Evaluation of Noise-Induced Hearing Loss in Young People
Using a Web-Based Survey Technique

Jeannie H. Chung, MD*; Catherine M. Des Roches, PhD‡; John Meunier, MS§; and Roland D. Eavey, MD*

ABSTRACT. Objective. Many adolescents and young adults consciously expose themselves to loud music for entertainment. We hypothesized that these individuals might not be aware that exposure to loud music could result in hearing loss. Furthermore, we wished to assess the feasibility of a web-based survey to collect health information from this group.

Methods. A 28-question survey was designed to target adolescents and young adults. The survey contained questions about views toward general health issues, including hearing loss, and was presented to random visitors at the MTV web site.

Results. In 3 days, 9693 web surveys were completed. Hearing loss was defined on a Likert scale as “a very big problem” by 8% of respondents compared with other health issues: sexually transmitted diseases, 50%; alcohol/drug use, 47%; depression, 44%; smoking, 45%; nutrition and weight issues, 31%; and acne, 18%. Notably, most respondents had experienced tinnitus or hearing impairment attending concerts (61%) and clubs (43%). Only 14% of respondents had used earplugs; however, many could be motivated to try ear protection if they were aware of the potential for permanent hearing loss (66%) or were advised by a medical professional (59%).

Conclusions. A majority of young adults have experienced tinnitus and hearing impairment after exposure to loud music. Fortunately, many of these individuals could be motivated to wear ear protection. This novel web-based survey technique rapidly generated a large database and is a feasible method to obtain health data from this group. Pediatrics 2005;115:861–867; noise-induced hearing loss.

ABBREVIATION. NIHL, noise-induced hearing loss.

Noise-induced hearing loss (NIHL) is a significant social and public health problem. Much of the efforts to reduce NIHL have concentrated on reducing risks from occupational noise exposure in adults. However, several studies have reported an increasing trend of NIHL in children and adolescents. In the first large, national, population-based study, Niskar et al1 estimated that 12.5% of children aged 6 to 19 years have noise-induced threshold shifts. In 1985, Lees et al2 reported that 40% of students aged 16 to 25 years had audiometric evidence of NIHL, and in 1996, Blair et al3 reported that 1% of all school-aged children have some degree of NIHL. Studies from the United Kingdom,4,5 France,6 Sweden,7 and China8 have also reported evidence of NIHL in children and young adults.

NIHL in children and young adults has been linked to recreational noise and leisure activities. In 1985, Axelsson and Jerson9 evaluated noisy toys as possible sources of NIHL in children. They found that squeaky toys could produce sound levels of 78 to 108 dBA at a distance of only 10 cm, whereas firecrackers produced sound levels of 125 to 156 dBA at a distance of 3 m. Other leisure activities involving woodwork, recreational vehicles, and power tools may produce sounds >85 dBA10. Classrooms also harbor potentially dangerous levels of noise. One study measured sound levels in band and industrial technology classrooms at 80 to 110 dB.11 Furthermore, adolescents who lived on farms had greater prevalence of hearing loss compared with their peers from their exposure to sound levels >95 dBA.12

In today’s society, adolescents and young adults consciously expose themselves to loud music, often for hours at a time. Loud music from concerts, clubs, and personal audio systems pose a potentially dangerous source of recreational noise. Sound levels at rock concerts have been recorded at 120 dB to 140 dB, and the sound levels in bars can reach >95 dB on a weekend night.4,13 Lee et al14 found that transient threshold shifts >10 dB could be seen after listening to headphones for 3 hours at normally used output levels. Despite evidence of hazardous noise exposure among adolescents and young adults, no safety standards or guidelines exist for nonoccupational noise exposure.

Although short periods of exposure to amplified sound may be experienced without permanent hearing loss, the damage from chronic exposure to these sound levels is cumulative so that a slight hearing loss in childhood can eventually become a substantial one in adulthood. The prevention of such hearing loss begins with education with hearing conservation programs ideally targeting children and young adults.

