The quality of healthcare for children in Australia

The CareTrack Kids study

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Key Points

Question Is healthcare for children in Australia consistent with quality standards?

Findings In this study of 6,689 Australian children aged 15 years and under, a comparison of clinical records against quality indicators for 17 important child health conditions such as asthma and type 1 diabetes, estimated that overall adherence was 59.8%, with substantial variation across conditions.

Meaning For many important child health conditions, the quality of care in Australia may not be optimal.

ABSTRACT

IMPORTANCE The quality of routine care to children is rarely assessed, and usually in single settings or for single clinical conditions.

OBJECTIVES To estimate the quality of healthcare for children in Australia, in inpatient and ambulatory healthcare settings.

DESIGN Multi-stage stratified sample with medical record review to assess adherence with quality indicators extracted from clinical practice guidelines for 17 common, high-burden clinical conditions (noncommunicable [n=5], mental health [n=4], acute infection [n=7], injury [n=1]), such as asthma, attention-deficit hyperactivity syndrome, tonsillitis, and head injury. For these 17 conditions, 479 quality indicators were identified, with the number varying by condition, ranging from nine for eczema to 54 for head injury. Four hundred medical records were targeted for sampling for each of 15 conditions, 267 for anxiety, and 133 for depression. Within each selected medical record, all visits for the 17 targeted conditions were identified, and separate quality assessments made for each. Nine experienced pediatric nurses were trained to review records and determine adherence.

SETTING Hospital emergency departments and inpatient admissions, and community based services provided by pediatricians and general practitioners in selected urban and rural locations in three Australian states.

PARTICIPANTS Care was evaluated for 6,689 children ≤ 15 years of age who had 15,240 visits for targeted conditions in 2012 and 2013, which generated 160,202 quality indicator assessments.

EXPOSURE Quality indicators were identified through a systematic search of local and international guidelines. Individual indicators were extracted from guidelines and assessed using a two-stage Delphi process.

MAIN OUTCOMES AND MEASURES Quality of care for each clinical condition, and overall.

RESULTS The 6,689 surveyed medical records were from children aged 0-15 years, with 54% aged 0-4 years, and 56% male. Adherence to quality of care indicators was estimated at 59.8% (95% CI, 57.5-62.0; n=160,202) across the 17 conditions, ranging from a high of 88.8% (95% CI, 83.0-93.1; n=2,638) for autism, to a low of 43.5% (95% CI, 36.8-50.4; n=2,354) for tonsillitis. The mean adherence by condition category was estimated as 60.6% (95% CI, 57.2-63.8; n=41,265) for noncommunicable conditions (range: 52.8% to 75.8%), 82.4% (95% CI, 79.0-85.5; n=14,622) for mental health conditions (range: 71.5% to 88.8%), 56.3% (95% CI, 53.2-59.4; n=94,037) for acute infections (range: 43.5% to 69.8%), and 78.3% (95% CI, 75.1-81.2; n=10,278) for injury.

CONCLUSIONS AND RELEVANCE Among a sample of children receiving care in Australia in 2012-2013, the overall prevalence of adherence to quality of care indicators for important conditions was not high. For many of these conditions, the quality of care may be inadequate.

Keywords
Appropriateness; patient safety; health systems; pediatrics; quality of care.

Introduction

Relatively little is known about the quality of care provided across modern health systems. Knowledge of care quality is limited to targeted studies in some countries,[1,2] small numbers of, or single, conditions,[3] or particular settings.[4] Previous population-level studies of adults in the United States (US)[1] and Australia[2] estimated a prevalence of adherence to clinical practice guidelines (CPGs) of 55% and 57%, respectively. In child health, a large US study of multiple conditions in children remains the benchmark.[5] That study, published a decade ago, examined ambulatory care delivered between 1998 and 2000 for 11 conditions in 12 metropolitan settings, and estimated adherence of 47%.

The purpose of this study was to estimate the prevalence of quality care, as measured by adherence to CPG recommendations, by undertaking a population-based study of care received by Australian pediatric patients aged ≤ 15 years in 2012 and 2013.

Methods

The CareTrack Kids study methods have been published elsewhere.[6,7] Briefly, this study audited medical records of children aged 0-15 years on the date of visit, in 2012 and 2013, across four healthcare settings: general practices; pediatricians' offices in the community; hospital Emergency Departments (EDs); and hospital inpatient settings.

This study developed a facility-based recruitment and selection strategy to maximize efficiency and condition-level sample sizes, customizing methods for selecting indicators, sampling sites and analyzing data. Seventeen child health conditions were identified on the basis of published research,[8,9] burden of disease,[10] frequency of presentation and national priority areas.[11-13] The 17 conditions are listed in Table 1, organized into four categories: noncommunicable (n=5), mental health (n=4), acute infection (n=7), injury (n=1). These included high prevalence conditions such as asthma which affects 10% of Australian children,[12] and gastro-esophageal reflux, a normal physiological condition in infants that needs to be distinguished from a variety of disease states. Also included were important lower prevalence conditions such as type 1 diabetes.

