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CLINICAL INVESTIGATION

Survey of the Use of Corticosteroids Among Neonatal Intensive Care Units for the Prevention or Treatment of Bronchopulmonary Dysplasia

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OBJECTIVE To survey neonatal intensive care units (NICUs) at academic medical centers to determine the current use of inhaled and systemic corticosteroids for the prevention or treatment of bronchopulmonary dysplasia (BPD).

METHODS A survey was developed to evaluate aspects of systemic and inhaled corticosteroid use in neonates. Eighty academic medical centers with neonatal/perinatal medicine fellowship programs were surveyed. Neonatology fellows or NICU clinical pharmacists with direct patient care activities responded via telephone, fax or e-mail.

RESULTS Fifty-three institutions responded to the survey (66.3% response rate). Twenty-nine percent of respondents (n = 15) use corticosteroids for prevention of BPD. Systemic corticosteroids are used by 6% of respondents (n = 3) and inhaled corticosteroids are used by 14% of respondents (n = 7) for prevention. Ten percent of respondents (n = 5) use either systemic or inhaled corticosteroids for prevention. Eighty-eight percent of respondents (n = 45) use corticosteroids for treatment of BPD. Systemic corticosteroids are used by 10% of respondents (n = 5) and inhaled corticosteroids are used by 10% of respondents (n = 5) for treatment. Sixty-nine percent of respondents (n = 35) use either systemic or inhaled corticosteroids for treatment. There was a wide variability in drug, dose, titration, taper, administration, and duration of therapy reported.

CONCLUSIONS These results indicate that systemic and inhaled corticosteroids are commonly used by practitioners for the prevention or treatment of BPD despite a recommendation against the routine use of systemic corticosteroids by the American Academy of Pediatrics' (AAP) Committee on Fetus and Newborn and the Canadian Paediatric Society's Fetus and Newborn Committee from February 2002.

KEYWORDS: bronchopulmonary dysplasia (BPD), corticosteroids, metered-dose inhaler (MDI), nebulization, neonatal

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INTRODUCTION

Bronchopulmonary dysplasia (BPD) has most recently been defined as the need for supplemental oxygen at 28 days of life. For infants < 32 weeks gestational age, this definition is further classified by severity as determined by oxygen requirement at 36 weeks postmen-

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ABBREVIATIONS: AAP, American Academy of Pediatrics; BPD, bronchopulmonary dysplasia; MDI, metered-dose inhaler; VLBW, very low birthweight

strual age: mild if no oxygen is needed, moderate if < 30% oxygen is required, and severe if ≥ 30% oxygen and/or ventilator therapy is required. For infants ≥ 32 weeks gestational age, the classification of severity is dependent on oxygen requirement at 56 days postnatal age. The disease is considered mild if there is no oxygen requirement, moderate if < 30% oxygen required, and severe if ≥ 30% oxygen and/or ventilation is required.[1] Multiple factors play a role in the development of this disease including surfactant deficiency in the structurally immature lungs of preterm neonates and the resulting exposure to barotrauma, volutrauma, and oxygen supplementation in the face of antioxidant deficiencies.[2]

Inflammation is thought to play a key role as higher concentrations of proinflammatory and chemotactic factors have been found in the airways of preterm infants who develop BPD.

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Normal lung growth and development is subsequently arrested resulting in the presence of fewer and larger alveoli and a reduction in pulmonary microvascular development.[2] Both systemic and inhaled corticosteroids have been used in the prevention or treatment of BPD for their anti-inflammatory properties.[3] Of the systemic corticosteroids, dexamethasone has been most widely studied. Its reported benefits include earlier extubation, decreased incidence of BPD or the combined risk of death or BPD at 36 weeks postconceptional age.[4,5] However, there has been no reported reduction in duration of hospitalization or mortality at discharge. There are also significant risks associated with its use in premature infants including hypertension, hyperglycemia, infection, hypertrophic obstructive cardiomyopathy, gastrointestinal hemorrhage, intestinal perforation, poor weight gain, and neurodevelopmental dysfunction.[6,7]

Inhaled corticosteroids have been evaluated as an alternative to systemic corticosteroids for both prevention and treatment of BPD.[8-11] Their theoretical advantages include localized drug delivery to the lungs with fewer systemic side effects. Unfortunately, the most recent studies consistently show no improvement in pulmonary outcomes. However, these studies include small numbers of patients and a wide variability in drug selection, dose administered, and administration technique. Therefore, it is difficult to draw final conclusions about the role of inhaled corticosteroids in BPD.

