indicator as a measurable component of a standard or guideline, with explicit criteria for inclusion, exclusion, time frame and practice setting.[18] More details on the development of indicators has been published separately.[19]

Three CPGs were found following a systematic search for Australian and international CPGs for URTI relevant for the years 2012-2013. From these three, 20 recommendations were extracted. Recommendations were screened for eligibility and excluded if they: (1) contained indefinite wording (e.g., “may”, “could”); (2) had a low likelihood of being documented; (3) consisted of guiding statements without recommended actions; or (4) addressed aspects of care deemed out of scope of the CTK study such as “structure-level” recommendations. Thirteen recommendations were excluded, with the remaining seven passed to internal review.

Candidate recommendations were ratified by experts over a two-stage multi-round modified Delphi process, which comprised an email-based three-round internal review and a collaborative, online, wiki-based two-round external review, custom-designed for the study.[16] In total, ten experts (comprising nine paediatricians and one general practitioner) were recruited for the internal (n=3) and external review (n=7). An expert coordinator was appointed to lead the reviews for each

condition. Reviewers completed a Conflict of Interest declaration [16] and these were managed according to an established protocol.[20]

In the internal review, experts scored each recommendation against three criteria (acceptability, feasibility and impact),[16] and recommended inclusion or exclusion. External reviewers applied the same scoring criteria as internal reviewers and, in addition, used a nine-point Likert scale to score each indicator as representative of appropriate care delivered to children during 2012 and 2013.[16, 17] Internal and external reviewers completed their assignments independently to minimise group-think.[21] Four recommendations were ratified by this process and these were formatted into 14 medical record audit indicator questions. All indicator questions are shown in Appendix 1.

Sample size, sampling process and data collection

A minimum of 400 medical record reviews per condition was required to obtain national estimates with 95% CIs and precision of ±5%, without adjustment for design effects. CTK targeted 400 medical records for URTI and 6000 medical records for 16 other conditions. If any of the 6400 medical records we targeted and sampled contained a visit for URTI, a separate assessment of appropriateness was made for each occasion. Detail on the sampling methods have been published;[14] additional details specific to URTI can be found in Appendix 2. Briefly, we sampled three healthcare settings (hospital inpatients, Emergency Department (ED) presentations, and consultations with GPs) in health department administrative units (health districts) in Queensland, New South Wales and South Australia, for children aged ≤15 years receiving care in 2012 and 2013. For the broader CTK study, the recruitment rate was 92% for hospitals, and estimated to be 24% for GPs (see Appendix 2). Data were collected by nine experienced paediatric nurses, trained to assess eligibility for indicator assessment and adherence with CPGs. Medical records for selected visits in 2012 and 2013 were reviewed on-site at each participating facility during March–October 2016. Data collectors had access to the entire medical record, not just the occasion of care.

Analysis

At indicator level, estimates of adherence were measured as the percentage of eligible indicators (i.e., indicators answered either 'Yes' or 'No') which were scored as 'Yes'. Adherence results for some clinically-related indicators were aggregated as bundles of care. For example, indicators URTI01-URTI03 all relate to the documentation of symptoms of children who presented with URTI; all three of these indicators would have to be scored 'Yes' for the bundle to be scored as adhering to the CPG. When assessing bundles, a visit was only included if there were responses for all component indicators.

Sampling weights were constructed as specified in Appendix 2 to adjust for oversampling of states and healthcare settings and for sampling within health districts. The weighted data were analysed in SAS version 9.4 (SAS Institute Inc, 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 analysis were used (see 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.[22] In both indicator and bundle reports, results were suppressed if there were <25 eligible visits, as small sample sizes could lead to misleading estimates. Differences in adherence rates between settings were restricted to comparisons between GP and the two hospital settings; as hospitals records were not sampled independently, they were not compared statistically. Statistical significance, where calculated, was based on the F-test approximation of the Rao-Scott chi-square test, which adjusts for the design effect.

Ethical considerations

We received primary ethics approval from relevant bodies including hospital networks (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68) and the Royal Australian College of General Practitioners (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 healthcare providers and

patients;[15] all relevant bodies provided this waiver. 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). Ethical approvals included reporting by healthcare setting for URTI.

Patient and public involvement

This study did not involve patients or the public.

Results

There were 1653 children with one or more assessable CPG indicators for URTI, with the age and sex distribution shown in Table 1. Over half the children in the CTK sample were under three years of age, with roughly equal number of males and females. Of 38,290 possible indicator assessments, 11,831 (30.9%) were designated as not applicable or otherwise ineligible. The field team conducted 26,459 eligible indicator assessments grouped into 2,714 visits, at a median of 10 indicators per visit. Eligible URTI visits were assessed in 81 GP practices, 34 hospital EDs and 25 hospital inpatient service providers.

Table 1: Characteristics of the eligible children with visits for URTI, 2012 - 2013

Characteristic	Children in the CTK Study
Age* - no. (%)	
< 3 months	46 (2.8)
3 - 11 months	262 (15.8)
1 - 2 years	568 (34.4)
3 - 5 years	363 (22.0)
6 - 12 years	350 (21.2)
13 - 15 years	64 (3.9)
Male - no. (%)	878 (53.1)

*The child's age was calculated as the age at visit where there was only one, or the midpoint of the child's age at her first and last URTI visit, where there was more than one.

Adherence

The assessed guideline adherence for each indicator is shown in Table 2, presented by healthcare setting and overall. Adherence is not reported for three of the 14 indicators, because they were assessed in fewer than 25 visits, and for some settings in the other 11 indicators. For the 11 reported indicators, overall adherence ranged from 0.5% (95% CI: 0.1-1.5) for indicator URTI09 ("*Parents of children with an URTI were advised against antibiotics as they may have side effects*") to 88.3% (95% CI: 79.3-94.4) for URTI05 ("*Children who presented with an URTI had their previous medical history documented*"). The interquartile range for overall adherence in the 11 indicators reported was 14.2% to 70.3%. Large confidence intervals on many of the indicators show substantial uncertainty in the estimates.

Table 2: Adherence by clinical indicator and by healthcare setting, 2012 - 2013

Indicator ID	Indicator Description	Healthcare Setting	No. of Children	No. of Visits	Proportion adherent, % (95% CI)
URTI01	Children who presented with URTI symptoms had the presence of a runny nose (rhinorrhea) documented.	GP	1197	2073	60.8 (49.0, 71.7)
		ED	423	530	77.5 (70.1, 83.8)*
		Inpatient	80	89	85.0 (68.0, 95.1)*
		Overall	1648	2692	61.4 (51.4, 70.8)
URTI02	Children who presented with URTI symptoms had the presence of a cough documented.	GP	1197	2073	70.1 (56.4, 81.6)
		ED	423	530	75.2 (60.9, 86.3)
		Inpatient	80	89	76.1 (57.5, 89.4)
		Overall	1648	2692	70.3 (58.6, 80.3)
URTI03	Children who presented with URTI symptoms had the presence of a fever documented.	GP	1196	2071	63.2 (52.0, 73.5)
		ED	422	529	85.2 (73.4, 93.2)*
		Inpatient	80	89	84.1 (59.8, 96.7)
		Overall	1646	2689	64.0 (54.3, 73.0)
URTI04	Children who presented with an URTI had their comorbidities documented.	GP	1178	2045	40.8 (28.9, 53.6)
		ED	417	518	78.8 (64.0, 89.6)*
		Inpatient	79	88	63.0 (32.6, 87.3)
		Overall	1623	2651	42.2 (32.0, 52.8)
URTI05	Children who presented with an URTI had their previous medical history documented.	GP	1201	2092	88.0 (77.3, 94.9)
		ED	423	530	95.8 (91.1, 98.4)
		Inpatient	80	89	98.2 (92.5, 99.9)*
		Overall	1652	2711	88.3 (79.3, 94.4)
URTI06	Children who presented with an URTI had their current medications documented.	GP	1198	2088	45.9 (37.2, 54.9)
		ED	422	529	82.9 (71.3, 91.2)*
		Inpatient	80	89	87.6 (74.5, 95.5)*
		Overall	1648	2706	47.3 (39.9, 54.7)
URTI07	Children who presented with an URTI had a physical examination.	GP	1200	2089	83.0 (71.7, 91.1)
		ED	422	529	94.8 (87.6, 98.4)
		Inpatient	80	89	100.0 (95.9, 100.0)*