In 2002, Folmer et al15 performed a comprehensive review of hearing conservation education programs for children. They reviewed 29 organizations with...
curricula in place to produce and disseminate hearing conservation materials suitable for children. Some of the organizations and programs reviewed included Crank It Down! (National Hearing Conservation Association), Stop That Noise! (League for the Hard of Hearing), and Wise Ears (National Institute on Deafness and Other Communication Disorders). Wise Ears is one of the most comprehensive curricula available for children and includes lesson plans for teachers, videos, and interactive programs on their web site. In their review, Folmer et al. found that the various hearing conservation programs had ef-

2. Now, thinking about how these same issues or concerns may affect you personally, how concerned are you about each one?

3. The following questions focus on hearing loss. First of all, have you heard, read, or seen anything lately related to the issue of hearing loss?

4. Have you ever experienced any type of hearing-related problems, such as ear pain, ringing in your ears, or difficulty in hearing?

5. Specifically what type of hearing-related problem have you experienced? (Check all that apply)

6. To your knowledge, what caused this problem or problems?

7. The following is a list of settings where someone might experience some type of hearing-related problem. Have you experienced some type of hearing-related problem in these settings?

8. How frequently have you experienced hearing loss or hearing-related problems in this setting?

9. When I see someone wearing earplugs at a concert, club, or rave, I think they look:__________________________

10. Have you ever worn earplugs at a concert, club, or some other place where loud music was being played?

11. Why did you start wearing earplugs? (Check all that apply)

12. Regardless of whether or not you have ever worn earplugs, has it ever been suggested by any group or person that it would be a good idea to do so?

13. What person or group made that suggestion?

14. Why didn’t you follow the suggestion to use earplugs?
effective program materials and resources but that dissemination of these materials to the schools was inadequate. Although concerned professionals can implement audiometric screenings and promote education about NIHL in schools, influence for behavior modifications may be achieved perhaps more effectively if we could understand the perceptions about hearing and NIHL. What do adolescents and young adults know about hearing loss? How do young patients feel about the use of hearing protection? Which interventions might influence preventive behavior? These are some of the questions that we wished to address. The objectives of this report were to evaluate awareness of NIHL among young adults, to examine perceptions of hearing protection, and to identify factors that might influence behavior in a positive way. In addition, we wished to determine the utility of a web-based survey technique to gather health information from this group.

16. How likely are you to use earplugs the next time you attend a concert, rave, or club?
   - Very likely
   - Somewhat likely
   - Not too likely
   - Not likely at all

17. If you were planning to wear ear plugs the next time you attend a concert, rave, or club, where would you get them? (check all that apply)
   - A drugstore
   - A health clinic
   - Your doctor’s office
   - A hearing aid store
   - An audiologist’s office
   - Order them on the internet
   - At the concert, rave, or club itself
   - Would not wear them
   - Other
   - Don’t know

18. To what extent would knowing each of the following increase the likelihood that you would wear earplugs on that occasion?

<table>
<thead>
<tr>
<th></th>
<th>Very likely</th>
<th>Somewhat likely</th>
<th>Not too likely</th>
<th>Not likely at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>A doctor or nurse telling you that you should wear earplugs to protect your hearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reading some sort of factoid that says you don’t lose any enjoyment, just muffle the bad stuff</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Learning about earplugs on T.V.</td>
<td></td>
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<tr>
<td>Finding out that even limited exposure to very loud music can permanently damage your hearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finding out that musicians and performers wear earplugs while performing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finding out that your friends wear earplugs when they listen to loud music</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19. In the past 6 months, how many times have you attended:
   - A concert ______
   - A rave ______
   - A club with loud music ______

20. In general, how often do you visit MTV.com?
   - 3 or more times a week
   - 1 or 2 times a week
   - A few times a month, but usually not every day
   - Once a month or less
   - Never

21. In a typical week, how much time do you spend watching MTV?
   - 1-3 hours
   - 4-6 hours
   - 7-9 hours
   - 10-12 hours
   - More than 12 hours

22. Do you visit health-related websites?
   - Yes □ No □ (If no, go to question 22)

23. How often do you visit health-related websites?
   - <Once a month
   - Once a month
   - Twice a month
   - Once a week
   - >Once a week

