



COVER SHEET

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A Clinical Pathway for Bronchiolitis is Effective in Reducing Readmission Rates

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Objective

To examine the use of a clinical pathway in the management of infants hospitalized with acute viral bronchiolitis.

Study design

A clinical pathway with specific management and discharge criteria for the care of infants with bronchiolitis was developed from pathways used in tertiary care pediatric institutions in Australia. Two hundred and twenty-nine infants admitted to hospital with acute viral bronchiolitis and prospectively managed using a pathway protocol were compared with a retrospective analysis of 207 infants managed without a pathway in 3 regional and 1 tertiary care hospital.

Results

Readmission to hospital was significantly lower in the pathway group ($P = .001$), as was administration of supplemental fluids ($P = .001$) and use of steroids ($P = .005$). There were no differences between groups in demographic factors or clinical severity. The pathway had no overall effect on length of stay or time in oxygen.

Conclusions

A clinical pathway specifying local practice guidelines and discharge criteria can reduce the risk of readmission to hospital, the use of inappropriate therapies, and help with discharge planning.

Abbreviations: ICU, Intensive care unit; LOS, Length of stay; RSV, Respiratory syncytial virus; TIO, Time spent in oxygen

Clinical pathways, developed to provide a systematic and organized method of managing the care of patients with a variety of conditions, have been used extensively, often without formal evaluation of their effectiveness.^{1 and 2}

Acute viral bronchiolitis results in hospital admission in about 1 in 100 usually healthy infants.³ Clinical pathways for bronchiolitis have been established in pediatric tertiary care centers in Australia. Two studies were unable to demonstrate any improvement in the management of oxygen therapy or hydration therapy after the introduction of clinical pathways; however, they did find a reduction in the use of antibiotics.^{4 and 5} Clinical practice guidelines for bronchiolitis have also been assessed and, according to Perlstein et al,⁶ use of guidelines has produced dramatic decreases in the number of admissions and the mean length of stay (LOS). Subsequent

authors³ have not been able to identify a similar level of success, although one recent large study⁷ found a significant decrease in resource use after introduction of clinical guidelines. A recent review of current management provides specific assessment and admission guidelines to promote best practice.⁸

A clinical pathway was developed and used to promote consistency of nursing management during a prospective clinical trial of epinephrine at 1 tertiary care and 3 regional hospitals in southeast Queensland.⁹ The epinephrine study identified oxygen saturation on admission, need for supplemental oxygen, and need for intravenous therapy as the major factors affecting LOS in hospital. The intervention of the epinephrine study had no effect on outcomes, and there was no difference in outcomes between the patients who took part in the study and those patients managed on a clinical pathway who did not take part. This lack of difference in outcomes afforded a unique opportunity to examine the use of the clinical pathway in the management of infants with acute viral bronchiolitis.

Methods

Selection of Patients

This study combined a prospective analysis of 229 patients admitted with bronchiolitis treated using a pathway protocol (pathway group) with a retrospective analysis of 207 randomly selected historical control patients managed without a pathway. For inclusion in the study, the infants had to be under 12 months of age (or 12 months corrected age if premature) with their first wheezing episode requiring admission. Infants with heart disease or significant respiratory problems, such as cystic fibrosis, and infants who had received corticosteroids within 24 hours of presentation or used bronchodilators within the previous 4 hours, were excluded. The pathway included specific admission assessment information, clinical management guidelines, and discharge criteria (Table I).

Table I.

Clinical pathway admission assessment, clinical management and discharge criteria

Initial respiratory assessment recorded

Oxygen saturation in room air

Respiratory rate and effort

Heart rate

Temperature

Skin color and tone

Presence/absence of wheezing and crackles on chest auscultation

Level of hydration

Medical and social history recorded

Birth history

Birth weight

Previous medical problems

Infectious disease screening

Immunization status

Current medications

Development assessment

Allergies

Family history, eg, atopy

Social history, esp. smoking status of parents
Discharge support eg. LMO/GP
Guidelines for oxygen administration and supplemental fluids
Administer supplemental oxygen if:
Oxygen saturation < 94%
A combination of: significant respiratory distress, respiratory rate > 60/min,
difficulty feeding
Wean or cease supplemental oxygen if:
Oxygen saturation consistently above 93%
Infant stable for more than 4 hours and tolerating oral feeds
Intravenous fluids administered if:
Oxygen required
Respiratory rate > 60/min
Oral feeding inadequate
Intravenous fluids ceased if:
Infant able to tolerate oral feeds
Discharge guidelines
Respiratory status stable in room air for > 10 hours
Nil or mild chest recessions
Oxygen saturation in room air > 93%
Discharge plan for the parents complete
Letter for the GP complete

Setting and Time Frame

The setting for this study was 1 tertiary care hospital (Royal Children's Hospital, Brisbane) and 3 regional hospitals (Gold Coast Hospital, Redcliffe Hospital, and Caboolture Hospital), all located in southeast Queensland.