Indicator ID	Indicator Description	Healthcare Setting	No. of Children	No. of Visits	Proportion adherent, % (95% CI)
		Overall	1650	2707	83.4 (73.9, 90.5)
URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	GP	1162	2013	11.0 (3.7, 23.8)
		ED	308	386	9.4 (4.7, 16.4)
		Inpatient	63	71	3.1 (0.1, 15.6)
		Overall	1491	2470	11.0 (4.3, 21.8)
URTI09	Parents of children with an URTI were advised against antibiotics as they may have side effects.	GP	1152	1993	0.4 (0.0, 1.7)
		ED	303	381	3.6 (0.9, 9.1)*
		Inpatient	63	71	0.0 (0.0, 5.1)
		Overall	1475	2445	0.5 (0.1, 1.5)
URTI10	Children with an URTI and pneumonia were prescribed antibiotics.	GP	39	41	12.0 (3.9, 25.9)
		ED	15	16	Insufficient data
		Inpatient	4	4	Insufficient data
		Overall	57	61	14.2 (6.6, 25.5)
URTI11	Children with an URTI and a peritonsillar abscess were prescribed antibiotics.	GP	8	8	Insufficient data
		ED	2	2	Insufficient data
		Inpatient	0	0	Insufficient data
		Overall	10	10	Insufficient data
URTI12	Children with an URTI and bordetella pertussis were prescribed antibiotics.	GP	9	9	Insufficient data
		ED	6	6	Insufficient data
		Inpatient	1	1	Insufficient data
		Overall	15	16	Insufficient data
URTI13	Children with an URTI and acute moderate/severe bacterial sinusitis were prescribed antibiotics.	GP	18	20	Insufficient data
		ED	1	1	Insufficient data
		Inpatient	3	3	Insufficient data
		Overall	21	24	Insufficient data
URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	GP	1183	2054	54.8 (46.8, 62.7)
		ED	368	451	78.4 (71.1, 84.5)*
		Inpatient	71	80	64.5 (47.0, 79.6)
		Overall	1603	2585	55.6 (48.7, 62.2)

Legend: GP=General Practitioner; ED=Emergency Department

* ED/Inpatient adherence statistically significantly higher than GP adherence at $p<0.05$.

By healthcare setting, estimated adherence in ED and inpatient settings was generally higher than in GP settings. As shown in Table 2, adherence in the GP setting was statistically significantly lower than in the ED setting for six indicators (URTI01, URTI03-04, URTI06, URTI09, URTI14), and in the inpatient setting for four indicators (URTI01, URTI05-07).

The assessed adherence for two bundles of care is shown in Table 3, for all three settings and overall. Bundle A assessed the documentation of three symptoms (runny nose, cough and fever), and found 43.1% overall adherence (95% CI: 32.8-54.0); the component indicator with the lowest

adherence was documentation of the presence of a runny nose (61.4%, 95% CI: 51.4-70.8; URTI01). Bundle B covered four indicators relating to the documentation of medical history and found 30.2% adherence (95% CI: 20.9-40.9); the component indicator with the lowest adherence was documentation of comorbidities (42.2%, 95% CI: 32.0-52.8; URTI04).

Table 3: Adherence by bundle of care and healthcare setting, 2012 – 2013

Bundle ID	Bundle Description	Indicator IDs*	Healthcare Setting	No. of Children	No. of Visits	No. of Indicator Assessments	Proportion Adherent, % (95% CI)
A	Children who presented with URTI symptoms had the presence of symptoms documented.	01 - 03	GP	1196	2071	6213	42.5 (30.5, 55.2)
			ED	422	529	1587	59.1 (46.5, 70.9)
			Inpatient	80	89	267	60.4 (44.1, 75.2)
			Overall	1646	2689	8067	43.1 (32.8, 54.0)
B	Children who presented with an URTI had medical history documented.	04 - 07	GP	1175	2039	8156	28.8 (17.8, 41.9)
			ED	415	516	2064	68.2 (51.4, 82.1)
			Inpatient	79	88	352	55.6 (29.8, 79.4)
			Overall	1618	2643	10572	30.2 (20.9, 40.9)

Legend: GP=General Practitioner; ED=Emergency Department

* In Table 2, the indicator ID was preceded by 'URTI'.

Discussion

This study assessed the guideline adherence of care for URTI provided to children aged 0-15 years in GP practices, EDs and inpatient services. Overall, guideline adherence was found to be suboptimal and inconsistent with indicator scores ranging from 88.3% (URTI05) to 0.5% (URTI09).

Documentation of past medical history scored the highest of the indicators at 88.3% (URTI05) but is only one aspect of a holistic assessment required to make appropriate management decisions; i.e., to rule out more serious underlying disease (e.g., cystic fibrosis) and to limit exacerbation of chronic conditions (e.g., asthma).[3] The second bundle of care measured documentation of past

medical history, comorbidities, current medications and a physical examination. All four aspects were documented in only 30.2% of patient encounters, indicating that one or more important aspects of assessment were potentially being overlooked. It could be argued that children who were seeing their usual GP or were regular presenters at the ED (for example, a well-known patient with asthma or cystic fibrosis) may not have had these co-morbidities documented at each individual episode of care. However, auditors had access to the whole medical record and were instructed to consider this when determining whether indicators were eligible for scoring (i.e., to check for previous entries or summaries likely to have been referred to by clinicians).

Children under three months of age were included in the study and accounted for 2.8% of the cohort. We acknowledge that it is difficult at that age to differentiate URTI from early bronchiolitis.

Antibiotics are not indicated for uncomplicated viral URTI presentations, and their inappropriate use may contribute to the major problem of antibiotic resistance,[11] and put children at risk of side effects. Other studies investigating this issue have measured inappropriate prescribing rates of 20.2% for children under 5 years of age with uncomplicated URTIs,[23] and 46% of patients of all ages with URTI in Australian general practice.[24] Prescribing for non-specific URTI increased fourfold in the UK between 1996 and 2006.[25] Pressure from parents to receive a prescription for antibiotics is a frequently mentioned issue affecting physicians' prescribing practice.[e.g., 24, 26, 27, 28] A study in South East Wales suggested that parents of pre-school children were being influenced to inappropriately seek antibiotics by the policy and social pressure exerted by day care providers, contrary to the evidence on URTI treatment.[29] A Canadian cluster-randomised trial which trained family physicians to engage parents in shared decision-making around treatment options demonstrated that it is possible to reduce the rate of inappropriate antibiotic use in children with acute respiratory infections by 60%.[30]

Two indicators were included in our study that relate to explaining to parents why antibiotics are not indicated (URTI08 - 09) to address this social pressure, and ensure engagement with, and education of parents. These indicators were guided by the National Institute for Health and Care Excellence (NICE) 2008 guidelines which recommend: "*When the "no antibiotic prescribing strategy" is adopted, patients should be offered reassurance that antibiotics are not needed immediately because they are likely to make little difference to symptoms and may have side effects, for example, diarrhoea, vomiting and rash*." Our indicators reflect this advice yet seem infrequently given to parents in our study or were not documented. Indicator URTI09 ("*Parents of children with an URTI were advised against antibiotics as they may have side effects*") showed the lowest level of adherence across the indicators (0.5%) with indicator URTI08 ("*Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms*") scoring second lowest with 11%. There may be several reasons for this: the advice may have been given but not documented; antibiotics may have been (inappropriately) prescribed; or pressure for antibiotic prescription may not have been an issue needing to be addressed. Alternatively, discussions around the inappropriateness of antibiotics to treat an uncomplicated URTI may have been framed in a different way that auditors did not judge as equivalent; e.g., focussing instead on the viral nature of URTIs and how antibiotics are only effective against bacterial infections.