24. Which websites have you visited?

25. In a typical week, how much time do you spend on the internet?
   - 1-3 hours
   - 4-6 hours
   - 7-9 hours
   - 10-12 hours
   - More than 12 hours

26. What is the highest level of education you have completed?
   - Less than high school
   - High school graduate
   - Some college or technical school
   - College graduate
   - Graduate degree

27. Which best describes your employment status?
   - Student
   - Employed full time
   - Employed part time
   - Not employed, looking for work
   - Not employed, not looking
   - Homemaker
   - Other
   - Prefer not to answer

28. To the best of your knowledge, what was your total family income in 2001?
   - Much above average
   - Somewhat above average
   - Average
   - Somewhat below average
   - Much below average
   - Don’t know
   - Prefer not to answer
METHODS

A 28-question survey was created by researchers at the Massachusetts Eye and Ear Infirmary, the Harvard School of Public Health, and Cogent Research, Inc (Fig 1). The survey was designed to target adolescents and young adults and contained initial questions about views toward several general health issues, including hearing loss. The survey further directed 16 questions at specific hearing issues such as the use of hearing protection, factors that might increase use of hearing preservation, and personal exposure to loud recreational music. The survey also collected demographic data such as age and occupational and socioeconomic status (Table 1). The survey format included multiple choice, multichotomous, and open-ended questions designed to be completed easily. The survey contained 4 questions with multiple subquestions that required the respondents to prioritize the significance of answers about a health issue on a Likert scale such as “a very big problem,” “somewhat of a problem,” “not too much of a problem,” or “not a problem at all.”

The survey was administered anonymously as a random pop-up survey to every 30th visitor to the MTV.com web site for 3 consecutive days. The MTV web site was chosen because of the large congruence of visitors (>400,000 visits per day) with the project requirements. MTV is accepted as a leading authority in Internet use/wk and recognized audiences (Fig 1). The survey was administered anonymously as a random pop-up survey to every 30th visitor to the MTV.com web site for 3 consecutive days. The MTV web site was chosen because of the large congruence of visitors (>400,000 visits per day) with the project requirements. MTV is accepted as a leading authority in music and is specifically geared toward 15- to 34-year-olds. In 3 days, 49,800 visitors received the pop-up survey and 9693 surveys were completed (19% cooperation rate). Of the surveys that were not completed (81%), the number of participants who withdrew from the survey versus the number of incomplete surveys was not recorded. Respondents between the ages of 13 and 65 years were included in the study. Those who were between the ages of 35 and 65 years constituted <0.2% of the study respondents. The resulting study population consisted of 3310 (35%) male and 6148 (65%) female respondents, with an average age of 19.2 years. The responses to each question are reported in percentages. Informed consent was not obtained given the inherent, voluntary nature of completing an anonymous web-based survey.

RESULTS

Hearing loss was defined as “a very big problem” by 8% of respondents compared with the following: sexually transmitted diseases, 50%; alcohol/drug use, 47%; depression, 44%; smoking, 45%; nutrition and weight issues, 31%; and acne, 18%. Female respondents were statistically more likely to consider drug and alcohol use, sexual issues, nutrition and weight-loss issues, and depression as a “very big problem” compared with male respondents (Table 2). A respondent was more likely to consider hearing loss a “very big problem” or “somewhat of a big” problem when they had previous education on hearing loss (41% vs 29%; P < .05).

The majority of respondents had attended a concert, club, or party with loud music in the last 6 months (Table 3), and 61% and 43% reported experiencing tinnitus or temporary hearing impairment, respectively, while attending loud music venues. Only 14% of respondents reported wearing ear protection in places where loud music was being played, but 39% reported that suggestions had been made to wear earplugs; suggestion to wear earplugs was made to 29% of all respondents <15 years, to 38% of respondents 15 to 18 years, to 35% of respondents 19 to 21 years, and to 44% of respondents >21 years. Parents (55%) were the most likely group to have recommended the use of earplugs. Physicians had recommended the use of hearing protection to 22% of respondents. Before this survey, only 16% of respondents had heard, read, or seen anything publicly related to the issue of hearing loss, with 9% receiving education at school.