Ethical approval

Ethics approval was obtained from hospital networks and individual hospitals in each sampled state, and the Royal Australian College of General Practitioners. Australian Human Research Ethics Committees can waive requirements for patient consent for external access to medical records if the study entails minimal risk to facilities, clinicians and patients; all relevant bodies provided this waiver. Ethical approvals for this study do not permit reporting of overall performance by healthcare setting. Participants were protected from litigation by gaining statutory immunity for this study as a quality assurance activity, from the Federal Minister for Health under Part VC of the Australian Health Insurance Act 1973.

Development and ratification of clinical indicators

The development and ratification of quality indicators is depicted in Figure 1. The RAND-UCLA method to develop indicators was modified and applied,[14] commencing with a systematic search for Australian and international CPGs. Recommendations were extracted from 99 CPGs. 1,266 recommendations were screened for eligibility, and 322 were excluded for one or more of four reasons: (1) weak strength of wording (e.g., "may" and "could"); (2) low likelihood of the information being documented (e.g., standard operating procedures such as temperature measurement); (3) guiding statements without recommended actions (e.g., general information such as "consideration should be given to", "be aware that"); and (4) "structure-level" recommendations (e.g., referral pathways, training requirements for healthcare professionals).[15] The 944 remaining recommendations were grouped into a standardized indicator format. After consolidation of similar recommendations, 385 were available for review.[6] These recommendations were categorized by the phase of care being addressed by the indicator (diagnosis, treatment, ongoing management) and the type of quality of care addressed (underuse – actions which are recommended, but not undertaken; overuse – actions which are not indicated, or contraindicated).

In total, 146 experts (104 pediatricians, 22 general practitioners, 11 psychiatrists, five psychologists, and four nurses) were recruited to undertake internal and external reviews.[16] An expert coordinator was appointed to lead the reviews for each condition. Proposed indicators were ratified by experts over a two-stage, multi-round modified Delphi process, comprising an email-based three-round internal review and an online, wiki-based two-round external review.[6] Internal reviewers (n=55) were recruited from the research team's professional networks, while external reviewers (n=91) were sourced through targeted advertisements and open to all qualified

applicants. Reviewers completed a conflict of interest declaration,[6,17] and worked independently to minimize group influence.[18]

For the internal review, experts scored each of the 385 recommendations against three criteria (acceptability, feasibility and impact, scored as 'Yes'/'No' or 'Not Applicable'),[6] to guide their decision to include or exclude a recommendation, and provided additional comments. Feedback was de-identified and collated, and used to revise recommendations between rounds. Internal review resulted in the removal of 162 recommendations, by majority decision, leaving 223 for external review.

External reviewers applied the same scoring criteria as internal reviewers and also used a nine-point Likert scale to score each recommendation as representative of quality care delivered to Australian children during 2012 and 2013.[6,14] A mean score of 7 or more was required for retention of the item; by the end of external review, 196 recommendations remained.

A single CPG recommendation was frequently separated into multiple quality indicators. For example, one recommendation relating to the treatment of children with *Depression* required that they should receive information about evidence-based management, and be offered community supports. This generated two quality indicators, one for provision of information about evidence-based management and another for community support. The 196 retained recommendations generated 479 indicator questions, that were grouped to create 17 condition-specific surveys; *Abdominal Pain*, for example, had 21 quality indicators while *Fever* had 47. Examples of indicators are shown in Table 1, with a full listing in eTable 1 (Appendix 1). Further examples of translating CPG recommendations into study indicators are shown in eTable 2 (Appendix 2.1). Of the 479

indicator questions, 356 (74.3%) did not have an evidence-level or grade of strength of recommendation specified in the CPGs.

Sample size

A survey was defined as the aggregated set of condition-specific indicators assessed for each visit. For inpatient care, a visit was defined as an occasion of admitted care; for ED care, a single presentation; and for General Practice (GP) and general (not sub-specialty) pediatrician care, a consultation. A minimum of 400 surveys per condition was required to obtain national estimates with 95% Confidence Interval (CI) and precision of +/- 5%. A pilot study did not contain sufficient clusters to provide an accurate estimate of the intracluster correlation coefficient, so the design effect could not be pre-specified.

Sampling targeted 400 medical records for each of 15 conditions, with *Anxiety* and *Depression* assigned 267 and 133 records respectively. *Anxiety or Depression* was initially conceptualized as a single condition for sampling purposes as they were often discussed together in CPGs, and allocated 400 records. During implementation, this was divided proportionate to the expected prevalence; as a result, lower precision was anticipated for these conditions.

For medical records containing multiple occasions of care for a condition, a separate survey of care quality was made for each occasion. If a record sampled for one condition contained occasions of care for other conditions, a separate condition-specific survey was undertaken for each visit, for each other condition. If two or more conditions were cared for during a single visit, each condition was separately surveyed. Based on the pilot study, it was anticipated that loss of precision due to design effects would be partially offset by additional surveys generated by this secondary sampling.

Sampling process

A multistage stratified random sampling process was applied. For logistical efficiency, three states were sampled (Figure 2): Queensland, New South Wales and South Australia, which together comprised 60.0% of the estimated Australian population aged ≤ 15 years on 31 December 2012. Australian geographical localities are classified into remoteness categories (Major Cities, Inner and Outer Regional Areas, and Remote and Very Remote Areas).[19] Remote and Very Remote regions accounted for 86% of the Australian land area and 2.3% of the population; the figures were slightly lower in the sampled states (81% of the area and 1.7% of the population) than in the non-sampled states and territories (91% of the area and 3.2% of the population).[19,20]

Each State's local department of health delivers health services through administrative units (referred to as 'Health Districts'), and designates these as Metropolitan or Regional (Figure 3). Six pediatric tertiary hospitals providing state-wide coverage were sampled outside this Metropolitan/Regional designation, and were considered a third stratum.