Our study did assess circumstances in which antibiotic prescription was appropriate. Appropriateness of antibiotic prescription for children with concurrent pneumonia (URTI10) was only 14.2% in the aggregated data and on breakdown by setting, only GPs had a large enough number of presentations to report. GPs for this indicator scored 12.0% (95% CI: 3.9-25.9), which is surprisingly low. The BEACH study[23] measured antibiotic prescription rates for children under five years diagnosed with pneumonia as 65.6%. Given that 85% of children with URTI and pneumonia in our study were under five years of age, it is not clear why our results differ. The BEACH study relies on physician documentation of a special form, while our study examined what was documented in the medical record. As early as 2005, we have Australian survey evidence of a

high level of penetration of electronic medical record use by GPs (~90%), with 98% of users 'mostly' using the inbuilt prescribing tool, so under-documentation seems unlikely to be the source of the discrepant results, at least for this setting.[31] It remains possible that the relatively small number of occasions of care surveyed (n=61), has by chance led to an unrepresentative result. Another reason may have been the lack of specificity of URTI10 which did not differentiate between bacterial and viral pneumonia. Insufficient data from EDs and Inpatient settings did not allow a comparison.

Strengths of the study include the large sample of Australian children: 1,653 children with one or more eligible indicator assessments were analysed. The use of paediatric registered nurses who underwent five days of training and assessment in auditing the indicators, and who are familiar with childhood illnesses and management, to collect data was another strength. This increased the likelihood that records were correctly interpreted, and data recorded accurately. A weakness of the study is the use of documentation to assess actual practice; i.e., if it was not documented, it was assumed it did not occur. We note, however that from a litigation, insurance and auditing point of view, documentation is an accepted proxy measure for action and has been shown to be acceptably correlated with actual practice.[32, 33]

Clinically, this study suggests the need for more thorough holistic assessment of the patient including consideration of all four aspects included in the indicators here (comorbidities, past medical history, current medications and physical examination). Since inappropriate prescription of antibiotics for URTIs is still known to be a problem in Australia,[23] there is a need for consistent clear communication and patient education around antibiotics' lack of impact on symptoms and the risks of undesirable side effects.

Conclusion

Uncomplicated URTIs are a common condition of childhood, with considerable time and resources expended in assessing and managing them.[4] This study has shown that appropriate care may not be

delivered consistently and there is room for improvement. Guideline adherence for bundles of care, that require all component indicators to be addressed, was low: documentation of all three common diagnostic symptoms was only adhered to in an estimated 43.1% of visits, and holistic assessment of the patient using four indicators was only adhered to in 30.2% of visits. In a context where pressure from parents still drives inappropriate antibiotic use for children with URTI, advice to parents was infrequently reported (0.5 and 11%).

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Ethics Statement

Primary ethics approval was received from hospital networks (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68) and the Royal Australian College of General Practitioners (NREEC 14-008), and site-specific approvals from 34 sites.

Data sharing statement

All additional data are provided in the Appendices.

Competing interests

All authors declare that they have no conflicts of interest.

Authors' contributions

JB, PH designed the overall study. SJ, HW contributed to design of URTI study. JB, PH, GA, HPT, CM carried out the collection and statistical analysis of the data. JCL drafted the manuscript and was responsible for coordination of all aspects of the work. KC, LAE reviewed and made substantial contributions to earlier drafts. All authors contributed to the interpretation of results and the final manuscript.

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Appendix 1: Characteristics of clinical indicators, 2012 - 2013

			No. of Sites					
Indicator ID	**Indicator Description**	**Age Inclusion Criteria**	**GP**	**ED**	**IP**	**Level of Evidence or Strength of recommendation#**	**Phase of Care**	**Quality Type***
URTI01	Children who presented with URTI symptoms had the presence of a runny nose (rhinorrhea) documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI02	Children who presented with URTI symptoms had the presence of a cough documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI03	Children who presented with URTI symptoms had the presence of a fever documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI04	Children who presented with an URTI had their comorbidities documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI05	Children who presented with an URTI had their previous medical history documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI06	Children who presented with an URTI had their current medications documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI07	Children who presented with an URTI had a physical examination.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	0 - 15 years	81	31	22	Consensus-based recommendation	Treatment	Underuse
URTI09	Parents of children with an URTI were advised against antibiotics as they may have side effects.	0 - 15 years	81	30	22	Consensus-based recommendation	Treatment	Underuse
URTI10	Children with an URTI and pneumonia were prescribed antibiotics.	0 - 15 years	24	12	4	Consensus-based recommendation	Treatment	Underuse
URTI11	Children with an URTI and a peritonsillar abscess were prescribed antibiotics.	0 - 15 years	7	2	0	Consensus-based recommendation	Treatment	Underuse
URTI12	Children with an URTI and bordetella pertussis were prescribed antibiotics.	0 - 15 years	8	5	1	Consensus-based recommendation	Treatment	Underuse
URTI13	Children with an URTI and acute moderate/severe bacterial sinusitis were prescribed antibiotics.	0 - 15 years	14	1	3	Consensus-based recommendation	Treatment	Underuse

			No. of Sites					
Indicator ID	**Indicator Description**	**Age Inclusion Criteria**	**GP**	**ED**	**IP**	**Level of Evidence or Strength of recommendation[#]**	**Phase of Care**	**Quality Type***
URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	0 - 15 years	81	34	24	Consensus-based recommendation	Ongoing management	Underuse

Legend: ID=Identifier; GP=General Practitioner; ED=Emergency Department; IP=Inpatient.

[#] Strength of recommendation as reported in individual CPGs. CPGs used a variety of classification schemes for allocating Strength of Recommendation in 'Grades' or Level of Evidence in 'Levels'. If strength of recommendation, or level of evidence, were not specified in the CPG, the term "Consensus-based recommendation" was assigned.

* The type of quality of care assessed was classified as underuse or overuse: underuse refers to actions which are recommended, but not undertaken; overuse refers to actions which are not indicated, or are contraindicated, in the context of the indicator's inclusion criteria.

Appendix 2: Additional details relating to study methods

The report of top-level CareTrack Kids (CTK) results[1] and its associated online appendix, detail the methods of the larger study, which generated the data reported in this paper. Selected methods specifically relevant to URTI are described below.

Sample size

A visit was defined as an occasion of admitted inpatient care, an Emergency Department (ED) presentation or a consultation with a General Practitioner (GP). Without adjustment for the design effect, a minimum of 400 surveys per condition was required to obtain national estimates with 95% Confidence Interval (CI) and precision of +/- 5% at condition level, conservatively assuming only one eligible indicator per visit. It was anticipated that loss of precision due to design effects would be largely offset by multiple eligible indicators per visit and additional surveys generated by the secondary sampling (multiple visits for care of URTI for each medical record identified for sampling of URTI, and visits for care of URTI incidentally found in medical records identified for sampling other conditions).

Sampling Process

A multistage stratified random sampling process was implemented. For logistical efficiency, sampling was targeted at three states, Queensland (QLD), New South Wales (NSW) and South Australia (SA), which together comprise 60.0% of the estimated Australian population aged 15 years or younger in the 2012 and 2013 calendar years. All six paediatric tertiary hospitals (two in QLD, three in NSW, and one in SA) were targeted as they have state-wide coverage. State Departments of Health organize care within administrative units ('health districts'): Hospital Health Services in QLD, Local Health Districts in NSW, and Local Health Networks in SA. For QLD, we targeted five health districts (two metropolitan, three

regional), in NSW four health districts (two metropolitan, two regional), and in SA three health districts (two metropolitan, one regional).

Recruitment of health care providers

Within the selected health districts, we approached all public hospitals, or private hospitals providing public services under contract, that had patient volumes of ≥2,000 ED presentations and ≥500 paediatric separations per year; we also advertised the study to GPs and approached all the providers we could identify through internet searches, and via personal contacts. Within the selected sites, we sampled medical records for each condition targeted at that setting.