Only 20% of respondents reported the personal intention to use earplugs at a future concert or club with loud music. However, this number increased (Table 4) when the respondents were made aware of the potential for permanent hearing loss (66%) or were encouraged by a medical professional (59%). The respondents also would be inclined to wear hearing protection if they knew that earplugs protect against noise (57%). When asked by open-ended question about the perceptions of peers who wear earplugs in a social situation with loud noise, 41% responded negatively and 59% were positive or equivocal. As to the availability, 68% of respondents knew that earplugs could be purchased in a drug store.

DISCUSSION

The results of this study indicate the low priority of hearing loss relative to other health issues. Ironically, a 61% majority of respondents have experienced hearing loss and tinnitus at rock concerts. The health issues that are considered to be of concern for our group, such as alcohol and drug use, smoking, sexually transmitted diseases, and depression, are consistent with results drawn from an original survey on Americans’ views toward children’s health issues designed by the Harvard School of Public Health Survey Research Center.16 Unlike such issues as alcohol and drug use, which may have immediate life-threatening consequences, hearing loss does not pose a concern for youths as the detrimental effects may not manifest for years. Furthermore, they are unable to appreciate fully the significant impact that hearing loss may have on future quality of life.

Given the low priority to hearing loss, the infrequent use of hearing protection is not unexpected. Expecting individuals to modify behavior requires a significant amount of education at many levels in society. A small number of respondents (16%) reported any exposure to or education about issues surrounding hearing health; significantly, this group was more likely to consider hearing loss an impor-

### TABLE 1. Demographic Data

<table>
<thead>
<tr>
<th>Respondents, %</th>
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<tbody>
<tr>
<td>Female gender</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Mean age</td>
</tr>
<tr>
<td>&lt;15</td>
</tr>
<tr>
<td>15–18</td>
</tr>
<tr>
<td>19–21</td>
</tr>
<tr>
<td>&gt;21*</td>
</tr>
<tr>
<td>Education level</td>
</tr>
<tr>
<td>In high school</td>
</tr>
<tr>
<td>High school graduate or higher</td>
</tr>
<tr>
<td>Employment status</td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>Employed part-time, full-time, homemaker, other</td>
</tr>
<tr>
<td>Family income in 2001</td>
</tr>
<tr>
<td>Above average</td>
</tr>
<tr>
<td>Internet use/wk</td>
</tr>
<tr>
<td>0–3 h</td>
</tr>
<tr>
<td>4 h or more</td>
</tr>
</tbody>
</table>

* Respondents between the ages of 35 and 65 constitute <0.2% of the study sample.
ment health concern. Experts advocate that educational programs must begin early in life and have suggested well-child physician visits and annual school examinations throughout elementary and high school as possible opportunities.\textsuperscript{1,13,17,18}

The substantial positive behavioral response (59\%) to a “doctor or nurse telling you that you should wear ear plugs” indicates that we in the medical community have failed to communicate an effective message but that we still do have a significant opportunity to have an impact on hearing behaviors. Importantly, only 9\% of respondents reported receiving any education about hearing in school, another opportunity for change. Several studies have shown the positive impact of hearing conservation programs on behavior modification of school-aged children and young adults.\textsuperscript{11,18,19} A survey by Lass et al\textsuperscript{18} examined high school students’ knowledge about hearing health. They found deficiencies in the students’ knowledge about normal hearing mechanism and hearing loss and about the effect on hearing of overexposure to noise. Although only 14\% of the study groups have worn hearing protection, the subjects report a positive influence to wear hearing protection if educated about the potential for permanent hearing loss (66\%) and if known that hearing protection would not decrease enjoyment (57\%). A study by Lewis\textsuperscript{19} also exemplifies the power of education. He evaluated 1529 students at 5 Ohio high schools before and after a hearing conservation-education program. Pretesting showed that 87\% of students had never worn protective earplugs; posttest results showed that 15\% to 20\% more students would wear them. These classic public health techniques of information and persuasion seem highly promising regarding hearing preservation at entertainment venues and are certainly easier to implement than the legislation-intensive techniques of restriction and/or prohibition.