The historical control group was admitted between May 1998 and August 1999, and the infants in the prospective study who were managed on a pathway were admitted between May 2000 and August 2001.

Data Collection

Baseline clinical data, and data on parental smoking, admission to the pediatric intensive care unit (ICU), and use of drug therapy were collected from the clinical notes for the historical control group and from the clinical pathway records in the pathway group. Data on all pathology tests ordered and chest X-ray films were obtained from the hospital databases and clinical records.

For the pathway group, infants who required supplemental oxygen, had weaned to air, and then required further supplemental oxygen, were identified. The lack of detailed documentation about supplemental oxygen requirements in the control group prohibited further investigation of these infants. The possible predictive factors that could account for this repeated oxygen requirement were examined and included hospital site, age, sex, respiratory syncytial virus (RSV) status, severity at admission (as determined by oxygen saturation, respiratory rate, and presence of recession),

length of time of initial supplemental oxygen requirement, need for supplemental fluids, and smoking status of parents.

Outcome Measures

Study outcomes included LOS, time spent in oxygen (TIO), use of supplemental fluids, readmission to hospital within 2 weeks of discharge, use of pathology, radiological investigations, and medications—specifically antibiotics and steroids—and predictors for return to oxygen therapy.

Ethics

Local institutional ethics committees from the 4 centers approved the study.

Sample Size Estimate

On the basis of a mean LOS of 82 hours and standard deviation of 67 hours from the epinephrine study, it was estimated that a sample size of 200 subjects in each group was required to detect a difference of 12 hours in length of stay (a clinically relevant difference) between groups with a power of 80% and an $\alpha = 5\%$.

Statistical Analysis

We compared the infants in the historical control group and the infants managed using a clinical pathway with respect to demographic data, baseline clinical measures, and study outcomes. Comparisons between different hospitals, as well as between the 2 groups, were made to determine whether there was any interhospital variation in practice. The χ^2 test for significance was used to determine any statistically significant differences between the 2 sets of discrete data, and a 1-way analysis of variance test was used for the continuous data. A P value $< .05$ was considered statistically significant. Logistic regression was used to screen risk factors for return to oxygen.

Results

Baseline Demographic and Clinical Data

The baseline characteristics of the prospective and control groups were similar with regard to age, sex, RSV infection, and admitting hospital. The 2 groups had similar severity of illness at admission, as determined by presence/absence of recession, respiratory rate, requirement for supplemental oxygen, oxygen saturations at admission, and admission to ICU (Table II).

Table II.

Demographic/clinical data at admission (Given as mean [SD])	Control patients (n = 207)	Pathway patients (n = 229)	P value
Age (months)	4.0 \pm 3.0	4.3 \pm 2.9	.40
Sex (male/female)	132 (63.8%)/75 (36.2%)	141 (61.6%)/88 (38.4%)	.64
Nasopharyngeal aspirate positive	139 (72.4%)	175 (76.4%)	.35
RSV +	127 (66.1%)	155 (67.7%)	.74
Admission numbers (% of total)			.72
RCH	114 (55.1%)	114 (49.8%)	
GCH	40 (19.3%)	50 (21.8%)	
Caboolture	27 (13.0%)	31 (13.5%)	
Redcliffe	26 (12.6%)	34 (14.8%)	

Chest recession present (n) 172 (90.5%) 211 (92.1%) .56
 Respiratory rate (per min) 50.7 (\pm 12.0) 51.8 (\pm 13.6) .41
 O2 saturations on arrival (before oxygen) 93.1% (\pm 5.3) 93.4% (\pm 4.0) .48
 Supplemental O2 requirement 120 (58.0%) 148 (64.6%) .15
 Admission to ICU 8 (3.9%) 7 (3.1%) .64

RCH, Royal Children's Hospital; GCH, Gold Coast Hospital.