Recruitment of GPs was decentralized. Administrative details for refusal rates, from cold-calling or direct contact by clinicians who facilitated recruitment of their peers, were maintained on project laptops. At the end of recruitment all computers were decommissioned and cleaned, with the files archived on a USB drive. Unfortunately, the USB drives created during laptop decommissioning were misplaced and have not been able to be located. This did not affect the indicator adherence data, as the database was remotely located and updated regularly via the internet. We have therefore sought to estimate the recruitment rates based on recruitment spreadsheets emailed to the administrative staff.

For GPs, we were only able to locate emailed spreadsheets with late stage records for one state, South Australia. Based on this spreadsheet, we approached 114 GPs and recruited 27 of them, giving a recruitment rate of 23.7%; an additional GP, not listed on the available spreadsheet, was recruited subsequently and was not added to either the numerator or the denominator, for this estimate. The spreadsheet did not have clear information on eligibility, so it is likely that an unknown number of the 114 approached were ineligible because: 1) they were not open during the whole 2012-2013 survey period; 2) they saw no or few children; or

3) they were not confident in their ability to generate full listings of children with the target conditions, or they did not use one of the four practice software systems our surveyors were trained to search. Our estimate of 23.7% is therefore likely to be an underestimate of the actual recruitment rate.

Self-selection of GPs could lead to bias in the estimated guideline adherence. It is plausible that self-selected practices were more confident of their guideline adherence, potentially leading to overestimation of guideline-adherence in the CareTrack Kids study.

Allocation of surveys to sampling units

The number of URTI records targeted at each site was determined by a nominal allocation of the 400 records targeted, informed by data available at the time, supplemented by expert opinion, with planned over-sampling of settings where fewer occasions of care were expected.[1, 2] For hospitals, a fixed number was targeted at each site; for GPs, different combinations of conditions were targeted at each site, to simplify the logistics of sampling.

Data collection

Nine experienced paediatric nurses were employed across the three states, with all nine assessing occasions of care for URTI. The surveyors undertook a one-week training program, prior to data collection. A surveyor manual was developed which included instructions, condition-specific definitions, inclusion and exclusion criteria, and guidance for assessing eligibility of each encounter for relevant indicators. Mock records were assessed during the surveying task for 6 of the 9 surveyors (2 had already terminated employment and 1 was excluded as their assessments may not have been made independently) and their results compared. A good level of agreement was found; $\kappa = 0.76$ (95%CI, 0.75-0.77; n = 1895) for

the child's eligibility for indicator assessment, and $\kappa = 0.71$ (95% CI, 0.69-0.73; n = 1009) for indicator assessment.[1]

A web-based tool, originally developed for the CareTrack Adults study[3, 4], was designed to enter data during medical record review. Surveyors undertook criterion-based medical record reviews using the data collection tool. Medical records for selected visits in 2012 and 2013 were reviewed on-site at each participating facility during March–October 2016. The surveyors responded to each indicator as 'Yes' (care provided during the encounter was consistent with the indicator), 'No', or 'Not Applicable' (NA; the indicator was not eligible for assessment). For example, a surveyor assessing an occasion of care for a child with URTI, but without pneumonia, would record 'NA' to indicator URTI10.

Analysis

Survey or register-derived data were used to estimate the proportion of occasions of care for URTI in each setting.[5-10] The number of occasions of healthcare for each condition was thereby estimated for each hospital or, for GPs, each health district, and sampling weights were calculated using the methods detailed in eAppendix 4 of the report of the top-line CTK results (this Appendix can be accessed by request via the corresponding author, if required).[1]

Differences in adherence rates between settings were restricted to comparisons between GP and the two hospital settings, as hospitals records were not sampled independently, they were not compared statistically. Statistical significance was based on the F-test approximation of the Rao-Scott chi-square test, which adjusts for the design effect; a modified Rao-Scott chi-square test was used when the design correction was negative.

A variety of stratifications, and sometimes domain analysis,[11, 12] were necessary to ensure accuracy of the confidence interval estimates. These are detailed in eTable 1, below.

eTable 1: Domain analysis and stratifications for different estimates presented in the manuscript.

Location	Sub-section/Area	Domain analysis[11, 12]	Strata
Table 2	Indicator x healthcare setting estimates	Yes	State
	Overall Indicator estimates	Yes	State and healthcare setting
Table 3	Bundle x healthcare setting estimates	Yes	State
	Overall estimate for bundle	Yes	State and healthcare setting

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1. Braithwaite J, Hibbert PD, Jaffe A, et al. Quality of health care for children in Australia, 2012-2013. *JAMA*2018;319(11):1113-24.
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12. Heeringa SG, West BT, Berglund PA. Applied survey data analysis. Boca Raton, FL: CRC Press; 2010.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P.2-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P.4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P.5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	P.5-6
Methods			
Study design	4	Present key elements of study design early in the paper	P.6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P.7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	P.7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P.7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P.7
Bias	9	Describe any efforts to address potential sources of bias	P.8
Study size	10	Explain how the study size was arrived at	P.7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P.8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P.8
		(*b*) Describe any methods used to examine subgroups and interactions	P.8
		(*c*) Explain how missing data were addressed	P.8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	P.8
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P.9
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P.9
		(b) Indicate number of participants with missing data for each variable of interest	P.9
Outcome data	15*	Report numbers of outcome events or summary measures	P.10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	P.10, 11,

		which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	P.10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P.12
Discussion			
Key results	18	Summarise key results with reference to study objectives	P.12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P.14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P.14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	P.15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P.16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Assessing the appropriateness of the management of Upper Respiratory Tract Infection in Australian children: a population-based sample survey

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Keywords:	Upper respiratory tract infection, guideline adherence, health care quality indicators, PAEDIATRICS, child health

Assessing the appropriateness of the management of Upper Respiratory Tract Infection in Australian children: a population-based sample survey

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Abstract

Objective

To assess the proportion of Australian children aged 0-15 years that received care in line with clinical practice guidelines (CPGs) for upper respiratory tract infections (URTIs).

Design

Retrospective medical record review using a multi-stage sampling strategy.

Setting

General Practices, hospital emergency departments and hospital inpatient service providers in three Australian states.

Participants

Children aged up to 15 years who received care for URTI in 2012 and 2013.

Primary and Secondary Outcome Measures

The primary assessment was estimated adherence with 14 indicators of appropriate care as documented in medical records. Indicators were extracted from national and international CPGs and ratified by experts. Secondary assessment was adherence to two bundles of indicators (diagnostic symptoms, and medical history taking), where all indicators must be adherent for the bundle to be scored as adherent.

Results

There were 1653 children with one or more assessments of URTI care to CPG adherence. Over half the children were under three years of age, with roughly equal numbers of males and females. Three indicators had fewer than 25 visits so were not reported. Overall adherence ranged from 0.5% for "documented advice around antibiotics" to 88.3% for "documentation of medical history". Adherence with Bundle A (documentation of all three definitive symptoms) was 43.1% (95% CI: 32.8-54.0) and Bundle B (documentation of all four indicators of medical history) was 30.2% (95% CI: 20.9-40.9).

Conclusions

URTIs in children are common, usually self-limiting, conditions that are allocated considerable resources. The results suggest there may be a need for more thorough holistic assessment of the patient, and improved documentation. Since inappropriate prescription of antibiotics for URTIs is still a known problem in Australia, there is a need for consistent, clear communication around antibiotics' lack of impact on symptoms and high association with undesirable side effects.