In February 2002, the American Academy of Pediatrics (AAP) Committee on Fetus and Newborn and the Canadian Paediatric Society's Fetus and Newborn Committee issued a joint statement on the use of postnatal corticosteroids to treat or prevent BPD in preterm infants. These groups concluded that systemic dexamethasone should not be routinely used for either prevention or treatment of BPD in very low birthweight (VLBW) infants, and that all corticosteroid use be restricted to randomized controlled trials or "exceptional clinical circumstances" such as the requirement of maximal ventilatory and oxygen support.[12] Furthermore, it was recommended that parents be fully informed of the risks of systemic corticosteroids and give consent prior to initiation of therapy. These groups also suggested the need for additional clinical trials with inhaled as well as alternative systemic corticosteroids before recommendations could be made on their place in therapy.[12] The objective of this study was to survey the neonatal intensive care units (NICUs) at academic medical centers in the United States to determine the current practice regarding systemic and inhaled corticosteroids for the prevention or treatment of BPD.

MATERIALS AND METHODS

A survey was developed to evaluate various aspects of systemic and inhaled corticosteroid use in neonates such as drug selection, mode of administration (nebulization, metered-dose inhalation, and/or systemic), dose, inpatient duration of therapy, criteria for selection of prevention or treatment, method of titrating and tapering doses, and procedure for obtaining consent from caregivers. The survey questions are listed in Table 1. The project was approved by the Institutional Review Board of the Medical University of South Carolina. The survey was conducted in May and June 2003 in the 80 institutions with neonatal/perinatal fellowship programs as published in January 2003.[13] A neonatology fellow or NICU clinical pharmacist was contacted from each institution. Each fellow or pharmacist was asked if he/she had direct patient care responsibilities, knowledge of the 2002

Table 1. Survey Assessing NICU Corticosteroid Use

DEMOGRAPHICS

1. What is the number of NICU beds at your institution?
2. What level is the NICU?
3. What is the average number of ventilated NICU patients per day?
4. What is the average duration of ventilation for patients in your NICU?

PREVENTION OF BPD

1. What percentage of patients receives inhaled corticosteroids for the prevention of BPD?
2. What percentage of patients receives oral or IV dexamethasone or other systemic corticosteroid for the prevention of BPD?
3. What are the criteria used in your NICU to determine which patients should receive corticosteroids for the prevention of BPD?

TREATMENT OF BPD

1. What are the criteria used in your NICU to determine which patients should receive corticosteroids for the treatment of BPD?
2. What percentage of patients receives inhaled corticosteroids for the treatment of BPD?
3. What factor(s) determine whether an inhaled corticosteroid is to be given via nebulization or MDI?
4. What percentage of patients receives inhaled corticosteroids via nebulization (e.g., budesonide (Pulmicort Respules)
5. What is the average starting dose of nebulized budesonide for the treatment of BPD?
6. What is the maximum dose of nebulized budesonide used in your NICU?

Questions regarding inhaled corticosteroids via metered-dose inhaler

7. What percentage of patients receives inhaled corticosteroids via metered-dose inhaler?
8. Which inhaled corticosteroid is given by metered-dose inhaler in your NICU?
9. What is the average starting dose of corticosteroids delivered via metered-dose inhaler? (Please give drug name, strength, number of actuations, and dosing interval)
10. What is the maximum dose of corticosteroids delivered via MDI used in your NICU?
11. Is a spacer or holding chamber used for MDI administration of corticosteroids in your NICU?

Questions regarding titration/duration/taper of inhaled corticosteroids

12. How is the dose of inhaled corticosteroid titrated?
13. Are intubated and nonintubated patients treated differently?
14. How are inhaled corticosteroids (both via nebulization and metered-dose inhaler) tapered in your NICU?