Health Districts which contained at least one hospital with ≥ 2,000 ED presentations and ≥ 500 pediatric inpatient discharges per year were eligible for selection. One of the three Metropolitan Health Districts in South Australia, containing 32.2% of the Metropolitan target population, was ineligible. Four Health Districts, all from Regional Queensland, were also ineligible, and a fifth Health District from Regional Queensland was excluded due to remoteness, for logistical reasons, prior to District selection; together, these five Health Districts contained 7.5% of the Regional target population. All New South Wales Health Districts were eligible.

In South Australia, the Regional stratum functioned as a single Health District and the Metropolitan stratum only contained two eligible Districts; all three were selected for study. This study was unable to recruit any pediatricians in the eligible Health Districts; all pediatricians were recruited from the third (ineligible) Metropolitan District, where they were clustered.

In Queensland and New South Wales two eligible Health Districts were selected within each stratum, using equal probability sampling. One of the two Districts randomly selected in Regional Queensland, containing two hospitals, was removed because neither hospital responded to recruitment efforts; two other Health Districts, each containing one eligible hospital, were selected for replacement.

Recruitment of hospitals, GPs and pediatricians, and selection of records

Recruitment within selected Health Districts was by direct mail, telephone and face-to-face contact by study investigators, clinical peers and study surveyors. GPs and pediatricians were recruited through advertising, internet searches, and personal contacts. Recording of recruitment, non-responses and refusals for GPs and pediatricians was decentralized, and records were unavailable after decommissioning of project laptops, so response rates cannot be precisely calculated. For GPs, recovered data from email communications were available for South Australia, and the recruitment rate was estimated at 24%. For pediatricians, recovered data were available in all states, and estimated at 25%. See Appendices 2.2.5 and 2.2.6 for additional detail.

All hospitals with the minimum patient volumes were targeted; 34 of 37 (92%) eligible hospitals approached agreed to participate, with 34 providing ED data and 31 providing inpatient data. Recruited hospitals were estimated to be responsible for 40% of all ED visits in the three sampled states, and 41% of all inpatient visits.

Within selected sites, a random sample of medical records for each condition was sought. For hospitals and GPs, eligible records for each condition were loaded into a Microsoft Excel spreadsheet and the records arranged randomly and selected consecutively; for pediatricians, selection was performed on site by the surveyor, with instructions to randomly select. Records were mostly electronic for GPs and hospitals, and paper-based for pediatricians. The process is described in Appendix 2.3; eTable 3 lists the ICD and SNOMED codes used to identify medical records in hospitals.

Surveyors

Nine surveyors, experienced registered pediatric nurses, were engaged across the three states, undergoing five days of training and competency assessment. Medical records were reviewed on-site at each participating facility during March–October 2016. As participating sites were separated by up to 2,000 miles, assessing inter-rater reliability on actual records was not feasible; mock records were assessed during the surveying task, for six of the nine surveyors (two had already terminated employment and one was excluded as their assessments may not have been independent) and their results compared. A good level of agreement was found; K=0.76 (95% CI, 0.75-0.77; n=1,895) for the child's eligibility for indicator assessment, and K=0.71 (95% CI, 0.69-0.73; n=1,009) for indicator assessment.

Data collection and analysis

An electronic data-collection tool,[2] incorporating indicators and recorded surveyor decisions, was adapted for the study. The tool included built-in filters to remove indicators that were not relevant to the child because of age or setting; for example, when assessing a GP visit by a 5-year-old, indicators for children aged <3 years were filtered, as were indicators restricted to ED

presentations. Patients' age and sex data, but not race/ethnicity and socioeconomic status data, were collected.

A surveyor manual provided definitions, inclusion and exclusion criteria, and guidance for assessing indicator eligibility. Surveyors assessed adherence with each indicator as 'Yes' (care provided was consistent with the indicator), 'No' (inclusion criteria met, but no documented compliance action performed), or 'Not Applicable' (the indicator was not eligible for assessment).

For each setting, survey or register-derived data were used to estimate the proportion of visits by condition.[21-24] Visits per condition were thereby estimated for each healthcare site, and sampling weights calculated (Appendix 2.4; eFigure 1 shows the conceptual model for the survey, eTables 4-8 list codes used to identify visits in each healthcare settings, and eTable 9 summarizes the level at which sampling fractions were calculated for inpatient visits in tertiary hospitals). The weights adjust for oversampling of settings and conditions.

The maximum number of assessable quality indicators ranged from nine for *Eczema* to 54 for *Head Injury;* Table 2 summarizes the number of indicators by condition in total, and by type of quality of care and phase of care. At indicator and condition level, the proportion adherent to underuse indicators was calculated as the total number of 'Yes' responses divided by the total number of eligible responses, using sample weights; adherence to overuse indicators was similarly calculated, after first reversing 'No' and 'Yes' responses. The overall assessment of care quality was the weighted mean of the 17 condition-level assessments. The overall condition category assessments were weighted averages of the included conditions.