Key words:

Upper respiratory tract infection; guideline adherence; health care quality indicators; paediatrics; child health

Article summary

Strengths and limitations of this study

- The study used a multi-stage representative sample across three Australian states, generalisable to the population
- Using medical records allowed assessment of guideline-adherence in real-world settings
- Lack of documentation of an action was interpreted as indicating the action did not occur
- Registered paediatric nurses familiar with childhood illnesses and management extracted data from medical records
- The patient's whole medical record was available to nurses extracting data not just the occasion of care

Introduction

Upper respiratory tract infections (URTIs) are characterised by nasal congestion, rhinorrhoea, cough, sore throat and fever with a median duration of symptoms of seven to 15 days.[1, 2] It is estimated that a normal child will experience five viral URTIs per year,[3] but more than 10% of children have 10 or more 'colds' per year.[1] It has been suggested that first-time parents may be surprised and concerned by this frequency, and misunderstand treatment options.[4]

URTIs are one of the most frequent problems managed by general practitioners (GPs) in Australia.[5] The Bettering the Evaluation And Care of Health (BEACH) study found that URTI presentations made up 3.3% of an Australian GP's workload, being third in frequency to hypertension and immunisations/vaccinations.[5] Children under 15 years old made up 31% of these patients and 17% are under 5 years old.[6] While URTIs are self-limiting, minor ailments, this represents a considerable use of time and resources. Other costs attributed to URTIs in children are mainly due to lost work time for carers.[7]

National clinical practice guidelines (CPGs) for assessment and management of childhood URTIs have been developed in a number of countries such as USA,[8-10] Sweden,[11] UK[12] and Australia.[13, 14] Most guidelines around assessment are consensus based as research on the clinical management on URTIs is scarce.[5] As URTIs are predominantly viral in origin and therefore mostly self-limiting, the clearest guidelines address the appropriate use of antibiotics, and assessment for complications such as peritonsillar abscess, bacterial sinusitis or pneumonia, or differential diagnoses such as pertussis. Other guidance addresses issues of care process, like ensuring past history and comorbidities are taken into account (e.g., neutropenia), and general advice to return if symptoms worsen or do not resolve.

Inappropriate management of URTIs in children can lead to overtreatment of a self-limiting condition, unnecessary antibiotic use leading to side effects and resistance of pathogenic bacteria, and increased burden for families. As one of the most frequent childhood illnesses, these considerations are significant.[12-14]

CareTrack Kids (CTK) assessed care of Australian children aged 0-15 years, in 2012 and 2013, to determine the proportion that received care in line with CPGs for 17 common conditions.[15] Across the 17 conditions, appropriate care per occasion of care was provided at an average of 59.8% (95% CI: 57.5-62.0), and at 53.2% (95% CI: 46.6-59.8) for URTI.[15] We present and discuss the CareTrack Kids results for URTI, at indicator level.

Methods

The CTK methods have been described in detail elsewhere.[15-17] We describe some aspects specifically relevant to URTI, with a focus on indicator development.

Development of indicators

The RAND-UCLA method was modified and applied to develop indicators.[18] This study defined a clinical indicator as a measurable component of a standard or guideline, with explicit criteria for inclusion, exclusion, time frame and practice setting.[19] More details on the development of indicators has been published separately.[20]

Three CPGs were found following a systematic search for Australian and international CPGs for URTI relevant for the years 2012-2013. From these three, 20 recommendations were extracted. Recommendations were screened for eligibility and excluded if they: (1) contained indefinite wording (e.g., “may”, “could”); (2) had a low likelihood of being documented; (3) consisted of guiding statements without recommended actions; or (4) addressed aspects of care deemed out of scope of the CTK study such as “structure-level” recommendations. Thirteen recommendations were excluded, with the remaining seven passed to internal review.

Candidate recommendations were ratified by experts over a two-stage multi-round modified Delphi process, which comprised an email-based three-round internal review and a collaborative, online, wiki-based two-round external review, custom-designed for the study.[17] In total, ten experts (comprising nine paediatricians and one general practitioner) were recruited for the internal (n=3) and external review (n=7). An expert coordinator was appointed to lead the reviews for each

condition. Reviewers completed a Conflict of Interest declaration [17] and these were managed according to an established protocol.[21]

In the internal review, experts scored each recommendation against three criteria (acceptability, feasibility and impact),[17] and recommended inclusion or exclusion. External reviewers applied the same scoring criteria as internal reviewers and, in addition, used a nine-point Likert scale to score each indicator as representative of appropriate care delivered to children during 2012 and 2013.[17, 18] Internal and external reviewers completed their assignments independently to minimise group-think.[22] Four recommendations were ratified by this process and these were formatted into 14 medical record audit indicator questions. All indicator questions are shown in Appendix 1.

Sample size, sampling process and data collection

A minimum of 400 medical record reviews per condition was required to obtain national estimates with 95% CIs and precision of ±5%, without adjustment for design effects. CTK targeted 400 medical records for URTI and 6000 medical records for 16 other conditions. If any of the 6400 medical records we targeted and sampled contained a visit for URTI, a separate assessment of appropriateness was made for each occasion. Detail on the sampling methods have been published;[15] additional details specific to URTI can be found in Appendix 2. Briefly, we sampled three healthcare settings (hospital inpatients, Emergency Department (ED) presentations, and consultations with GPs) in health department administrative units (health districts) in Queensland, New South Wales and South Australia, for children aged ≤15 years receiving care in 2012 and 2013. For the broader CTK study, the recruitment rate was 92% for hospitals, and estimated to be 24% for GPs (see Appendix 2). Data were collected by nine experienced paediatric nurses, trained to assess eligibility for indicator assessment and adherence with CPGs. Medical records for selected visits in 2012 and 2013 were reviewed on-site at each participating facility during March–October 2016. Data collectors had access to the entire medical record, not just the occasion of care.

Analysis

At indicator level, estimates of adherence were measured as the percentage of eligible indicators (i.e., indicators answered either 'Yes' or 'No') which were scored as 'Yes'. Adherence results for some clinically-related indicators were aggregated as bundles of care. For example, indicators URTI01-URTI03 all relate to the documentation of symptoms of children who presented with URTI; all three of these indicators would have to be scored 'Yes' for the bundle to be scored as adhering to the CPG. When assessing bundles, a visit was only included if there were responses for all component indicators.

Sampling weights were constructed as specified in Appendix 2 to adjust for oversampling of states and healthcare settings and for sampling within health districts. The weighted data were analysed in SAS version 9.4 (SAS Institute Inc, 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 analysis were used (see 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.[23] In both indicator and bundle reports, results were suppressed if there were <25 eligible visits, as small sample sizes could lead to misleading estimates. Differences in adherence rates between settings were restricted to comparisons between GP and the two hospital settings; as hospitals records were not sampled independently, they were not compared statistically. Statistical significance, where calculated, was based on the F-test approximation of the Rao-Scott chi-square test, which adjusts for the design effect.

Ethical considerations

We received primary ethics approval from relevant bodies including hospital networks (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68) and the Royal Australian College of General Practitioners (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 healthcare providers and

patients;[16] all relevant bodies provided this waiver. 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). Ethical approvals included reporting by healthcare setting for URTI.

Patient and public involvement

This study did not involve patients or the public.

Results

There were 1653 children with one or more assessable CPG indicators for URTI, with the age and sex distribution shown in Table 1. Over half the children in the CTK sample were under three years of age, with roughly equal number of males and females. Of 38,290 possible indicator assessments, 11,831 (30.9%) were designated as not applicable or otherwise ineligible. The field team conducted 26,459 eligible indicator assessments grouped into 2,714 visits, at a median of 10 indicators per visit. Eligible URTI visits were assessed in 81 GP practices, 34 hospital EDs and 25 hospital inpatient service providers.

Table 1: Characteristics of the eligible children with visits for URTI, 2012 - 2013

Characteristic	Children in the CTK Study
Age* - no. (%)	
< 3 months	46 (2.8)
3 - 11 months	262 (15.8)
1 - 2 years	568 (34.4)
3 - 5 years	363 (22.0)
6 - 12 years	350 (21.2)
13 - 15 years	64 (3.9)
Male - no. (%)	878 (53.1)

*The child's age was calculated as the age at visit where there was only one, or the midpoint of the child's age at her first and last URTI visit, where there was more than one.