Questions regarding systemic corticosteroids

15. What percentage of patients receives dexamethasone for the treatment of BPD?
16. What percentage of patients receives another systemic corticosteroid for the treatment of BPD?
17. What dosing regimen of dexamethasone is used for the treatment of BPD? (oral versus IV dose, duration)
18. What dosing regimen of other systemic corticosteroids is used for the treatment of BPD? (oral vs. IV dose, duration)
19. What, if any, method of informed consent is being used to educate parents about potential benefits and risks of systemic corticosteroids?

Additional Questions

20. What percentage of patients receive bronchodilator therapy in addition to corticosteroids for the treatment of BPD?
21. What percentage of patients receive dexamethasone or another systemic corticosteroid for the prevention of postextubation stridor?

AAP/Canadian Paediatric Society recommendations, and the ability to answer specific questions about NICU corticosteroid use. Surveys were then conducted via telephone, unless the respondent requested a survey via fax or email. One individual asked the survey questions to allow for consistency. All demographic data are reported as mean ± standard deviation.

RESULTS

There were 53 respondents to the survey representing a 66.3% response rate. Forty surveys were conducted via telephone, 10 via email and 3 via fax. All NICUs were level III or IV based on ECMO capabilities. The respondents' NICUs averaged 43 ± 14 beds with 14 ± 9 ventilated patients per day for a reported duration of ventilation of 14 ± 8 days. Thirty-six clinical pharmacists, 12 neonatology fellows, and 2 attending neonatologists participated in the survey. Three surveys were completed by collaboration between the clinical pharmacist and the neonatology fellow or attending neonatologist.

Prevention of BPD

Fifty-one out of 53 institutions responded to the questions regarding prevention of BPD (96% response rate). Corticosteroids are used for prevention by 29% (n = 15) of respondents. Six percent (n = 3) of institutions use only systemic corticosteroids and 14% (n = 7) use only inhaled corticosteroids for prevention. Five institutions (10% of respondents) utilize either inhaled or systemic corticosteroids. Of the NICUs that reported using corticosteroids for prevention, the range of patients that receive inhaled corticosteroids is < 1 to 80% and < 1 to 100% for systemic corticosteroids. The percentages of patients receiving inhaled or systemic corticosteroids for the prevention of BPD are reported in Figure 1 with criteria for use cited by respondents shown in Table 2. Other criteria reported by 1 respondent each were failed extubation attempt, tachypnea, "life or death situations," and airway edema following extubation.

Treatment of BPD

Fifty-one out of 53 institutions responded to the questions regarding treatment of BPD (96% response rate). Eighty-eight percent (n = 45) of institutions use corticosteroids for treatment.

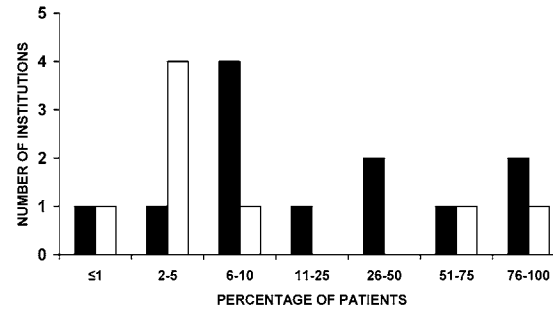

Figure 1. Percentage of Patients Receiving Inhaled (■, n =12) or Systemic (□, n = 8) Corticosteroids for the Prevention of BPD.

Ten percent (n = 5) of institutions use only systemic corticosteroids and 10% (n = 5) use only inhaled corticosteroids for treatment. Thirty-five institutions (69% of respondents) utilize either inhaled or systemic corticosteroids. Of the NICUs that reported using corticosteroids for treatment, the range of patients that receive inhaled and systemic corticosteroids is < 1 to 100%. The percentages of patients receiving inhaled or systemic corticosteroids for the treatment of BPD are reported in Figure 2 with criteria for use cited by respondents shown in Table 3.

