Neonatal Encephalopathy and Cerebral Palsy Revisited: The Current State of Knowledge and the Impact of American College of Obstetricians and Gynecologists Task Force Report

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OBJECTIVES:

To re-assess obstetrician-gynecologists' knowledge of neonatal encephalopathy and cerebral palsy after publication of the ACOG/AAP Task Force report.

STUDY DESIGN:

A questionnaire investigating knowledge of neonatal encephalopathy and cerebral palsy was mailed to 1060 members of ACOG, 337 of whom participated in a similar study in 2001.

RESULTS:

There was a strong association between familiarity with ACOG documentation and knowledge of neonatal encephalopathy (NE) and cerebral palsy (CP) (p < 0.001). As with obstetricians surveyed in 2001, knowledge gaps remain. Performance was better on practices questions than knowledge questions. About one-third (34.2%) of the physicians said their knowledge of neonatal encephalopathy was poor or deficient; the majority (76%) rated their residency training as inadequate to marginal.

CONCLUSION:

The results indicate better knowledge of neonatal encephalopathy and cerebral palsy among physicians more familiar with the Task Force report. There is a clear need for emphasis on these topics during training and continuing medical education.

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INTRODUCTION

The causes of neonatal encephalopathy (NE) and cerebral palsy (CP) historically have been poorly understood within the medical community. Not surprisingly, therefore, in a recent research publication,¹ the American College of Obstetricians and Gynecologists (ACOG) reported that issues of neonatal encephalopathy pathogenesis and pathophysiology were not well understood by practicing obstetricians throughout the United States. The survey used to obtain those results was the first part of a larger study undertaken, in part, to determine the effectiveness of an ACOG/American Academy of Pediatrics' (AAP) Task Force report distributed to ACOG members in January 2003: Neonatal Encephalopathy and Cerebral Palsy; Defining the pathogenesis and pathophysiology.²

The original NE survey questionnaire was distributed in May 2001 to 1013 ACOG Fellows. (Results from the first survey can be found in Hankins et al.¹) ACOG subsequently published and distributed its report on NE and CP in January 2003. In the current follow-up survey study, a questionnaire similar to the original was distributed 2.5 years after the first survey was conducted and 11 months after the Task Force report was distributed, in December 2003, to 1060 ACOG Fellows and Junior Fellows in Practice, a subset of whom had participated in the original survey study. The purpose of the current study was three-fold: (1) to determine whether level of familiarity with the ACOG/AAP report was associated with increased knowledge of issues related to NE and CP; (2) to assess physicians' current knowledge and practices regarding NE and CP, and whether this was affected by previous exposure to the questionnaire; and (3) to compare physician knowledge levels and practice patterns in 2001 (pre-ACOG/AAP Task Force report) with knowledge and practices at the end of 2003 (11 months after the distribution of ACOG/AAP's report).

MATERIALS AND METHODS

Questionnaires were mailed in December 2003 to 1060 ACOG Fellows and Junior Fellows in Practice. A total of 437 of these subjects are members of the Collaborative Ambulatory Research Network (CARN), a group of practicing obstetrician—gynecologists who have volunteered to participate in survey studies on a regular basis. CARN was established to facilitate assessment of clinical practice patterns and aid the development of educational materials.

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Journal of Perinatology 2005; 25: 519–525 © 2005 Nature Publishing Group All rights reserved. 0743-8346/05 \$30 Of the CARN subjects, 204 had received and returned a nearly identical questionnaire 2.5 years earlier. The remaining 233 CARN subjects had not received this questionnaire 2.5 years prior. There were an additional 623 subjects who consisted of ACOG Fellows and Junior Fellows who practice obstetrics and/or gynecology and typically have not received a survey from ACOG during the previous two years (non-CARN). Of these non-CARN subjects, 133 had received and returned a nearly identical questionnaire 2.5 years earlier. The remaining 490 non-CARN subjects consisted of a computer-generated random sample of ACOG Fellows and Junior Fellows in Practice. All nonrespondents received a second mailing of the questionnaire 5 weeks after the first mailing. A final reminder mailing was sent approximately 6 weeks later. Questionnaires returned by April 8, 2004 were included in the survey. This protocol has typically resulted in a total sample size of >450, which is sufficient to detect differences between groups of <0.5 standard deviation with power of 80% and significance at the 0.05 level.³