Parents were the group most likely to recommend the use of hearing protection. However, other groups should also play an allied role in convincing children and adolescents to protect hearing as individuals in this age group may typically engage in rebellious behavior against parental authority. Our respondents reported that social influences such as peers (39\%), public role models (46\%), and television (24\%) could also influence behavior to use hearing protection.

This study attests to the accessibility and feasibility of a web-based survey as shown by the overwhelming response to the survey. The World Wide Web has emerged as a powerful tool in which to collect data and allows unprecedented access to the population. Although the Internet and the use of the web is not yet as ubiquitous as the conventional telephone survey technique, Internet survey methodology is increasing.\textsuperscript{20} Most of the respondents (77\%) spend 4 or more hours per week on the Internet. In fact, a study by the Kaiser Family Foundation revealed that teens spend a considerable amount of web time visiting health sites.\textsuperscript{21} The study report GenerationRX.com was a national, random, telephone survey of 1209 young people aged 15 to 24 years. The GenerationRx.com survey reported that 75\% of teens and young adults who have used the Internet most often have searched for health information compared with playing games (72\%), downloading music (72\%), shopping (50\%), or checking sports scores (46\%). Of those who have accessed health information online, the majority (55\%) have done so only a few times a year, but 39\% do so at least once a month. The survey also found that 39\% of respondents have changed their personal behavior because of the health information that they obtained on-line.\textsuperscript{21} As a significant portion

<table>
<thead>
<tr>
<th>TABLE 2. Relative Priority of Health Concerns Considered a “Very Big Problem”</th>
<th>Gender, %†</th>
<th>Age, %‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Concern</td>
<td>Male: 10</td>
<td>&lt;15 Years 15–18 Years 19–21 Years &gt;21 Years</td>
</tr>
<tr>
<td></td>
<td>Female: 8</td>
<td>9</td>
</tr>
<tr>
<td>Hearing loss</td>
<td>Male: 47</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Female: 54</td>
<td>40</td>
</tr>
<tr>
<td>Sexually transmitted diseases</td>
<td>Male: 40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Female: 51</td>
<td>37</td>
</tr>
<tr>
<td>Alcohol/drug use</td>
<td>Male: 37</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Female: 59</td>
<td>19</td>
</tr>
<tr>
<td>Depression</td>
<td>Male: 39</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Female: 45</td>
<td>31</td>
</tr>
<tr>
<td>Smoking</td>
<td>Male: 23</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Female: 36</td>
<td>31</td>
</tr>
<tr>
<td>Nutrition and weight issues</td>
<td>Male: 14</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Female: 18</td>
<td>31</td>
</tr>
<tr>
<td>Acne</td>
<td></td>
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</tbody>
</table>

* Percentage of the total number of respondents.
† Percentage of all male or all female respondents.
‡ Percentage of respondents within a corresponding age group.

<table>
<thead>
<tr>
<th>TABLE 3. Number of Attendances at Concerts or Clubs in the Past 6 Months</th>
<th>Respondents, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Attendances</td>
<td>Concert</td>
</tr>
<tr>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>1–9</td>
<td>60</td>
</tr>
<tr>
<td>10+</td>
<td>6</td>
</tr>
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<td></td>
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</table>

Downloaded from by guest on April 1, 2017
of adolescents and young adults spend time “surfing
the net” for health information, health researchers
and educators should extract the full potential of
the World Wide Web as a powerful communication me-
dium. Examples of web sites that are dedicated to
NIHL are www.hearinghealth.net (The National
Campaign for Hearing Health Online) and www.
hearnet.com (Hearing Education and Awareness for
Rockers).