Data were analyzed in SAS/STAT™ software v9.4, using the SURVEYFREQ procedure. Variance was estimated by Taylor series linearization. At condition level, state and healthcare setting were specified as strata or pseudo-strata, and the primary sampling unit (Health District) was specified as the clustering unit, to account for clustering at all levels. For the overall assessment of adherence with indicators, the overall condition category assessments and the analysis by indicator characteristics, condition was added as a stratum. Exact 95% CIs were generated using the modified Clopper–Pearson method. Domain analysis was applied to assessments of indicator characteristics (Appendix 2.5).

Results

Characteristics of surveyed medical records

The 6,689 children in this study received care for one to seven separate clinical conditions (median=1), had a total of one to nineteen visits where one or more indicators were assessed (median=2), and had one to 232 indicator assessments (median=18). A single child, for example, may have had three visits to a GP for targeted conditions in 2012 and 2013, two for asthma management and one for acute abdominal pain, with 42 care quality indicators assessed across the three visits. Table 3 compares the age and sex composition of this study population to all Australia, separately for children (median age 4 years and 55.5% male in the sample vs 7 years and 51.3% male in Australia) and for occasions of healthcare provided to children (median age 3 years and 56.2% male in the sample vs 4 years [see footnote d] and 52.4% male in Australia). The distribution of occasions of healthcare in the four settings in the study shows a much closer correspondence for age, but with an over-representation of children aged 0-4 years and males. The differences that remain may reflect differences in age-sex structure between the conditions targeted by this study and all conditions managed in these healthcare settings, and over-sampling of some conditions and healthcare settings.

Of 439,704 possible indicator assessments, 97,468 (22.2%) were automatically filtered, and 182,034 (41.4%) were designated as not applicable by surveyors or otherwise deemed ineligible in data cleaning (e.g., if aged 16 years on the visit date). The field team conducted 160,202 eligible indicator assessments during 15,240 visits; each visit included one to 40 indicators (median=10) with 'Yes' or 'No' answers. The surveys were conducted at 139 healthcare sites: 85 GP sites, 20 pediatricians and 34 hospitals. The number of children, visits and indicators assessed in each setting, is presented in eTable 10 (Appendix 3), for each of the 17 conditions.

Quality of care indicators

Mean prevalence of adherence with quality of care indicators, by condition, is shown in Table 4. Estimated adherence ranged from 43.5% (95% CI, 36.8-50.4) for *Tonsillitis* to 88.8% (95% CI, 83.0-93.1) for *Autism*. *Tonsillitis* was the only condition with under 50% estimated adherence, while the four *Mental Health* conditions, *Diabetes* and *Head Injury* had estimated adherence of over 70%. The mean adherence was estimated as 60.6% (95% CI, 57.2-63.8) for the five noncommunicable conditions (range: 52.8% for *Gastro-Esophageal Reflux Disease* to 75.8% for *Diabetes*), 82.4% (95% CI, 79.0-85.5) for the four mental health conditions (range: 71.5% for *Depression* to 88.8% for *Autism*), 56.3% (95% CI, 53.2-59.4) for the seven acute infections (range: 43.5% for *Tonsillitis* to 69.8% for *Croup*), and 78.3% (95% CI, 75.1-81.2) for *Head Injury*. Overall, quality of care was estimated to be adherent for 59.8% (95% CI, 57.5-62.0) of indicators.

Mean adherence was also calculated by indicator characteristics (Table 5). Estimated adherence was 61.4% (95% CI, 57.3-65.4) for diagnosis, 57.4% (95% CI, 52.4-62.4) for treatment and 58.7% (95% CI, 55.8-61.6) for ongoing management. Indicators associated with overuse (e.g., unjustified antibiotic prescription, or diagnostic testing) had an estimated adherence of 87.2% (95% CI, 80.7-92.1), while indicators associated with underuse had an estimated adherence of 56.2% (95% CI, 53.5-58.9).

Individual indicator estimates were calculated. For example, for children with asthma: among those prescribed preventer therapy in any of the four settings, 46.5% (95% CI, 38.4-54.8; n=1070) were estimated to have had a written action plan; and among those discharged from hospital after an acute asthma episode, 91.5% (95% CI, 85.2-95.8; n=125) were estimated to have had a written action plan. For *Gastro-Esophageal Reflux Disease* indicators in any setting: of infants and children with regurgitation, only 44.4% (95% CI, 33.7-55.5; n=292) were estimated to have had their height

and weight documented; while of healthy thriving infants presenting with irritability or unexplained crying, it was estimated that 41.2% (95% CI, 15.0-71.2; n=92) were prescribed acid-suppression medication at the first presentation. Children diagnosed with type 1 diabetes in any setting received investigations for glutamic acid decarboxylase at diagnosis on an estimated 72.4% (95% CI, 50.9-88.3; n=128) of occasions.

Discussion

Of the care provided to Australian children, approximately 60% met quality indicators, with considerable variation between conditions. The only condition with estimated adherence below 50% was *Tonsillitis,* while six conditions had estimated adherence above 70%: the four mental health conditions*, Diabetes* and *Head Injury*.