Systemic Corticosteroid Administration

Dexamethasone is the sole systemic corticosteroid for the treatment of BPD in 29 institutions (73%). Hydrocortisone is the sole systemic corticosteroid for treatment of BPD in 1 institution. An unspecified agent is the sole systemic corticosteroid in 1 institution. Nine institutions use various combinations of corticosteroids. Alternative agents used, primarily in patients tolerating oral feedings or medications, include methylprednisolone (n = 1), hydrocortisone (n = 2), oral prednisone (n = 2), and prednisolone (n = 4). Three institutions did not specify the alternative agent used. Two institutions administer systemic corticosteroids only when patients meet specific treatment criteria; of the patients meeting criteria, 100% then receive dexamethasone. The dose of dexamethasone used by respondents ranged from 0.1 mg/kg/day to 0.5 mg/kg/day. The most common regimen, reported by 11 respondents (28%), is 0.5 mg/kg/day IV divided every 12 hours for 2–5 days with or without a taper. The systemic corticosteroid agents, doses, and number of respondents are reported in Table 4.

Dexamethasone is used for the prevention of postextubation stridor in 79% of institutions (n

Table 2. Criteria for Use of Corticosteroids for the Prevention of Bronchopulmonary Dysplasia

Criteria	No. of Respondents
Duration of mechanical ventilation/inability to wean	9
Birthweight and estimated gestational age	3
No specific criteria identified	3
High oxygen requirements	3
AAP*/CPS† recommendations	2
Decision of attending physician	2

*AAP, American Academy of Pediatrics
†CPS, Canadian Paediatric Society

= 41) in < 1–100% of patients. One institution did not respond to this question.

Eighty-three percent (n = 33) of institutions using systemic corticosteroids report that parents give some type of informed consent prior to the administration of systemic corticosteroids. A verbal discussion with parents to educate them about the risks and benefits of systemic corticosteroids is conducted in 23 institutions. In addition to a verbal discussion, parents give written consent in 7 institutions. The type of informed consent obtained varies at two institutions depending on the situation or attending physician. One institution reported that informed consent was obtained, but could not determine if the consent was verbal or written.

Inhaled Corticosteroid Administration

Inhaled corticosteroids are administered only via nebulization by 30% (n = 12) and only via metered-dose inhaler (MDI) by 30% (n = 12) of respondents. Of the institutions that use MDIs, 18 (64%) use spacers. The following factors were listed as affecting method of delivery: ventilated vs. extubated patient (n = 7), prescriber/respiratory therapist preference (n = 5), maintenance medication at time of admission (n = 2), and ease of administration (n = 2).

The inhaled corticosteroid agents with starting and maximum doses are reported in Table 5. The table also indicates whether the doses used are low, medium, or high based upon categories determined for children with asthma.[14] Fluticasone, beclomethasone, and budesonide are the only inhaled agents used by the respondents. Three of the eight institutions that use beclomethasone reported a recent change to the chlorofluorocarbon-free product, QVAR® (IVAX Laboratories, Inc.).

Of the institutions using inhaled corticosteroids, 21 (53%) differ in treatment of intubated and nonintubated patients. Eight institutions use MDIs for ventilator-dependent patients and nebulizer therapy for extubated patients (including those requiring continuous positive airway pressure). Inhaled corticosteroids are only used in intubated patients at 7 institutions. Additional differences include: using a spacer for intubated patients and a spacer with a facemask for nonintubated patients (n = 2), and treating intubated patients more aggressively than nonintubated patients (n = 1). Three respondents did not specify their differences in practice. Of the 40 institutions that use inhaled corticosteroids, the dose is titrated up based on clinical response in 9 institutions (22%), and is not titrated in 30 institutions (75%). The remaining institution stated titration was based on guidelines from *Neofax: A Manual of Drugs Used in Neonatal Care*.

The dose of inhaled corticosteroids is tapered in 16 institutions (40%). The most common method of tapering inhaled corticosteroids (n = 9) is decreasing the frequency of doses per day followed by decreasing the dose. Other methods of tapering include decreasing the dose once weekly (n = 1) and per patient response/clinical status (n = 2). Four institutions did not

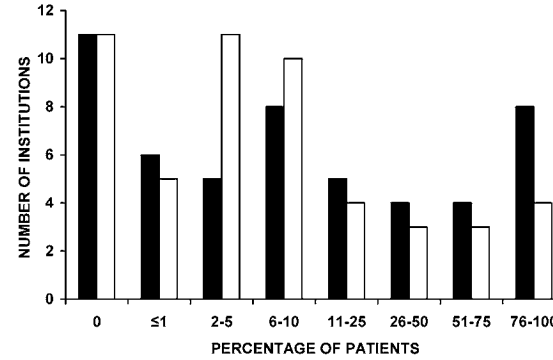

Figure 2. Percentage of Patients Receiving Inhaled (■, n = 51) or Systemic (□, n = 51) Corticosteroids for the Treatment of BPD.