The current questionnaire was nearly identical to the questionnaire distributed 2.5 years earlier except for the addition of two questions pertaining to physicians' familiarity with the 2003 ACOG/AAP Task Force report. The survey consisted primarily of questions in a multiple-choice format that pertained to physicians' practices and knowledge regarding NE. Items included 14 standalone knowledge questions and three clinical scenarios containing an additional ten subquestions. Six of the knowledge questions directly assessed knowledge of cerebral palsy. All but two of these 14 knowledge questions contained the answer choice "don't know." The questionnaire also contained items concerning demographic details of the physicians and their patient populations, physicians' ratings of their educational background, and how physicians stay current in their knowledge of NE.

The data were analyzed using a personal computer-based software package (SPSS[®] 12.0, SPSS Inc., Chicago, IL). Descriptive statistics were computed for the measures used in the analyses, which are reported as mean \pm SEM. The student's *t* test and analysis of variance were used to compare group means of continuous variables. Group differences on ordinal measures were assessed using the Mann-Whitney U and Kruskal-Wallis tests. Differences on categorical measures were assessed using the χ^2 test. Correlations including an ordinal measure used the Spearman's rho coefficient. All analyses were tested for significance using an alpha of 0.05.

RESULTS

A total of 1060 questionnaires were sent, and 691 questionnaires were returned, resulting in a response rate of 65.2%. Subjects were divided into four groups: CARN who had received and returned a similar survey 2.5 years earlier ('CARN old', 176 returns of 204

Table 1 Obstetrician Demographics		
	Total (N = 563)	
Gender % M:F	59.9:40.1	
CARN % Yes:No	53.6:46.4	
Prior exposure % Yes:No	44.0:56.0	
Mean age*	46.91 ± 0.39	
Males	49.48 ± 0.51	
Females	43.07 ± 0.50	
Mean years since residency*	15.33 ± 0.39	
Males	18.05 ± 0.51	
Females	11.30 ± 0.49	
Mean deliveries 2003	128.72 ± 3.41	
Primary medical specialty		
General Ob/Gyn	504 (89.5%)	
Maternal fetal medicine	51 (9.1%)	
Other	8 (1.4%)	
* $p < 0.001$ males differed from females.		

sent = 86.3% response rate); CARN who had not received the earlier survey ('CARN new', 172/233 = 73.8%); non-CARN old (96/133 = 72.2%); and non-CARN new (247/490 = 50.4%). Of these, 11 respondent questionnaires were judged invalid (physician retired, survey returned blank, etc) and were not included in further analyses. Age and sex ratio of respondents closely matched the characteristics of the larger population to whom the survey was sent. There were responding physicians from every state of the United States, as well as the District of Columbia, Puerto Rico, Canada, and overseas military installations. Since we were concerned with the knowledge and practices of physicians who might encounter or manage a pregnancy affected by NE or CP, the remaining analyses are limited to the 82.8% (563) of respondents who indicated that they practice obstetrics. See Table 1 for basic demographics.

Document Familiarity

Physicians were asked how familiar they were with the ACOG/AAP Task Force report distributed in January 2003. "I have read it thoroughly" was the response given by 11.6% of responding physicians; almost half (46.6%) said they had "skimmed it," 29.9% said they had "heard of it but not read it," and 11.8% said they had "never heard of it." Previous exposure to the survey was not associated with document familiarity.