Outcome Measures

There was no significant difference overall between the 2 groups for LOS or TIO. The mean LOS in hours for infants in the control group was 86 hours (75.3-96.6, 95% CI), and 88.6 hours (78.8-98.3, 95% CI) for the pathway group. The length of stay was 22.0 hours longer in the tertiary care hospital than in the regional hospitals ($P = .006$), but this difference was reduced to 11.1 hours ($P = .064$) after adjustment for use of supplemental oxygen and supplemental fluids. Fifty-eight percent of infants in the control group required supplemental oxygen for a mean time of 72.6 hours (59.9-85.4, 95% CI), whereas 65% of the pathway group required supplemental oxygen for a mean time of 79.9 hours (69.1-90.8, 95% CI). There was a significant difference, however, in a subgroup of both cohorts. Infants in the pathway group requiring oxygen but not supplemental fluids had a longer LOS ($P = .006$) and a longer TIO ($P = .003$) than infants in the control group requiring oxygen only.

Fifteen infants (7.2%) in the control group required readmission within 2 weeks after discharge, with 9 of these infants also being administered supplemental oxygen during their initial hospital stay. This number compares with only 2 infants (0.9%) in the pathway group ($P = .001$) requiring readmission. Both these infants needed supplemental oxygen.

Supplemental fluids were administered to 33.8% of the control group compared with 19.2% of infants managed on a pathway ($P = .001$); however, more patients required supplemental fluids in the tertiary care hospital than regional hospitals (28.9% vs 16.3%, $P = .006$) There was greater use of steroids in the control group compared with the pathway group ($P = .005$), although the use of antibiotics was not significantly different between the 2 groups.

There was a marked difference between the 2 groups in the collection of data on the smoking status of the parents. In the control group, the parental smoking status of only 16% of the infants was collected. In the pathway group, however, data on smoking status were obtained for every infant (Table III).

Table III.

Outcome measures (mean - 95% confidence interval)	Control patients (n = 207)	Pathway patients (n = 229)	P value
LOS (hours)	86.0 (75.3-96.6)	88.6 (78.8-98.3)	.72
Nil O2 or supp fluids	40.2 (33.1-47.3)	34.4 (29.9-38.9)	.18

O2 only 81.5 (70.5-92.6) 107.0 (94.9-119.1) .006
 O2 and supp fluids 158.0 (132.5-183.5) 147.6 (115.7-179.4) .61
 TIO (hours) 72.6 (59.9-85.4) 79.9 (69.1-90.8) .39
 O2 only 45.0 (35.0-55.1) 69.8 (58.7-80.9) .003
 O2 and supp fluids 101.1 (79.2-123.1) 106.4 (80.7-132.1) .77
 Number requiring supplemental O2 (%) 120 (58%) 148 (64.6%) .15
 Number requiring supplemental fluids (%) 70 (33.8%) 44 (19.2%) .001
 Readmission within 2 weeks 15 (7.2%) 2 (0.9%) .001
 Parental smoking status known (%) 33 (16%) 229 (100%) .029

There was no significant difference between the 2 groups for the number of chest X-ray films or pathology tests including blood cultures, arterial blood gases, full blood counts, urea and electrolytes and liver function tests, lumbar punctures, methicillin-resistant *Staphylococcus aureus* screening, and urine culture and sensitivity tests. A higher proportion of patients in the control group (4%) had blood taken for *Bordetella pertussis* compared with the pathway group (0.9%) ($\chi^2 = 6.32$; $P = .13$). In contrast, a higher proportion of patients on the pathway (11%) had feces culture and sensitivity testing done, compared with the control group (4%) ($\chi^2 = 7.23$; $P = .007$).

Forty infants (27%) on the clinical pathway required supplemental oxygen again after being weaned to room air. Boys were 3 times more likely to return to oxygen (OR = 3.30; 95% CI, 1.39-7.81) after adjusting for oxygen saturations on admission, in spite of the fact that there was no significant difference between the oxygen saturation levels on admission of boys and girls for the entire cohort. Eight hours of monitoring after weaning from oxygen resulted in only 14 (9.5%) requiring a return to oxygen therapy. For every 1% increase in admission oxygen saturation levels, the infant's likelihood of returning to oxygen decreased by 16% (OR = 0.84; 95% CI, 0.75-0.95). Of the infants who did require further supplemental oxygen, 80% had supplemental oxygen restarted between 6 am and 6 pm. Time to return to oxygen was not affected by sex, age at admission, or oxygen saturation levels on admission.