These results provide insights into the management of each condition. Consider, for example, the management of asthma, the most common chronic disease in children,[25] affecting 334 million people worldwide and imposing a significant burden on health services; in Australia, one in 10 children has asthma.[12] Written plans to manage asthma flare-ups are an important part of management, and have been shown to improve asthma control, reducing time off school and contact with health facilities.[26] Asthma guidelines recommend that each child has a written asthma plan, regularly updated.[27] While an estimated 92% of children discharged from hospital following a flare-up were given an asthma action plan, only 47% of children prescribed a preventer were estimated to have a plan.

Poor adherence may affect patient outcomes and contribute to sub-optimal use of resources. For example, infants with suspected *Gastro-Esophageal Reflux Disease* are often treated with acid-suppressive medications. Evidence to support the effectiveness of these medications in the infant population is limited, and their use is associated with increased incidence of infections.[28] This study found that 41% of infants who were healthy and thriving and presented with irritability or unexplained crying were prescribed acid suppression medication at the first presentation.

The findings are similar to previous population-level estimates of quality of care for adults in the US (55%)[1] and Australia (57%)[2] but are higher than those reported in a survey conducted almost

two decades ago of children in ambulatory settings in the US (47%).[5] This could reflect differences in study population, this study's addition of inpatient conditions, indicators chosen, system performance or performance improvement over time. The substantial variation in adherence rates by condition found here was also found in the previous adult[1,2] and child[5] studies.

Adherence gaps and practice variation persist despite decades of development and endorsement of CPGs, designed to promote the uptake of evidence into routine practice, and to standardize care. The problems with CPGs have been well described and include redundancy, lack of currency, inconsistent structure and content, voluminous documents,[29] and concerns about the quality of evidence on which CPGs are based.

Limitations

This study had several limitations. First, while a large sampling frame was developed, covering 60% of the Australian population ≤15 years of age, the rest of Australia has a slightly larger proportion of remote population. Only 2.3% of the Australian population resides in Remote or Very Remote areas, and the results may not generalize to these settings. In other settings the estimated quality of care is likely to be generalizable. There is broad similarity between these results and other Australian[2] and US[1,5] studies of the quality of care, but the extent to which the results can be generalized to the US or elsewhere is unknown.

Second, while this study was more inclusive and larger than the US children's study,[5] covering both ambulatory and inpatient care for 17 conditions in four care settings, it nevertheless did not include some clinicians such as clinical psychologists and psychiatrists.

Third, as the quality indicators assessed in the audits had diverse sources it is possible that the clinicians were adhering to guidelines other than those selected. Mitigating this, a systematic search for guidelines was undertaken and a mean of 5.8 guidelines were used per condition. Additionally, indicator development included an assessment, by reviewers external to the project, to ensure that each recommendation was a relevant standard of quality care for clinicians in 2012 and 2013.

Fourth, the kappa-scores were consistent with other medical record reviews but, for logistical reasons, were restricted to mock records. Given the greater inconsistency of medical records in the field, this process may have overestimated agreement.

Fifth, convenience sampling of GPs and pediatricians may mean that the recruited practices were non-representative of the population. Relevant data were unavailable to assess the representativeness of the sampled sites at a local level. The sample had more children aged 0-4 years (58.4% vs 51.1% for the Australian population), fewer children aged 10-15 years (18.4% vs 25.0%), and more males (56.2 % vs 52.4%).

Sixth, the study has a potential for self-selection bias. The best available estimate was a recruitment rate of 25% for GPs and pediatricians. Hospital recruitment was, in contrast, high (92%). Losses in sampling are an unavoidable challenge in large quality of care studies: recruitment rates reported by the other studies were 37% for the adult US study,[1] 8% for the adult Australian study,[2] and 42% for the US child health study.[5] If self-selecting GPs and pediatricians were more likely to provide adherent care, this study likely overestimated the quality of care.

Seventh, there remains a potential bias arising from the possibility that the care documented may not reflect the care delivered. All studies seeking to assess the quality of care based on medical record audit face this possibility. Alternate methods may result in an estimate of adherence approximately 10 percentage points higher in primary care.[1]

Conclusions

Among a sample of children receiving care in Australia in 2012-2013, the overall prevalence of adherence to quality of care indicators for important conditions was not high. For many of these conditions, the quality of care may be inadequate.

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Table 1. Exemplars of quality of care indicators and characteristics