Knowledge

Physicians answered a mean of 5.89 ± 0.11 out of 14 knowledge questions correctly (median = 6, mode = 6), or $42.10 \pm 0.77\%$ correct. Respondents in 2003 performed significantly better than did respondents in 2001 on seven of the 14 questions. Overall mean percent correct was significantly higher in 2003 than in 2001 but this difference was minimal (2001: mean of 5.01 ± 0.10 correct or $35.82\pm0.74\%$; p<0.001, median = 5, mode = 4). Having taken the survey previously and CARN membership were not significant factors on overall test score or on response accuracy on more than one knowledge question. See Table 2 for a list of knowledge questions, the percent of all valid respondents from 2003 answering correctly, the percent of all valid respondents from 2003 answering correctly, and the impact of document familiarity on accurate responding. The extent of familiarity with the Task Force report was highly associated with performance on several of the knowledge questions (see Table 2, last 4 columns) and on overall test score (p<0.001).

Scenarios

Physicians were presented with three clinical scenarios and asked what they would do in these situations (see Table 3). Responses were assessed in terms of answers being in correspondence with best practices (Scenario I) or being correct (scenarios II and III). The majority of physicians agreed or strongly agreed with statements corresponding with recommended practices (Table 3, Scenario I). Physicians answered a mean of 4.57 ± 0.055 out of seven questions correctly, or $65.34 \pm 0.78\%$ (Scenarios II and III). Correct response rates were similar to those from 2001, although respondents in 2003 were more likely to select the correct response on Scenario III than respondents in 2001 (2001: 15.6%, 2003: 24.1%; p = 0.003). There were minimal differences between physicians based on previous exposure to the survey (mean % correct: "old" = $66.94 \pm 1.23\%$, "new" = $64.05 \pm 1.03\%$). Increased familiarity with the Task Force report was associated with increased mean scenario score (mean % correct: thoroughly $read = 72.12 \pm 2.29\%$, skimmed = 64.05\%, not read = $64.42 \pm 1.43\%$, not heard = 60.22 ± 2.31 , p = 0.002); however, level of familiarity was not associated with better performance on several of the individual questions.

Education

Physicians were asked to rate their knowledge of NE and the quality of training they received, the frequency with which they read professional materials regarding NE, and the types of professional materials they used to stay informed about NE (see Table 4). How highly physicians rated their knowledge of NE and the frequency with which they read relevant professional materials correlated positively with document familiarity as well as performance on the knowledge and scenario tests (all p's <0.001). Previous exposure to the survey was not associated with self-ratings of knowledge or the frequency of reading professional materials. Physicians surveyed in 2003 rated their knowledge of NE more highly than did physicians surveyed in 2001 (% rating their knowledge as average or good: 2001 = 48.7, 2003 = 64.9,

p < 0.001), and reported reading relevant professional materials more frequently (p = 0.002).

Specialists

A total of 51 physicians indicated that their primary medical specialty was maternal fetal medicine (MFM). Compared with the 504 physicians indicating general obstetrics and gynecology as their primary medical specialty, MFMs performed significantly better on 8 of the 14 knowledge questions, with a mean percent correct of 54.06 ± 2.91 (vs $40.94 \pm 0.78\%$ for nonspecialists); they performed better on one of the seven practices questions. MFMs rated their knowledge of NE more highly (p < 0.001), read professional materials pertaining to NE more frequently (p < 0.02), and were more likely to have read the Task Force report (p < 0.001); they were not more likely to have changed their practices since the report was distributed (p = 0.904).

SIGNIFICANCE

The incidence of NE is reported as approximately 3.8 per 1000 term births.⁴ Up to 70% of cases of NE can be attributed to antenatal risk factors.² Causes of NE are frequently attributed to preventable intrapartum events, which has resulted in unwarranted obstetrical litigation due to misattribution of blame for this complex of disorders: the number of cases of NE primarily attributable to intrapartum hypoxia is approximately 1.6 per 10,000.² Much is still not known regarding the specific range of causes of NE.⁵ In order to address these problems, ACOG convened a Task Force to review the scientific data available.