Adherence

The assessed guideline adherence for each indicator is shown in Table 2, presented by healthcare setting and overall. Adherence is not reported for three of the 14 indicators, because they were assessed in fewer than 25 visits, and for some settings in the other 11 indicators. For the 11 reported indicators, overall adherence ranged from 0.5% (95% CI: 0.1-1.5) for indicator URTI09 ("*Parents of children with an URTI were advised against antibiotics as they may have side effects*") to 88.3% (95% CI: 79.3-94.4) for URTI05 ("*Children who presented with an URTI had their previous medical history documented*"). The interquartile range for overall adherence in the 11 indicators reported was 14.2% to 70.3%. Large confidence intervals on many of the indicators show substantial uncertainty in the estimates.

Table 2: Adherence by clinical indicator and by healthcare setting, 2012 - 2013

Indicator ID	Indicator Description	Healthcare Setting	No. of Children	No. of Visits	Proportion adherent, % (95% CI)
URTI01	Children who presented with URTI symptoms had the presence of a runny nose (rhinorrhea) documented.	GP	1197	2073	60.8 (49.0, 71.7)
		ED	423	530	77.5 (70.1, 83.8)*
		Inpatient	80	89	85.0 (68.0, 95.1)*
		Overall	1648	2692	61.4 (51.4, 70.8)
URTI02	Children who presented with URTI symptoms had the presence of a cough documented.	GP	1197	2073	70.1 (56.4, 81.6)
		ED	423	530	75.2 (60.9, 86.3)
		Inpatient	80	89	76.1 (57.5, 89.4)
		Overall	1648	2692	70.3 (58.6, 80.3)
URTI03	Children who presented with URTI symptoms had the presence of a fever documented.	GP	1196	2071	63.2 (52.0, 73.5)
		ED	422	529	85.2 (73.4, 93.2)*
		Inpatient	80	89	84.1 (59.8, 96.7)
		Overall	1646	2689	64.0 (54.3, 73.0)
URTI04	Children who presented with an URTI had their comorbidities documented.	GP	1178	2045	40.8 (28.9, 53.6)
		ED	417	518	78.8 (64.0, 89.6)*
		Inpatient	79	88	63.0 (32.6, 87.3)
		Overall	1623	2651	42.2 (32.0, 52.8)
URTI05	Children who presented with an URTI had their previous medical history documented.	GP	1201	2092	88.0 (77.3, 94.9)
		ED	423	530	95.8 (91.1, 98.4)
		Inpatient	80	89	98.2 (92.5, 99.9)*
		Overall	1652	2711	88.3 (79.3, 94.4)
URTI06	Children who presented with an URTI had their current medications documented.	GP	1198	2088	45.9 (37.2, 54.9)
		ED	422	529	82.9 (71.3, 91.2)*
		Inpatient	80	89	87.6 (74.5, 95.5)*
		Overall	1648	2706	47.3 (39.9, 54.7)
URTI07	Children who presented with an URTI had a physical examination.	GP	1200	2089	83.0 (71.7, 91.1)
		ED	422	529	94.8 (87.6, 98.4)
		Inpatient	80	89	100.0 (95.9, 100.0)*

Indicator ID	Indicator Description	Healthcare Setting	No. of Children	No. of Visits	Proportion adherent, % (95% CI)
		Overall	1650	2707	83.4 (73.9, 90.5)
URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	GP	1162	2013	11.0 (3.7, 23.8)
		ED	308	386	9.4 (4.7, 16.4)
		Inpatient	63	71	3.1 (0.1, 15.6)
		Overall	1491	2470	11.0 (4.3, 21.8)
URTI09	Parents of children with an URTI were advised against antibiotics as they may have side effects.	GP	1152	1993	0.4 (0.0, 1.7)
		ED	303	381	3.6 (0.9, 9.1)*
		Inpatient	63	71	0.0 (0.0, 5.1)
		Overall	1475	2445	0.5 (0.1, 1.5)
URTI10	Children with an URTI and pneumonia were prescribed antibiotics.	GP	39	41	12.0 (3.9, 25.9)
		ED	15	16	Insufficient data
		Inpatient	4	4	Insufficient data
		Overall	57	61	14.2 (6.6, 25.5)
URTI11	Children with an URTI and a peritonsillar abscess were prescribed antibiotics.	GP	8	8	Insufficient data
		ED	2	2	Insufficient data
		Inpatient	0	0	Insufficient data
		Overall	10	10	Insufficient data
URTI12	Children with an URTI and bordetella pertussis were prescribed antibiotics.	GP	9	9	Insufficient data
		ED	6	6	Insufficient data
		Inpatient	1	1	Insufficient data
		Overall	15	16	Insufficient data
URTI13	Children with an URTI and acute moderate/severe bacterial sinusitis were prescribed antibiotics.	GP	18	20	Insufficient data
		ED	1	1	Insufficient data
		Inpatient	3	3	Insufficient data
		Overall	21	24	Insufficient data
URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	GP	1183	2054	54.8 (46.8, 62.7)
		ED	368	451	78.4 (71.1, 84.5)*
		Inpatient	71	80	64.5 (47.0, 79.6)
		Overall	1603	2585	55.6 (48.7, 62.2)

Legend: GP=General Practitioner; ED=Emergency Department

* ED/Inpatient adherence statistically significantly higher than GP adherence at $p<0.05$.

By healthcare setting, estimated adherence in ED and inpatient settings was generally higher than in GP settings. As shown in Table 2, adherence in the GP setting was statistically significantly lower than in the ED setting for six indicators (URTI01, URTI03-04, URTI06, URTI09, URTI14), and in the inpatient setting for four indicators (URTI01, URTI05-07).

The assessed adherence for two bundles of care is shown in Table 3, for all three settings and overall. Bundle A assessed the documentation of three symptoms (runny nose, cough and fever), and found 43.1% overall adherence (95% CI: 32.8-54.0); the component indicator with the lowest

adherence was documentation of the presence of a runny nose (61.4%, 95% CI: 51.4-70.8; URTI01). Bundle B covered four indicators relating to the documentation of medical history and found 30.2% adherence (95% CI: 20.9-40.9); the component indicator with the lowest adherence was documentation of comorbidities (42.2%, 95% CI: 32.0-52.8; URTI04).

Table 3: Adherence by bundle of care and healthcare setting, 2012 – 2013

Bundle ID	Bundle Description	Indicator IDs*	Healthcare Setting	No. of Children	No. of Visits	No. of Indicator Assessments	Proportion Adherent, % (95% CI)
A	Children who presented with URTI symptoms had the presence of symptoms documented.	01 - 03	GP	1196	2071	6213	42.5 (30.5, 55.2)
			ED	422	529	1587	59.1 (46.5, 70.9)
			Inpatient	80	89	267	60.4 (44.1, 75.2)
			Overall	1646	2689	8067	43.1 (32.8, 54.0)
B	Children who presented with an URTI had medical history documented.	04 - 07	GP	1175	2039	8156	28.8 (17.8, 41.9)
			ED	415	516	2064	68.2 (51.4, 82.1)
			Inpatient	79	88	352	55.6 (29.8, 79.4)
			Overall	1618	2643	10572	30.2 (20.9, 40.9)

Legend: GP=General Practitioner; ED=Emergency Department

* In Table 2, the indicator ID was preceded by 'URTI'.

Discussion

This study assessed the guideline adherence of care for URTI provided to children aged 0-15 years in GP practices, EDs and inpatient services. Overall, guideline adherence was found to be suboptimal and inconsistent with indicator scores ranging from 88.3% (URTI05) to 0.5% (URTI09).

Documentation of past medical history scored the highest of the indicators at 88.3% (URTI05) but is only one aspect of a holistic assessment required to make appropriate management decisions; i.e., to rule out more serious underlying disease (e.g., cystic fibrosis) and to limit exacerbation of chronic conditions (e.g., asthma).[4] The second bundle of care measured documentation of past

medical history, comorbidities, current medications and a physical examination. All four aspects were documented in only 30.2% of patient encounters, indicating that one or more important aspects of assessment were potentially being overlooked. It could be argued that children who were seeing their usual GP or were regular presenters at the ED (for example, a well-known patient with asthma or cystic fibrosis) may not have had these co-morbidities documented at each individual episode of care. However, auditors had access to the whole medical record and were instructed to consider this when determining whether indicators were eligible for scoring (i.e., to check for previous entries or summaries likely to have been referred to by clinicians).