The World Wide Web has been used in survey
research, and these studies have compared tradi-
tional, mailed questionnaires, personal interviews,
and e-mail surveys for differences in response rates
and response effects.22,23 A recent study also assessed
the feasibility of collecting health risk behavior data
from undergraduate students using a web-based sur-
vey.20 Undergraduate students were randomized to
receive a traditional paper survey in the mail or a
web-based survey. There were no statistical differ-
ences for demographics, response rates, item com-
pletion, and item completion errors. However, the
study found that the web group participants were
more inclined to reveal potentially embarrassing or
sensitive information than were participants in the
mail survey group.

Web-based surveys offer advantages and distinct
design elements such as checkboxes, radiobuttons,
pop-up questions, and text-entry boxes that limit
data entry errors. Software now exists that allows
raw data to be entered directly into a statistical da-
atabase, which allows for immediate data analysis
such as for this survey. Furthermore, the survey may
be designed in such a manner that maximizes the
question completion rate and decreases the comple-
tion time with such features as skip patterns.

Traditional surveys pose numerous methodologi-
ical problems and are costly and time-consuming.
Furthermore, surveys that allow contact between
the respondent and the surveyor may lead to biased
overreporting of socially desirable responses, espe-
cially when sensitive information is being asked.20
Self-administered, anonymous surveys are less likely
to overreport socially desirable responses, but re-
response rates and item completion rates may be low.

Although this study had a large number of respon-
dents, there are several shortfalls in the study. First,
by virtue that the survey was linked to the sole
MTV.com web site, respondents were not a random
sample taken from the population. Second, the inher-
ent nature of a web survey excludes those without a
computer or access to the Internet. Third, the volun-
tary nature of the respondents’ participation may
influence data by self-selection of those who are bi-
ased in a certain opinion.

### Table 4

<table>
<thead>
<tr>
<th>Factors That Are Likely to Influence the Use of Hearing Protection</th>
<th>Respondents, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finding out that limited exposure to very loud music can</td>
<td>66</td>
</tr>
<tr>
<td>permanently damage hearing</td>
<td></td>
</tr>
<tr>
<td>A doctor or nurse telling you that you should wear ear plugs</td>
<td>59</td>
</tr>
<tr>
<td>Finding out that many musicians and performers wear</td>
<td>46</td>
</tr>
<tr>
<td>earplugs while performing</td>
<td></td>
</tr>
<tr>
<td>Finding out that friends wear ear plugs</td>
<td>39</td>
</tr>
<tr>
<td>Learning about earplugs on television</td>
<td>24</td>
</tr>
</tbody>
</table>

### Conclusion

This study shows that NIHL has a low level of
awareness priority among adolescents and young
adults. Fortunately, many would be persuaded to
wear hearing protection with adequate education
and counseling. Hearing conservation education
must be implemented on many fronts in society to
educate our youths about hearing health. The World
Wide Web is powerful medium to collect health data
from this group, and with additional experience, sur-
vey result interpretations hopefully will refine even
further.

### Acknowledgments

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Elizabeth Thorpe from the Deafness Research Foundation and
Peter Venner of Mack’s Ear Plugs generously provided advice and
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Jose Ignatio Santos provided Mexican educational media oppor-
tunities. Betty Treanor provided excellent manuscript preparation.

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“It does not look like anyone’s mother, and the baby it delivers has none of the emotional appeal of a newborn. But a life-like birth simulator developed at Johns Hopkins University may provide some important new information about problem deliveries in real mothers and infants. The birth simulator, which started out as a research project in engineering, has now been used to determine the best way to deliver a baby whose shoulders become stuck in the birth canal, a condition called shoulder dystocia. . . . The researchers found that the Rubin’s maneuver produced less than half the force of the McRobert’s method, suggesting that it might be safer. The findings, being published . . . in American Journal of Obstetrics and Gynecology, still require further validation through additional research and clinical evaluation, so recommendations for a change in practice may not come for some time. But the evidence is mounting. . . . ‘There are commercially available birthing simulators,’ Dr. Edith D. Gurewitch said in a telephone interview, ‘but really they’re just dolls. None have instrumentation like ours that actually tells you what kind of force you’re exerting on the head, neck, and nerves of the infant.’”


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