The current survey study was conducted over 11 months after ACOG/AAP issued its defining documentation on NE and CP,² and 2.5 years after we conducted a nearly identical survey study in 2001.¹ The goal was to determine whether level of familiarity with the Task Force report was associated with increased knowledge of issues related to NE and CP, to assess physicians' current knowledge and practices regarding NE and CP, and to compare physician knowledge levels and practice patterns before (2001 study) and after (current study) the distribution of the report.

Increased familiarity with the Task Force report was highly associated with better performance on the knowledge portion of the questionnaire. However, while respondents in the current study performed better than did respondents in 2001 on seven of the 14 knowledge questions, there continue to be substantial gaps in obstetrician—gynecologists' knowledge of NE and CP pathogenesis, as measured by this survey. Of encouragement is the fact that physicians performed far better on the practices portion of the survey than they did on the test of didactic knowledge, as was also found in the 2001 study. Despite poor test scores, almost two-thirds (65.0%) of physicians in the current study rated their knowledge of NE as average to good, while just under half (48.7%) did so in 2001. How highly physicians rated their knowledge of NE correlated **Table 2** Percent of Physicians Selecting the Correct Response (in quotes) on 14 Knowledge Questions on a Questionnaire Distributed in 2001 and2003, and on the 2003 Questionnaire Broken into Groups According to how Familiar they were with the Task Force Report

	Prior to report	After report	After publication: how familiar are you with this report?				
	publication (2001)*	cation publication 01)* (2003)	I've never heard of it	I've heard of it but not read it	I've skimmed it	I have read it thoroughly	
Cases of intrapartum asphyxia sufficient to result in cerebral palsy injury to organ systems other than the brain are almost invariably seen. To your knowledge, these injuries most likely result from "redistribution of cardiac output"	34.3	34.9	21.0	32.1	36.8	47.5 ^{&}	
Using electronic fetal heart rate monitoring, it is possible to prospectively recognize the precise point in time at which cerebral injury becomes irreversible following interruption of placental blood flow "disagree"	97.7	96.4	95.4	97.6	96.1	98.4	
For cerebral palsy even to be considered to be of intrapartum origin, it must be "spastic quadriplegia or dyskinetic type"	9.5	36.1±	3.2	18.1	44.2	85.5#	
Required criteria to define an acute intrapartum hypoxic event sufficient to result in cerebral palsy do not include "a sentinel (signal) hypoxic event occurring immediately before or during labor"	42.5	53.0 [±]	44.3	41.4	59.7	66.1#	
In order to suggest that asphysia occurring intrapartum was causal of organ system injury, it should manifest within "72 hours" ^{\dagger}	7.7	14.7 [±]	6.3	10.1	15.5	32.8#	
In your experience, the most common outcomes for the fetus exposed to an acute catastrophic hypoxic event, but who is live born, is "normal neurological outcome"	66.4	71.2	64.1	61.0	74.4	91.8#	
In the absence of significant congenital anomalies, what percent of cerebral palsy is due to intrapartum asphyxial insults? "6" or "10%" ^{\dagger}	24.4	28.4	20.3	20.6	31.0	45.2 [#]	
The most characteristic brain lesion after the death of a co-twin in a monochorionic twin pregnancy is multicystic encephalomalacia. This is most likely caused by "capacitance effect of the dead fetus and hypotension in the surviving twin"	42.3	55.7 [±]	46.0	48.8	56.2	80.6#	
In the above case, injury to the surviving twin is most likely to occur "almost immediately" †	15.4	24.3 [±]	13.8	15.7	26.1	46.7#	
As regards neonatal encephalopathy, the most frequent observation made from epidemiological studies is "most had only antepartum risk factors" †	6.0	11.9 [±]	3.2	6.3	12.4	33.9 [#]	
To the best of your knowledge, the majority of infants who develop cerebral palsy are "birthweight $> 2500 \text{ g}^{3,\dagger}$	19.7	21.6	10.9	16.3	23.1	39.3 [#]	
Neonatal encephalopathy is a diagnosis restricted to ''term and near term'' †	9.5	19.5 [±]	7.8	11.4	22.3	41.7#	
Randomized controlled clinical trials show that antepartum fetal testing decreases the rate of cerebral palsy "disagree"	92.6	92.7	87.3	91.9	94.0	95.1	
In evaluation of neonatal encephalopathy, do you believe the EEG primarily "documents the presence of and severity of the injury"	40.8	46.2	51.6	42.1	47.0	50.0	