Condition	No. of indicators	Indicator ID	Description of selected indicator	Phase of care	Quality type[a]
NONCOMMUNICABLE					
Abdominal pain	21	ABDO01	Children presenting with acute abdominal pain had their pain history documented (e.g. onset, location, severity, progression, character).	Diagnosis	Underuse
		ABDO19	Children presenting with acute abdominal pain who were severely dehydrated or shocked, had their electrolytes measured.	Treatment	Underuse
Asthma	39	ASTH38	Children with asthma prescribed preventer therapy had a written asthma action plan.	Ongoing management	Underuse
		ASTH39	Children discharged from hospital after an acute asthma episode had a written asthma action plan.	Ongoing management	Underuse
Diabetes	35	DIAB02	Children and adolescents with type 1 diabetes, at diagnosis, received investigations for GAD antibodies.	Diagnosis	Underuse
		DIAB12	Children and adolescents with type 1 diabetes had an intensive glycemic control plan implemented that included monitoring of HbA1c at least 4-monthly.	Treatment	Underuse
Eczema	9	ECZE07	Children with atopic eczema and no signs of infection were prescribed antibiotics.	Treatment	Overuse
		ECZE08	Parents of children diagnosed with atopic eczema were advised to provide ongoing everyday treatments to avoid irritants.	Ongoing management	Underuse
GERD	32	GERD01	Infants/children who presented with regurgitation had their weight and height (growth chart) documented.	Diagnosis	Underuse
		GERD17	Infants with reflux who were healthy and thriving and presented with irritability or unexplained crying were prescribed acid suppression medication at the first presentation.	Treatment	Overuse
MENTAL HEALTH					
ADHD	34	ADHD04	Children who presented to a clinical specialist with symptoms/signs of ADHD had a comprehensive medical, developmental and mental health assessment.	Diagnosis	Underuse
		ADHD27	Children with ADHD had their management plan reviewed at least every 6 months.	Ongoing management	Underuse
Anxiety	13	ANXI04	Children who presented with suspected anxiety were assessed for other causes (e.g. physical illness, co-morbid depression, medication or illicit drug effect).	Diagnosis	Underuse
		ANXI07	Children with anxiety were provided education and support as first line management.	Treatment	Underuse
Autism	17	AUTI04	Children were diagnosed with ASD using the criteria of DSM-IV, DSM-V OR ICD-10.	Diagnosis	Underuse
		AUTI16	Children diagnosed with ASD were assessed and monitored for co-morbid disorders (e.g. epilepsy, sleep disorders, anxiety disorder, OCD, ADHD and depression).	Ongoing management	Underuse
Depression	15	DEPR09	Children and adolescents with depression had an emergency safety plan.	Ongoing management	Underuse
		DEPR12	Children and adolescents prescribed selective serotonin reuptake inhibitor therapy were monitored for adverse drug reactions.	Treatment	Underuse

Condition	No. of indicators	Indicator ID	Description of selected indicator	Phase of care	Quality type[a]
ACUTE INFECTIONS					
Acute gastroenteritis	35	AGE10	Children who presented with gastroenteritis had their degree of dehydration assessed.	Diagnosis	Underuse
		AGE19	Children with gastroenteritis and no signs and symptoms of dehydration, received routine blood tests.	Treatment	Overuse
Bronchiolitis	40	BRON03	Infants (aged less than 12 months) presenting with acute bronchiolitis had their feeding history recorded.	Diagnosis	Underuse
		BRON17	Children diagnosed with acute mild/moderate bronchiolitis had chest physiotherapy.	Treatment	Overuse
Croup	26	CROU04	Children diagnosed with croup were assessed for stridor.	Diagnosis	Underuse
		CROU16	Children diagnosed with croup were treated with antibiotics.	Treatment	Overuse
Fever	47	FEVE06	Children with a fever (over 38°C) had their immunization status documented.	Diagnosis	Underuse
		FEVE47	Parents of children with a fever (over 38°C) who were discharged received a fever fact sheet.	Ongoing management	Underuse
Otitis media	37	OTIT16	Children with otitis media with effusion without hearing loss were prescribed or advised to use antibiotics, or decongestants, or antihistamines, or mucolytics or steroids (topical or systemic).	Treatment	Overuse
		OTIT22	Children with acute otitis media and chronic perforation not responding to treatment over three months were referred to an ear, nose and throat specialist.	Ongoing management	Underuse
Tonsillitis	11	TONS02	Children with a sore throat and with no other symptoms or signs of tonsillitis were prescribed antibiotics.	Treatment	Overuse
		TONS03	Parents of children with a sore throat were instructed to provide fluids.	Treatment	Underuse
URTI	14	URTI08	Parents of children with an URTI were advised against antibiotics as they are likely to make little difference to the symptoms.	Treatment	Underuse
		URTI14	Parents of children with an URTI were advised to return if the condition worsens or becomes prolonged.	Ongoing management	Underuse
INJURY					
Head injury	54	HEAD27	Children with a severe head injury (GCS 3-8) received immobilization of their cervical spine.	Treatment	Underuse
		HEAD46	Children who presented with a head injury were intubated via a nasotracheal airway.	Treatment	Overuse

Legend**:** GERD=Gastro-esophageal Reflux Disease; ADHD=Attention-Deficit Hyperactivity Disorder; URTI=Upper Respiratory Tract Infection; GAD= Glutamic Acid Decarboxylase; HbA1c=Hemoglobin A1c; DSM-IV=Diagnostic and Statistical Manual of Mental Disorders, 4th edition; DSM-V=Diagnostic and Statistical Manual of Mental Disorders, 5th edition; ICD-10=International Statistical Classification of Diseases and Related Health Problems, 10th revision; ASD=Autism Spectrum Disorder; OCD=Obsessive-compulsive disorder; GCS=Glasgow Coma Scale.

[a] 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 contraindicated in the context of the indicator's inclusion criteria.