Children under three months of age were included in the study and accounted for 2.8% of the cohort. We acknowledge that it is difficult at that age to differentiate URTI from early bronchiolitis.

Antibiotics are not indicated for uncomplicated viral URTI presentations, and their inappropriate use may contribute to the major problem of antibiotic resistance,[12] and put children at risk of side effects. Other studies investigating this issue have measured inappropriate prescribing rates of 20.2% for children under 5 years of age with uncomplicated URTIs,[24] and 46% of patients of all ages with URTI in Australian general practice.[25] Prescribing for non-specific URTI increased fourfold in the UK between 1996 and 2006.[26] Pressure from parents to receive a prescription for antibiotics is a frequently mentioned issue affecting physicians' prescribing practice.[e.g., 25, 27, 28, 29] A study in South East Wales suggested that parents of pre-school children were being influenced to inappropriately seek antibiotics by the policy and social pressure exerted by day care providers, contrary to the evidence on URTI treatment.[30] A Canadian cluster-randomised trial which trained family physicians to engage parents in shared decision-making around treatment options demonstrated that it is possible to reduce the rate of inappropriate antibiotic use in children with acute respiratory infections by 60%.[31]

Two indicators were included in our study that relate to explaining to parents why antibiotics are not indicated (URTI08 - 09) to address this social pressure, and ensure engagement with, and education of parents. These indicators were guided by the National Institute for Health and Care Excellence (NICE) 2008 guidelines which recommend: "*When the "no antibiotic prescribing strategy" is adopted, patients should be offered reassurance that antibiotics are not needed immediately because they are likely to make little difference to symptoms and may have side effects, for example, diarrhoea, vomiting and rash*." Our indicators reflect this advice yet seem infrequently given to parents in our study or were not documented. Indicator URTI09 ("*Parents of children with an URTI were advised against antibiotics as they may have side effects*") showed the lowest level of adherence across the indicators (0.5%) with indicator URTI08 ("*Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms*") scoring second lowest with 11%. There may be several reasons for this: the advice may have been given but not documented; antibiotics may have been (inappropriately) prescribed; or pressure for antibiotic prescription may not have been an issue needing to be addressed. Alternatively, discussions around the inappropriateness of antibiotics to treat an uncomplicated URTI may have been framed in a different way that auditors did not judge as equivalent; e.g., focussing instead on the viral nature of URTIs and how antibiotics are only effective against bacterial infections.

Our study did assess circumstances in which antibiotic prescription was appropriate. Appropriateness of antibiotic prescription for children with concurrent pneumonia (URTI10) was only 14.2% in the aggregated data and on breakdown by setting, only GPs had a large enough number of presentations to report. GPs for this indicator scored 12.0% (95% CI: 3.9-25.9), which is surprisingly low. The BEACH study[24] measured antibiotic prescription rates for children under five years diagnosed with pneumonia as 65.6%. Given that 85% of children with URTI and pneumonia in our study were under five years of age, it is not clear why our results differ. The BEACH study relies on physician documentation of a special form, while our study examined what was documented in the medical record. As early as 2005, we have Australian survey evidence of a

high level of penetration of electronic medical record use by GPs (~90%), with 98% of users 'mostly' using the inbuilt prescribing tool, so under-documentation seems unlikely to be the source of the discrepant results, at least for this setting.[32] It remains possible that the relatively small number of occasions of care surveyed (n=61), has by chance led to an unrepresentative result. Another reason may have been the lack of specificity of URTI10 which did not differentiate between bacterial and viral pneumonia. Insufficient data from EDs and Inpatient settings did not allow a comparison.

Strengths of the study include the large sample of Australian children: 1,653 children with one or more eligible indicator assessments were analysed. The use of paediatric registered nurses who underwent five days of training and assessment in auditing the indicators, and who are familiar with childhood illnesses and management, to collect data was another strength. This increased the likelihood that records were correctly interpreted, and data recorded accurately. A weakness of the study is the use of documentation to assess actual practice; i.e., if it was not documented, it was assumed it did not occur. We note, however that from a litigation, insurance and auditing point of view, documentation is an accepted proxy measure for action and has been shown to be acceptably correlated with actual practice.[33, 34]

Clinically, this study suggests the need for more thorough holistic assessment of the patient including consideration of all four aspects included in the indicators here (comorbidities, past medical history, current medications and physical examination). Since inappropriate prescription of antibiotics for URTIs is still known to be a problem in Australia,[24] there is a need for consistent clear communication and patient education around antibiotics' lack of impact on symptoms and the risks of undesirable side effects.

Conclusion

Uncomplicated URTIs are a common condition of childhood, with considerable time and resources expended in assessing and managing them.[5] This study has shown that appropriate care may not be

delivered consistently and there is room for improvement. Guideline adherence for bundles of care, that require all component indicators to be addressed, was low: documentation of all three common diagnostic symptoms was only adhered to in an estimated 43.1% of visits, and holistic assessment of the patient using four indicators was only adhered to in 30.2% of visits. In a context where pressure from parents still drives inappropriate antibiotic use for children with URTI, advice to parents was infrequently reported (0.5 and 11%).

Acknowledgements

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Ethics Statement

Primary ethics approval was received from hospital networks (HREC/14/SCHN/113; HREC/14/QRCH/91; HREC/14/WCHN/68) and the Royal Australian College of General Practitioners (NREEC 14-008), and site-specific approvals from 34 sites.

Data sharing statement

All additional data are provided in the Appendices.

Competing interests

All authors declare that they have no conflicts of interest.

Authors' contributions

JB, PH designed the overall study. SJ, HW contributed to design of URTI study. JB, PH, GA, HPT, CM carried out the collection and statistical analysis of the data. JCL drafted the manuscript and was responsible for coordination of all aspects of the work. KC, LAE reviewed and made substantial contributions to earlier drafts. All authors contributed to the interpretation of results and the final manuscript.

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Appendix 1: Characteristics of clinical indicators, 2012 - 2013

			No. of Sites					
Indicator ID	**Indicator Description**	**Age Inclusion Criteria**	**GP**	**ED**	**IP**	**Level of Evidence or Strength of recommendation#**	**Phase of Care**	**Quality Type***
URTI01	Children who presented with URTI symptoms had the presence of a runny nose (rhinorrhea) documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI02	Children who presented with URTI symptoms had the presence of a cough documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI03	Children who presented with URTI symptoms had the presence of a fever documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI04	Children who presented with an URTI had their comorbidities documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI05	Children who presented with an URTI had their previous medical history documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI06	Children who presented with an URTI had their current medications documented.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI07	Children who presented with an URTI had a physical examination.	0 - 15 years	81	34	25	Consensus-based recommendation	Diagnosis	Underuse
URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	0 - 15 years	81	31	22	Consensus-based recommendation	Treatment	Underuse
URTI09	Parents of children with an URTI were advised against antibiotics as they may have side effects.	0 - 15 years	81	30	22	Consensus-based recommendation	Treatment	Underuse
URTI10	Children with an URTI and pneumonia were prescribed antibiotics.	0 - 15 years	24	12	4	Consensus-based recommendation	Treatment	Underuse
URTI11	Children with an URTI and a peritonsillar abscess were prescribed antibiotics.	0 - 15 years	7	2	0	Consensus-based recommendation	Treatment	Underuse
URTI12	Children with an URTI and bordetella pertussis were prescribed antibiotics.	0 - 15 years	8	5	1	Consensus-based recommendation	Treatment	Underuse
URTI13	Children with an URTI and acute moderate/severe bacterial sinusitis were prescribed antibiotics.	0 - 15 years	14	1	3	Consensus-based recommendation	Treatment	Underuse

			No. of Sites					
Indicator ID	**Indicator Description**	**Age Inclusion Criteria**	**GP**	**ED**	**IP**	**Level of Evidence or Strength of recommendation[#]**	**Phase of Care**	**Quality Type***
URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	0 - 15 years	81	34	24	Consensus-based recommendation	Ongoing management	Underuse

Legend: ID=Identifier; GP=General Practitioner; ED=Emergency Department; IP=Inpatient.