*Results of this survey previously reported in Hankins et al.¹

 $p^* < 0.001$, $p^* = 0.014$ response accuracy was associated significantly with level of familiarity with the ACOG document.

p < 0.005 respondents on the 2003 questionnaire performed significantly better than did respondents on the 2001 questionnaire.

[†]Questions for which the most common response was an incorrect response.

Table 3 Responses to Three S	Scenarios					
Scenario I. You have just delivered a	39-week fetus who presen	nted and had a precipitous delivery.	The new	born on quick examination is	noted to be mecon	nium stained, to
have long nails, peeling skin, and i	is stained green with mec	conium. Apgars 1, 1, 3 at 1, 5, an	nd 10 min	nutes. This is a case where I	would send:	
Values are % of physicians	Strongly agree	Agree		Disagree	Strongly	
responding					disagree	
The placenta for histopathologic	74.5	22.4		1.6	1.5	
examination						
An umbilical cord arterial blood	80.1	14.6		3.8	1.5	
sample						
An umbilical cord venous blood	55.6	17.3		22.8	4.2	
gas						
Scenario II(a). A woman presents at	31 weeks EGA having just	been in a motor vehicle accident.	She has s	ustained minor abrasions and	contusions but ha	s no evidence of
major injury. There is no evidence	for rupture of fetal mem	branes but she is actively contract	ting. Your	care would include:		
		Yes (%)		No (%)		
Tetanus immunization		53.0		47.0		
Rhogam		91.7		8.3		
Fetal monitoring for 2 hours and	42.8			57.2		
then discharge						
Kleinhauer-Betke smear		84.0		16.0		
Tests for rupture of membranes		52.5		47.5		
Scenario II(b). The above woman i	s concerned that her fetu	s has sustained brain injury. You	would co	ounsel that:		
Response choice:	This is very possible	A history of trauma is often		Minor maternal trauma	Don't know	
	and often reported	present in mothers whose		very rarely results in a		
		infants subsequently develop		significant fetal injury		
		cerebral palsy				
% Physicians:	0.0	1.6		95.5	2.9	
Scenario III. A woman with an unco	omplicated antepartum cou	urse presents to labor and delivery	with a not	rmal reactive tracing. Six hou	rs later she develoj	ps persistent late
decelerations that do not resolve ove	r 45 minutes with medical	l interventions. As she is remote fro	om deliver	ry, you advise a cesarean secti	on. She asks you t	he false positive
rate of such a tracing to predict su	bsequent cerebral palsy a	nd you advise that it is:				
Response choice:	10%	50%	75%	90%	99%	Don't know
% Physicians:	7.4	16.5	6.3	16.9	24.1	28.9
Bold values are "preferred practices"	(Scenario I) or correct resp	ponses (Scenarios II and III).				

positively with performance on the knowledge questions, as well as with extent of familiarity with the Task Force report. Having had prior exposure to the survey (2.5 years earlier) did not appear to be a factor on any measure, including knowledge score or document familiarity.

It should be noted that, while substantial knowledge gaps are still apparent, physicians were told that "it is not necessary to study any extra materials prior to completing the questionnaire." Further, the survey did not measure the full range of issues surrounding the knowledge and management of NE and CP, nor do we know the full range of resources available to the physician, including the extent to which they may consult an MFM specialist. MFMs performed better than nonsubspecialist ostetrician gynecologists on the knowledge portion of the questionnaire and reported reading relevant professional materials with greater frequency. It is possible that physicians who were more interested in or knowledgeable about the topic of the survey were more likely to respond. In an attempt to control for this, a subset of our subject pool comprises CARN members, who respond to several questionnaires a year, covering a wide variety of topics. It is unlikely that NE is a topic of greater interest to this control group than to the group of randomly selected ACOG members. CARN members did not differ significantly from non-CARN subjects on most nondemographic responses. Further, the age and sex ratio of respondents as a whole closely matched the characteristics of the larger population to whom the survey was sent, all of which indicate that response bias was minimized.