Table 2. Number of indicators by condition, overall and by indicator characteristic

Condition	No. of Unique Indicators[a]	Quality type		Phase of Care			Healthcare setting[b]			
		Over-use	Under-use	Diag-nosis	Treat-ment	Ongoing Manage-ment	GP	Pediat-rician	ED	In-patient
NONCOMMUNICABLE										
Abdominal pain	21	3	18	15	6	0	19	0	21	21
Asthma	39	6	33	4	22	13	38	35	36	37
Diabetes	35	0	35	4	27	4	15	16	34	35
Eczema	9	1	8	2	5	2	8	8	8	9
GERD	32	4	28	13	11	8	32	30	29	29
MENTAL HEALTH										
ADHD	34	0	34	14	10	10	29	31	0	0
Anxiety	13	2	11	4	9	0	13	11	7	7
Autism	17	0	17	8	6	3	17	17	0	0
Depression	15	1	14	5	8	2	15	15	14	14
ACUTE INFECTIONS										
Acute gastroenteritis	35	4	31	10	13	12	18	0	34	26
Bronchiolitis	40	9	31	13	19	8	23	0	39	37
Croup	26	8	18	13	7	6	23	0	25	25
Fever	47	1	46	33	13	1	38	34[c]	43	35
Otitis media	37	5	32	0	16	21	37	37	37	37
Tonsillitis	11	3	8	1	4	6	6	6[c]	6	10
URTI	14	0	14	7	6	1	14	0	14	14
INJURY										
Head injury	54	2	52	25	28	1	21	0	54	52
OVERALL	**479**	**49**	**430**	**171**	**210**	**98**	**366**	**240**	**401**	**388**

Legend: GERD=Gastro-esophageal Reflux Disease; ADHD=Attention-Deficit Hyperactivity Disorder; URTI=Upper Respiratory Tract Infection.

[a] Total number of unique indicators in a condition-specific visit assessment.

[b] Most indicators are not unique to a setting; thus, the sum of indicators across settings exceeds the total number of unique indictors.

[c] These conditions were targeted for sampling in pediatrician's offices, but only one visit for fever and three for tonsillitis were found, so these records were not included in analyses.

Table 3. Characteristics of the study sample and Australia, 2012–2013, for children and for healthcare visits

Characteristic	Children		Healthcare visits for children	
	Study sample (n=6,689)	Australian population ≤ 15 years[a] (n=4,618,935)	Study sample (n=15,240)	Australian population ≤ 15 years[b] (n=19,352,690)
Age[c] - no. (%)				
0 - 4 years	3585 (53.6)	1503262 (32.5)	8899 (58.4)	9887182 (51.1)
5 - 9 years	1661 (24.8)	1437296 (31.1)	3530 (23.2)	4623506 (23.9)
10 - 15 years	1443 (21.6)	1678377 (36.3)	2811 (18.4)	4842002 (25.0)
Median age (Q1-Q3)	4 (1-9)	7 (3-11)	3 (1-8)	nc[d]
Sex - no. (%)				
Male	3714 (55.5)	2370904 (51.3)	8559 (56.2)	10143724 (52.4)
Female	2975 (44.5)	2248031 (48.7)	6681 (43.8)	9208966 (47.6)

Legend: Q1=25th percentile; Q3=75th percentile; nc=not calculable.

[a] Population as estimated at 31 December 2012, using Australian Bureau of Statistics mid-year population estimates for 2012 and 2013.[30]

[b] Visits, in the period 1 July 2012 to 30 June 2013, for hospital care (inpatient and Emergency Department) and care in the community provided by General Practitioners and pediatricians; see Appendix 2.3.3 for detail on the data sources.

[c] In the study sample, 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 eligible visits, where there was more than one.

[d] Data was sourced by age-group (0-4, 5-9, 10-14) and the median and interquartile range cannot therefore be calculated. Based on the age-group data, the 25th percentile is not estimable, but the median is likely to be 4 years and the 75th percentile 10 years.

Table 4. Quality of care by clinical condition, 2012–2013

Condition	No. of Unique Indicators[a]	No. of Children[b]	No. of Visits[c]	No. of Indicators asessed[d]	Percentage Adherent[e] (95% CI)
NONCOMMUNICABLE					
Abdominal pain	21	514	696	9785	69.9 (64.8, 74.6)
Asthma	39	881	1600	18453	58.1 (53.7, 62.5)
Diabetes	35	261	570	6536	75.8 (66.5, 83.6)
Eczema	9	609	829	4241	59.2 (54.9, 63.5)
GERD	32	285	359	2250	52.8 (45.7, 59.9)
MENTAL HEALTH					
ADHD	34	306	591	6544	83.6 (77.7, 88.5)
Anxiety	13	356	514	3159	80.8 (75.5, 85.4)
Autism	17	228	382	2638	88.8 (83.0, 93.1)
Depression	15	156	239	2281	71.5 (56.4, 83.8)
ACUTE INFECTIONS					
Acute gastroenteritis	35	669	854	14434	59.6 (56.7, 62.5)
Bronchiolitis	40	494	796	13979	59.3 (54.6, 63.9)
Croup	26	728	982	15010	69.8 (65.0, 74.2)
Fever	47	550	708	14879	53.5 (50.0, 56.9)
Otitis media	37	1063	1533	6922	58.0 (53.7, 62.1)
Tonsillitis	11	821	1127	2354	43.5 (36.8, 50.4)
URTI	14	1653	2714	26459	53.2 (46.6, 59.8)
INJURY					
Head injury	54	629	746	10278	78.3 (75.1, 81.2)
OVERALL	**479**	**6689**	**15240**	**160202**	**59.8 (57.5, 62.0)**

Legend: GERD=Gastro-esophageal Reflux Disease; ADHD=Attention-Deficit Hyperactivity Disorder; URTI=Upper Respiratory Tract Infection.