Table 3. Criteria for Use of Corticosteroids for the Treatment of Bronchopulmonary Dysplasia

Criteria	No. of Respondents
Duration of mechanical ventilation/inability to wean	29
High oxygen requirements	20
Decision of attending physician	10
No specific criteria identified	8
Clinical diagnosis of BPD	6
Abnormal chest radiographic findings	4
Postnatal age > 2 weeks	4
Failed extubation	4
AAP*/CPS† recommendations	2
Very low birth weight	2

*AAP, American Academy of Pediatrics
†CPS, Canadian Paediatric Society

elaborate on the method of tapering inhaled corticosteroids. The duration of inhaled corticosteroids in the NICUs surveyed ranged from 1 week to several months. Eight institutions (20%) reported that inhaled corticosteroids are continued after hospital discharge.

Bronchodilator Administration

Forty-two institutions (84%) report that bronchodilator therapy is given in addition to corticosteroids for the treatment of BPD. Fifty institutions responded to this question (94% response rate). The percent of patients receiving bronchodilators ranged from < 1 to 100%. Sixteen institutions (38%) responded that bronchodilators are used in 100% of patients in addition to corticosteroids. An additional 17 institutions (40%) use bronchodilators in ≥ 50% of patients.

DISCUSSION

The prevention and treatment of BPD remains a challenging problem. In addition to mechanical ventilation and nutrition support, current pharmacologic modalities include vitamin A supplementation, diuretics, bronchodilators, and systemic or inhaled corticosteroids. In general, these agents have demonstrated only modest benefits and are associated with common problems limiting their usefulness.

In the case of systemic corticosteroids, significant short- and long-term adverse effects have now been reported. Long-term follow-up of the initial clinical trials demonstrated an increased proportion of cerebral palsy, developmental delay, and abnormal neurologic examination (primarily diplegia and hypotonia) in the dexamethasone-treated groups.[15] This information led to the joint statement issued by the AAP and Canadian Paediatric Society recommending against the routine use of dexamethasone to treat or prevent BPD in preterm infants.[12] Despite these published recommendations, this survey demonstrates that dexamethasone is still widely used in dosage regimens consistent with earlier published studies.[16-18] This continued use may be due to the frustration felt by clinicians in the prevention and management of this challenging disease state along with the lack of highly effective alternative prevention and treatment strategies.

There is limited published information in the United States available before the issuance of the AAP/Canadian Paediatric Society statement concerning the frequency of corticosteroid use for BPD. Therefore, it is difficult to determine if the results of this survey reflect a change in use after the release of the statement. One study determined postnatal dexamethasone use of 43% in 1990–1992 with an increase to 84% in 1993–1995.[19] These percentages are similar to the current survey for treatment of BPD with systemic corticosteroids (78%), however the results do not address the use of inhaled corticosteroids. A European survey including 331 NICUs in 14 countries in 1999–2000 reported 67% of centers used postnatal steroids for the prevention or treatment of BPD.[20] In addition, 48% of centers initiated treatment in non-intubated infants, 84% used dexamethasone, and 24% used inhaled corticosteroids. No distinction was made between use for prevention or treatment in the study, but rather early or late initiation of steroids. This percentage of postnatal systemic steroid use is similar to that reported