The following observations suggest the possibility that a number of physicians actually may be specifically misinformed about various aspects of NE, rather than simply unsure. On six of the 14 knowledge questions, an incorrect answer was the most common

	%
Rate your knowledge of neonatal encephalo	pathy [#]
Excellent or good	14.2
Average	51.6
Poor or deficient	34.2
Rate the training you received in NE durin	ng medical school* ^{,#}
Comprehensive or adequate	6.4
Marginal or inadequate	93.6
Rate the training you received in NE durin	ng your residency*,#
Comprehensive or adequate	24
Marginal or inadequate	76
Rate the training you received in NE durin	ng postgraduate CME* ^{,#}
Comprehensive or adequate	34.4
Marginal or inadequate	65.6
Frequency of reading professional material	s pertaining to NE*
More than once per month	7.4
Every month to 3 months	20.5
About $2-3$ times per year	33.3
Once a year or less	33.7
Not at all	5.1
How do you stay informed about advances	in NE? Source used most of
ACOG committee opinions	36.3
Journals	26.9
Educational bulletins	16
College postgraduate courses	10.2
Other CME activities	6.5
Practice patterns changed since Task Force	report issued in 2003
Yes	13.6

response, even more so than the choice of "Don't Know." In the 2001 study,¹ rates of incorrect responding were very similar to those found in this study, with the same incorrect answers being selected. For example, only 11.9% were aware that, in epidemiologic studies, the most frequent observation concerning neonatal encephalopathy has been that most cases have "only antepartum risk factors";⁶ 73.3% of physicians selected the response option "no recognized risk factors." Only 1 in 5 (19.5%) were aware that the diagnosis of neonatal encephalopathy was restricted to "term and near term (\geq 34 weeks)" infants;⁴ 33.8% of physicians selected the response option "first 3 days of life." And only 21.6% recognized that the majority of infants who develop CP have a birth weight greater that 2500 g;⁷ 29.8% thought it was "birthweight <1500 g." Physicians

who had thoroughly read the Task Force report did substantially better, such that an incorrect answer was the most common response on two questions.

This study clearly indicates a strong association between familiarity with ACOG documentation and knowledge levels of NE. Further, the data indicate that physicians rely heavily on ACOG publications to stay informed about topics related to pregnancy. Despite this, only 11.6% of doctors said they had thoroughly read the report issued by ACOG almost a year earlier, and 13.6% of physicians said their practice patterns regarding NE had changed since ACOG issued its report. These numbers were somewhat higher in a 2003 survey study on cystic fibrosis^{8,9} and corresponding ACOG documentation distributed in 2001,¹⁰ in which 19.2% of physicians said they had thoroughly read the ACOG cystic fibrosis documentation, and 72.7% said their practice patterns regarding CF carrier screening had changed since the documentation was issued.

One reason for this difference may be the more recent distribution of the NE and CP document; physicians may not have had sufficient time to incorporate the information obtained from the NE report into their knowledge base and practices, and changes may not be as clearly delineated for this less well-defined medical issue. Given the complexity of this type of disorder, it may be that additional medical training, postgraduate education, and other resources are necessary in addition to the NE and CP document to ensure that required information is obtained by the majority of practicing obstetricians. The vast majority of physicians rated the training they received on NE as inadequate to marginal during medical school (93.6%), residency (76%), and CME (65.6%), and two-thirds (67.0%) of physicians read professional materials regarding NE two to three times per year or less.

Given the vast array of topics in which obstetrician gynecologists must stay current, our findings suggest that additional professional resources are needed, specifically addressing this complex disorder. This study highlights the need for greater emphasis on NE and CP during training and post-training CME.

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