[#] Strength of recommendation as reported in individual CPGs. CPGs used a variety of classification schemes for allocating Strength of Recommendation in 'Grades' or Level of Evidence in 'Levels'. If strength of recommendation, or level of evidence, were not specified in the CPG, the term "Consensus-based recommendation" was assigned.

* The type of quality of care assessed was classified as underuse or overuse: underuse refers to actions which are recommended, but not undertaken; overuse refers to actions which are not indicated, or are contraindicated, in the context of the indicator's inclusion criteria.

Appendix 2: Additional details relating to study methods

The report of top-level CareTrack Kids (CTK) results[1] and its associated online appendix, detail the methods of the larger study, which generated the data reported in this paper. Selected methods specifically relevant to URTI are described below.

Sample size

A visit was defined as an occasion of admitted inpatient care, an Emergency Department (ED) presentation or a consultation with a General Practitioner (GP). Without adjustment for the design effect, a minimum of 400 surveys per condition was required to obtain national estimates with 95% Confidence Interval (CI) and precision of +/- 5% at condition level, conservatively assuming only one eligible indicator per visit. It was anticipated that loss of precision due to design effects would be largely offset by multiple eligible indicators per visit and additional surveys generated by the secondary sampling (multiple visits for care of URTI for each medical record identified for sampling of URTI, and visits for care of URTI incidentally found in medical records identified for sampling other conditions).

Sampling Process

A multistage stratified random sampling process was implemented. For logistical efficiency, sampling was targeted at three states, Queensland (QLD), New South Wales (NSW) and South Australia (SA), which together comprise 60.0% of the estimated Australian population aged 15 years or younger in the 2012 and 2013 calendar years. All six paediatric tertiary hospitals (two in QLD, three in NSW, and one in SA) were targeted as they have state-wide coverage. State Departments of Health organize care within administrative units ('health districts'): Hospital Health Services in QLD, Local Health Districts in NSW, and Local Health Networks in SA. For QLD, we targeted five health districts (two metropolitan, three

regional), in NSW four health districts (two metropolitan, two regional), and in SA three health districts (two metropolitan, one regional).

Recruitment of health care providers

Within the selected health districts, we approached all public hospitals, or private hospitals providing public services under contract, that had patient volumes of ≥2,000 ED presentations and ≥500 paediatric separations per year; we also advertised the study to GPs and approached all the providers we could identify through internet searches, and via personal contacts. Within the selected sites, we sampled medical records for each condition targeted at that setting.

Recruitment of GPs was decentralized. Administrative details for refusal rates, from cold-calling or direct contact by clinicians who facilitated recruitment of their peers, were maintained on project laptops. At the end of recruitment all computers were decommissioned and cleaned, with the files archived on a USB drive. Unfortunately, the USB drives created during laptop decommissioning were misplaced and have not been able to be located. This did not affect the indicator adherence data, as the database was remotely located and updated regularly via the internet. We have therefore sought to estimate the recruitment rates based on recruitment spreadsheets emailed to the administrative staff.

For GPs, we were only able to locate emailed spreadsheets with late stage records for one state, South Australia. Based on this spreadsheet, we approached 114 GPs and recruited 27 of them, giving a recruitment rate of 23.7%; an additional GP, not listed on the available spreadsheet, was recruited subsequently and was not added to either the numerator or the denominator, for this estimate. The spreadsheet did not have clear information on eligibility, so it is likely that an unknown number of the 114 approached were ineligible because: 1) they were not open during the whole 2012-2013 survey period; 2) they saw no or few children; or

3) they were not confident in their ability to generate full listings of children with the target conditions, or they did not use one of the four practice software systems our surveyors were trained to search. Our estimate of 23.7% is therefore likely to be an underestimate of the actual recruitment rate.

Self-selection of GPs could lead to bias in the estimated guideline adherence. It is plausible that self-selected practices were more confident of their guideline adherence, potentially leading to overestimation of guideline-adherence in the CareTrack Kids study.

Allocation of surveys to sampling units

The number of URTI records targeted at each site was determined by a nominal allocation of the 400 records targeted, informed by data available at the time, supplemented by expert opinion, with planned over-sampling of settings where fewer occasions of care were expected.[1, 2] For hospitals, a fixed number was targeted at each site; for GPs, different combinations of conditions were targeted at each site, to simplify the logistics of sampling.

Data collection

Nine experienced paediatric nurses were employed across the three states, with all nine assessing occasions of care for URTI. The surveyors undertook a one-week training program, prior to data collection. A surveyor manual was developed which included instructions, condition-specific definitions, inclusion and exclusion criteria, and guidance for assessing eligibility of each encounter for relevant indicators. Mock records were assessed during the surveying task for 6 of the 9 surveyors (2 had already terminated employment and 1 was excluded as their assessments may not have been made independently) and their results compared. A good level of agreement was found; $\kappa = 0.76$ (95%CI, 0.75-0.77; n = 1895) for

the child's eligibility for indicator assessment, and $\kappa = 0.71$ (95% CI, 0.69-0.73; n = 1009) for indicator assessment.[1]

A web-based tool, originally developed for the CareTrack Adults study[3, 4], was designed to enter data during medical record review. Surveyors undertook criterion-based medical record reviews using the data collection tool. Medical records for selected visits in 2012 and 2013 were reviewed on-site at each participating facility during March–October 2016. The surveyors responded to each indicator as 'Yes' (care provided during the encounter was consistent with the indicator), 'No', or 'Not Applicable' (NA; the indicator was not eligible for assessment). For example, a surveyor assessing an occasion of care for a child with URTI, but without pneumonia, would record 'NA' to indicator URTI10.

Analysis

Survey or register-derived data were used to estimate the proportion of occasions of care for URTI in each setting.[5-10] The number of occasions of healthcare for each condition was thereby estimated for each hospital or, for GPs, each health district, and sampling weights were calculated using the methods detailed in eAppendix 4 of the report of the top-line CTK results (this Appendix can be accessed by request via the corresponding author, if required).[1]

Differences in adherence rates between settings were restricted to comparisons between GP and the two hospital settings, as hospitals records were not sampled independently, they were not compared statistically. Statistical significance was based on the F-test approximation of the Rao-Scott chi-square test, which adjusts for the design effect; a modified Rao-Scott chi-square test was used when the design correction was negative.

A variety of stratifications, and sometimes domain analysis,[11, 12] were necessary to ensure accuracy of the confidence interval estimates. These are detailed in eTable 1, below.

eTable 1: Domain analysis and stratifications for different estimates presented in the manuscript.

Location	Sub-section/Area	Domain analysis[11, 12]	Strata
Table 2	Indicator x healthcare setting estimates	Yes	State
	Overall Indicator estimates	Yes	State and healthcare setting
Table 3	Bundle x healthcare setting estimates	Yes	State
	Overall estimate for bundle	Yes	State and healthcare setting

References:

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P.2-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P.4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P.5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	P.5-6
Methods			
Study design	4	Present key elements of study design early in the paper	P.6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P.7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	P.7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P.7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P.7
Bias	9	Describe any efforts to address potential sources of bias	P.8
Study size	10	Explain how the study size was arrived at	P.7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P.8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P.8
		(*b*) Describe any methods used to examine subgroups and interactions	P.8
		(*c*) Explain how missing data were addressed	P.8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	P.8
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P.9
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P.9
		(b) Indicate number of participants with missing data for each variable of interest	P.9
Outcome data	15*	Report numbers of outcome events or summary measures	P.10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	P.10, 11,

		which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	P.10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P.12
Discussion			
Key results	18	Summarise key results with reference to study objectives	P.12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P.14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P.14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	P.15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P.16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.