Table 4. Systemic Corticosteroids and Doses Used

Drug	Dose	Number of Respondents
Dexamethasone	0.25–0.5 mg/kg/dose q 6–24 hrs x 2–7 days ± taper	16
	no taper	7
	taper x 2–7 days	5
	taper x 7–14 days	3
	unspecified taper	1
	0.05–0.2 mg/kg/dose q 12 hrs x 2–7 days ± taper	18
	no taper	7
	taper x 2–7 days	3
	taper x 7–14 days	6
	taper x 3 weeks–1 month	1
	unspecified taper	1
	3 day burst, 7 days off	3
	"Neofax dose"	1
	Unknown dose	1
Hydrocortisone	1 mg/kg/dose q 8 hrs + taper	1
	"Stress dose"	1
	Not specified	1
Prednisolone	0.5–1 mg/kg/dose q 6–24 hrs	4
Prednisone	0.5–1 mg/kg/dose	1
	1 mg/kg/dose q 12 hrs x 1 day, 1 mg/kg/dose q 24 hrs x 5–7 days	1
	1 mg/kg/dose q 12 hrs x 1 day 1 mg/kg/dose q 24 hrs x 5-7 days	1
Methylprednisolone	1 mg/kg/dose q 12 hrs x 1 day 1 mg/kg/dose q 24 hrs x 5-7 days	1

by the respondents in our survey for treatment. A majority of institutions in the current survey indicated that systemic corticosteroids were used primarily in those mechanically ventilated patients with the greatest risk of developing BPD or most severe symptoms in an attempt to facilitate extubation.

According to our survey, alternative systemic corticosteroids are also used in practice although they have not been studied to the extent of dexamethasone. Their theoretical advantages include shorter half-lives and less potent anti-inflammatory activities. One institution reported using methylprednisolone in the current survey. The available evidence for this agent is one short-term study comparing tapering regimens of methylprednisolone and dexamethasone, both followed by a course of oral betamethasone in preterm infants at risk for BPD.[21] There was no reported difference in pulmonary outcomes with fewer adverse effects (i.e., glucose intolerance, reduced weight gain, and cystic periventricular leukomalacia) in the methylprednisolone group. Three institutions reported using hydrocortisone which is supported by a short-term placebo-controlled study reporting improved survival without oxygen dependence at 36 weeks postconceptional age and reduced duration of mechanical ventilation and supplemental oxygen as well as requirement for supplemental oxygen at discharge.[22] The dose of hydrocortisone used in the study (1 mg/kg/day) was smaller than the doses reported in the current survey. Lastly, oral prednisone (n = 2) and prednisolone (n = 4) were used by the surveyed institutions in doses similar to those used in older infants for other respiratory disorders such as asthma.[23] There is currently no evidence for the use of these oral agents for the prevention or treatment of BPD. However, their use may reflect the inclusion of NICU patients outside the neonatal period in this survey. Further studies are needed to define the short- and long-term risks and benefits of these less potent systemic corticosteroids.

Another potential method of minimizing the risks associated with corticosteroids is the inhaled route of administration. Although to date, the short-term risks reported with inhaled corticosteroids have been minimal, there have been no significant benefits reported either. A recent meta-analysis by the Neonatal Collaborative Review Group of the Cochrane Collaboration concluded that inhaled cortico-

Table 5. Inhaled Corticosteroids and Doses Used

Drug (Number of Institutions)	Starting Dose (Number of Respondents)	Maximum Dose (Number of Respondents)
Budesonide* (28)	125 µg bid (3)	250 µg bid (9)
	250 µg daily (4)	250 µg tid (1)
	250 µg bid (19)	500 µg daily (3)
	500 µg daily (1)	500 µg bid (11)
	Unknown (1)	Unknown (2)
		No maximum dose (2)
Fluticasone† (22)	44 µg daily (2)	44 µg bid (4)
	44 µg bid (6)	88 µg bid (4)
	88 µg bid (8)	110 µg bid (2)
	110 µg bid (2)	176 µg bid (1)
	220 µg bid (1)	220 µg bid (7)
	Unknown (3)	440 µg q6h (1)
		Unknown (2)
		No maximum dose (1)
Beclomethasone‡ (8)	42 µg bid (1)	42 µg bid (1)
	84 µg bid (1)	126 µg bid (1)
	210 µg bid (1)	210 µg bid (1)
	500 µg/kg/day ÷ bid§ (1)	500 µg/kg/day ÷ bid§ (1)
	500 µg/kg/day ÷ q 6–8 hrs§ (1)	500 µg/day (1)
	240-320 µg/day ÷ tid–qid§ (1)	480 µg/day§ (1)
	Neofax dose (1)	Neofax dose (1)
	Unknown (1)	No maximum dose (1)