[a] Total number of unique indicators assessed in a visit.

[b] Number of children with one or more indicators assessed as 'Yes' or 'No'. The condition-specific numbers do not sum to the total because a single child could be assessed for more than one condition.

[c] Number of visits where one or more indicators was assessed as 'Yes' or 'No'.

[d] Number of indicators assessed as 'Yes' or 'No'.

[e] Adherence is defined as use for an underuse indicator and non-use for an overuse indicator.

Table 5. Quality of care by indicator characteristics, 2012 – 2013

	Classification	No. of Unique Indicators[a] (%)	No. of Children[b]	No. of Visits[c]	No. of Indicators assessed[d]	Percentage Adherent[e] (95% CI)
Phase of care	Diagnosis	171 (35.7)	5640	11095	86280	61.4 (57.3, 65.4)
	Treatment	210 (43.8)	6263	13755	49574	57.4 (52.4, 62.4)
	Ongoing management	98 (20.5)	4848	9573	24348	58.7 (55.8, 61.6)
Quality type	Overuse	49 (10.2)	4309	7337	22847	87.2 (80.7, 92.1)
	Underuse	430 (89.8)	6634	15050	137355	56.2 (53.5, 58.9)

[a] Number of unique indicators with the characteristic (percentage of all included indicators with that characteristic).

[b] Number of children with one or more indicators assessed as 'Yes' or 'No'.

[c] Number of visits where one or more indicators was assessed as 'Yes' or 'No'.

[d] Number of indicators assessed as 'Yes' or 'No'.

[e] Adherence is defined as use for an underuse indicator and non-use for an overuse indicator.

Figure titles and legends (captions):

[a] Acceptability, feasibility and impact were assessed by reviewers scoring them as Yes/No or not applicable. "Acceptability" refers to the relevance of the indicator to Australian healthcare in 2012 and 2013; "feasibility" refers to the frequency of presentation and the likelihood of documentation; and "impact" refers to the influence of the recommended action on patient experience, safety or effectiveness.

Figure 1. Flow diagram of indicator development and ratification

[a] South Australia: Population aged ≤ 15 years=314,511; percentage of population Metropolitan=68%; total recruited: 28 GPs, eight pediatricians and seven hospitals.
[b] Queensland: Population aged ≤ 15 years=976,821; percentage of population Metropolitan=66%; total recruited: 35 GPs, four pediatricians and twelve hospitals.
[c] New South Wales: Population aged ≤ 15 years=1,479,680; percentage of population Metropolitan=70%; total recruited: 22 GPs, eight pediatricians and 15 hospitals.
Notes.

1) All populations aged ≤ 15 years as estimated at 31 December 2012 (Australian Bureau of Statistics, ABS; Australian Demographic Statistics, series 3101).
2) Percentage of population Metropolitan calculated on population estimates (aged ≤ 15 years) from state departments of health.
3) Each square and circular pin identifies a Health District that was sampled within Metropolitan and Regional strata; pins in the Regional strata are approximately at the center of the sampled Health District, to prevent identification of individual sites. Numbers in square and circular pinheads are the sum of GPs, pediatricians and non-tertiary hospitals recruited in a Health District, except for eight pediatricians (shown with *) all recruited from Metropolitan South Australia (see Figure 3, footnote g).
4) Triangular pins mark the approximate location of tertiary pediatric hospitals, and the number in the triangle indicates the number of tertiary hospitals in that location.

Figure 2. Sample distribution

Legend: NSW=New South Wales; QLD=Queensland; SA=South Australia; Health District = Local Health District in New South Wales, Hospital Health Service in Queensland, and Local Health Network in South Australia; GPs=General Practitioners.
[a] Metropolitan and Regional strata are geographically defined; tertiary pediatric hospitals were sampled outside of this classification as they have state-wide responsibility; five of the six tertiary hospitals were physically located within metropolitan strata.
[b] Number of Health Districts or tertiary hospitals selected, of the total number of eligible Health Districts or tertiary hospitals in the stratum; one of the six tertiary pediatric hospitals was located within a selected Health District.
[c] Number of sites of each type successfully recruited within the metropolitan or regional strata, or among the tertiary pediatric hospitals.
[d] Five excluded, four ineligible due to lack of a hospital with sufficient patient volumes, 1 excluded due to remoteness; together comprise 7.5% of regional population aged ≤ 15 years.
[e] One excluded as ineligible due to lack of a hospital with sufficient patient volumes; 32.2% of metropolitan population aged ≤ 15 years.
[f] Two Health Districts were randomly selected in Regional Queensland initially. One, which contained two eligible hospitals, was removed because neither hospital responded to recruitment efforts; two other Districts, each containing one eligible hospital, were non-randomly selected to replace this lost District.
[g] This study was unable to recruit any pediatricians in the eligible Health Districts in South Australia; all eight pediatricians were therefore recruited from a Health District which was not eligible for selection because it lacked a hospital with the required patient volumes.

Figure 3. Sampling structure

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