Discussion

One of the major benefits of using this clinical pathway for infants with bronchiolitis appears to be in discharge planning and reducing the chances of a required readmission through the achievement of specified clinical outcomes before discharge. This benefit aligns with current findings by Meuthing et al⁷ that emphasize the importance of having specific guidelines, including admission and discharge criteria, which direct clinical practice.

Another advantage to be gained from use of a clinical pathway may be a more accurate assessment of the infant in relation to their need for supplemental fluids. Predetermined guidelines to direct clinical practice may lead to the elimination of some variability in practice and the avoidance of unnecessary invasive procedures for the patient. It may also be valuable as a cost-cutting measure, both in the up-front costs associated with nasogastric and intravenous feeds, and in terms of a reduction in the nursing time required in setting up and monitoring these procedures.

The areas in which specific recommendations were identified in the clinical pathway were the areas where there were statistically significant differences in outcomes between groups. This finding is evidenced by the reduction in the administration of supplemental fluids and steroids and the consistent collection of data on parental smoking status. The reduction in the use of steroid therapy that we found occurred while the patient LOS was unaltered and readmission rates to hospital dropped suggests that the change in drug prescribing practice had no detectable negative effect on short-term patient outcomes. Wang et al¹⁰ describe the variations in interventions relating to both steroids and antibiotics, suggesting that variation can occur when the most appropriate management is not clear. Areas of the pathway that did not mention specific management guidelines such as the administration of antibiotics, and the requirements for pathology testing and chest X-ray films, saw no significant change in practice between the 2 groups.

The lack of significant difference between the groups overall in terms of LOS or TIO suggests that either the particular clinical pathway used was not able to affect these outcomes, or that use of any clinical pathway may not significantly change these outcome measures for bronchiolitis. The longer LOS for children in the pathway group who required supplemental oxygen is likely to be due to the guidelines given for oxygen administration. The pathway was designed to be reasonable and acceptable to health care providers at a number of centers, and the actual cutoff for an acceptable level of oxygen saturation for weaning had not previously been examined. The value chosen is likely to have an effect on both LOS and possible readmission and should be formally tested. The subgroups of infants from the tertiary care hospital who were hospitalized and in supplemental oxygen for longer periods of time would be expected because this was the center to which the sicker infants were transferred because it was the only one with a pediatric ICU. Boys and infants with lower oxygen saturation levels on admission were the most “at-risk” group for requiring further supplemental oxygen after being previously weaned to room air. In addition, the fact that significantly more infants returned to oxygen therapy during the day may lead us back to the cornerstone of bronchiolitis management, namely minimal handling and supportive nursing care.

Although the use of a historical control group is not ideal, prospectively randomizing patients to pathway care or not pathway care would be extremely difficult from the point of view of nursing practice and adherence with pathway use. This study was conducted in a variety of hospital settings that allowed larger numbers and also ensured that the study participants were likely to be representative of most infants hospitalized in either tertiary care or regional hospitals. Seasonal variation occurs with bronchiolitis leading to significantly greater numbers presenting during the winter months. Genotype variations in the causative organisms for bronchiolitis can mean that 1 year might have milder cases than a subsequent year, theoretically resulting in shorter LOS or reduced TIO. By collecting data over 2 winter periods, the possibility of such an occurrence was minimized. In addition, severity data suggested similar groups were studied.

Clinical pathways provide a systematic way of managing the care of infants with acute viral bronchiolitis. This pathway significantly decreased the likelihood of readmission almost certainly because it provided specific discharge criteria. Other tangible positive outcomes from using this pathway with specified management

criteria were decreased use of supplemental intravenous fluids and steroid therapy and the collection of more accurate baseline data. Although this clinical pathway is no longer used in the tertiary hospital, it is still being used in the 3 regional centers probably because the specific criteria developed at the local level provided guidelines in hospitals that do not have large numbers of experienced pediatric staff. This study demonstrates the importance of clear specific guidelines to effect change in clinical practice. The challenge is to ensure that these guidelines are evidence based and achieve the best possible outcomes for patients.

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