**Budesonide potency (low dose = 500 µg/day, medium dose = 1,000 µg/day, high dose = 2,000 µg/day)*
†Fluticasone potency (low dose = 88-176 µg/day, medium dose = 176-440 µg/day, high dose > 440 µg/day)
‡Beclomethasone potency (low dose = 84-336 µg/day, medium dose = 336-672 µg/day, high dose >672 µg/day)
§Doses listed are for QVAR® (Beclomethasone HFA, IVAX Laboratories, Inc.) potency (low dose = 80–160 µg/day, medium dose = 160–320 µg/day, high dose >320 µg/day)

steroids should not be considered as part of the standard practice of managing ventilated preterm neonates.[9] The analysis evaluated five trials using inhaled corticosteroids within the first 15 days of life for prevention of BPD. No statistically significant benefit was demonstrated with the use of inhaled corticosteroids for either mortality or the development of BPD at 28 days (or 36 weeks corrected gestational age). There was a reduction seen in the use of systemic corticosteroids. The lack of more significant benefit may be secondary to inadequate dosing or administration practices. The sample sizes in the studies of inhaled corticosteroids have generally been small with a wide variability in dosing, drug selection and mode of administration. In our survey, the respondents reported using inhaled corticosteroids that have been studied for the prevention or treatment of BPD (nebulized budesonide, fluticasone MDI, and beclomethasone MDI). There was wide variability in the doses and administration techniques, however the majority of respondents currently use doses consistent with those in published clinical trials.[24-26] One institution reported dosing and titration of inhaled corticosteroids based on guidelines published in *Neofax: A Manual of Drugs Used in Neonatal Care*. However, the authors were unable to find guidelines in the current edition for inhaled corticosteroids.[27]

Inhaled bronchodilator therapy can be useful in alleviating the symptoms due to airway hyperresponsiveness and muscle hypertrophy in preterm infants with BPD. In addition, patients with a reactive airway component to their disease can benefit from inhaled β-agonist therapy. Because dysplasia and not bronchoconstriction leads to the changes in pulmonary dynamics of BPD patients, the vasodilatory effects of β-agonists can also cause paradoxical hypoxemia. There is no evidence currently available that supports the use of bronchodilators to prevent BPD.[28] Several

small studies have been conducted demonstrating a beneficial effect on pulmonary mechanics with the use of salbutamol (albuterol) in patients with established BPD, however no randomized, controlled trials exist evaluating the use of bronchodilators in the treatment of BPD. [29] The majority of institutions surveyed use bronchodilators in addition to corticosteroids despite the lack of evidence.

This survey had several strengths, including consistency of the surveyor, detail of the questions asked, uniqueness of content, good response rate, and timing of the survey in relation to the AAP/Canadian Paediatric Society recommendations. The questions were reviewed and edited by two NICU clinical pharmacists for content and comprehension prior to the survey.

The survey also had limitations. As is the case with most surveys, the respondents were asked to retrospectively recall their pattern of corticosteroid use. The survey was not representative of all NICUs in the United States because only academic institutions with neonatology fellowships were contacted. In addition, the survey was not designed to determine steroid use in various patient populations and therefore, the results should not be interpreted to reflect all potential patients in a NICU. The 13 respondents who answered the questions via email or fax did not have the opportunity for questions to be clarified if needed. However, these individuals were given contact information if assistance was needed.

The results of this survey indicate that despite the recommendations published by the AAP and Canadian Paediatric Society in February 2002, systemic and inhaled corticosteroids are commonly used in the prevention or treatment of BPD.[12] There was a wide variability in drug, dose, dosage titration or tapering scheme, method of administration, and duration of therapy reported. Criteria for use most commonly cited were the need for prolonged mechanical ventilation and high oxygen requirements when other therapeutic measures failed. Further research is needed to define the relative risks and benefits of corticosteroids in order to determine guidelines for their appropriate use including indication, drug, dose, route, and method of administration.

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