Clinical Forum

Apgar Scores in the Identification of Sensorineural Hearing Loss

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Abstract

Apgar scores of 0–4 at 1 minute and 0–6 at 5 minutes have been investigated as risk criteria in the Utah High Risk Hearing Screening Program. The 1990 Joint Committee on Infant Hearing (JCIH) statement recommended only an Apgar score of 0–3 at 5 minutes be included in a risk registry for sensorineural hearing loss (SNHL). An analysis of live births indicates the more lenient Utah cut-off criteria are justified. It is concluded that both of the Utah Apgar scores, even when moderately depressed, are sensitive risk factors for SNHL in infants. These findings suggest serious consideration be given to expanding the 1990 JCIH Apgar recommendation.

Key Words: Anoxia, Apgar score, asphyxia, at risk, hearing loss, hearing screening, high risk, hypoxia

The use of Apgar scores in the screening of at-risk infants for hearing loss was first recommended in 1982 by the Joint Committee on Infant Hearing (JCIH). In the Committee's initial recommendations (1982), an Apgar score of zero through three was included as one of seven risk criteria; however, the statement did not specify whether the 1 minute, the 5 minute, or both scores should be implemented in a high risk registry. Recently, the JCIH (1991) clarified its position on Apgar scores and recommended the use of zero through three at 5 minutes (0–3 @5) only. The state of Utah has adopted more lenient Apgar score criteria than recommended by the JCIH or than any other state in the nation (English, 1992). This article reports on the effectiveness of using the more lenient Apgar scores in identifying sensorineural hearing loss (SNHL).

There has been some recent criticism of Apgar scores and even a suggestion that they be eliminated (Anonymous, 1989). The Committee on Fetus and Newborn of the American Academy of Pediatrics (1986) has criticized the use of Apgar scores in isolation as an indicator of "neurologic damage." However, concerning SNHL, Simmons (1980) reported that infants with hearing impairment in intensive care were 7.6 times more likely to have an Apgar score of 0–6 at 5 minutes than their normal-hearing counterparts. He suggested "that anoxia, or the sequela of anoxia, is the underlying factor in the majority of neonatal deafness" (p. 450). Fox and Duara (1983) reported that infants with immediate recognition of persistent pulmonary hypertension of the neonate have asphyxia and low Apgar scores at delivery. This group is also known to have a 20 to 40 percent prevalence of SNHL (Sell et al, 1985). Other sequelae associated with low Apgar scores have been reported. Nelson and Ellenberg (1981) indicated that low Apgar scores at 1 and 5 minutes were markers of increased risk of death or chronic motor disability. In addition, a fourfold increase in neurologic abnormalities at 1 year was found in infants with low Apgar scores (Drage et al, 1966). Subtle visual inattentiveness has also been demonstrated in infants with lower Apgar scores.
scores (Lewis et al., 1967), and in a large prospective study in Sweden (Wennergren et al., 1987), a 1-minute Apgar score of 0–6 was found to be a powerful risk factor for respiratory disturbances. Brazelton et al. (1977) suggested that Apgar scores reflect a spectrum of behavior that may predict future functioning, if more sensitive tests are employed along with it. In support of using risk factors for the identification of hearing loss, Richards and Roberts (1967) stated “loss of hearing is the only handicap in which the screening of children with risk factors is likely to uncover a high proportion of handicaps” (p. 712).

In the state of Utah, birth certificate information has been used since 1978 for high-risk registry data collection, and since that time over one half million birth certificates have been screened for risk factors. Recommendations for Apgar score risk criteria did not exist at the inception of the program and various cut-off scores were intentionally implemented for investigative purposes. Consequently, the most lenient Apgar scores chosen were zero through four at 1 minute (0–4 @1) and zero through six at 5 minutes (0–6 @5). In this study, these Apgar criteria have been evaluated in 290,737 live births, over a period of more than 8 years, in an effort to evaluate their effectiveness as risk criteria and to report on their efficacy in identifying SNHL during infancy.

**RESULTS**

During this period of investigation, there were 290,737 live births in the state of Utah. Of those live births, 26,854 (9.2%) were classified as high risk by information obtained from birth certificates. Implementation of the Utah Apgar criterion (0–4 @1 or 0–6 @5) re-
Figure 3 Flow chart of the 290,737 live births for the Utah and JCIH Apgar criteria.

resulted in an accumulation of 11,883 infants, or 4.1 percent being classified as at risk by the Utah Apgar scores.

Figure 1 illustrates the distribution of Apgar scores at 5 minutes for those 290,737 live births. By applying the 1990 JCIH Apgar criterion (0-3 ©5), an accumulation of only 545 infants, only 0.19 percent of the total cohort, would have been classified at risk. The higher Utah Apgar criterion (4-6 ©5) resulted in an additional 5,594 infants, 1.9 percent of the total cohort, being classified as at risk. Figure 2 illustrates the distribution of 1-minute Apgar scores for those same infants. An accumulation of 10,060 infants, 3.5 percent of the cohort, was classified as at risk on the basis of the Utah 1-minute score (0-4 ©1). A total of 3,733 infants, 31.4 percent of

the total low Apgar group, had low Utah scores at both (0-4 @1 and 0-6 ©5).

The inclusion of Apgar scores in high-risk screening increases the number of infants classified as at risk only when those infants have no other risk factors. Of the 11,883 newborns with the Utah Apgar scores, 9,565 (3.3% of the cohort) were classified as at risk by Apgar score alone, i.e., no other hearing risk factors were identified on their birth certificates (Fig. 3). One fourth (2,408) of those infants classified as at risk by the Utah Apgar criteria were tested by the Bureau.

By applying the 1990 JCIH Apgar criteria (0-3 ©5), only 545 infants would have been placed on the register and only 422 of those (0.15% of the cohort) would have been classified as at risk by Apgar score alone. If the 1990 JCIH recommended criteria had been used, only 111 of the 2,408 infants tested by the Bureau would have been classified as at risk.

As shown in Table 1, those infants tested by the Bureau that had low Apgar scores as their only risk criteria had a high rate of SNHL as compared to the general newborn population. Of those infants with a JCIH Apgar score (0-3 ©5), 9 of the 111 tested had SNHL (81.1 per thousand). Of those infants tested with either Utah Apgar score (0-4 ©1 or 0-6 ©5), 47 of the 2,408 or 19.5 per thousand had SNHL. Of the infants tested with a low Utah 1-minute score, regardless of the 5-minute score, 42 of 2,137 or 19.7 per thousand had SNHL and 31 of 991 or 31.3 per thousand with a low Utah 5-minute score regardless of the 1-minute score, had SNHL. Of those with only a low 1-minute score (0-4 ©1 and 7-10 ©5), 16 of 1,517 or 10.5 per thousand had SNHL. When only the Utah 5-minute score was low (5-10 ©1 and 0-6 ©5), 5 of 271 infants, or 18.5 per thousand had SNHL. When both the 1- and 5-minute scores met the Utah criteria (0-4 ©1 and 0-6 ©5), 26 of 620

<table>
<thead>
<tr>
<th>High Risk Factor</th>
<th>Number Hearing Impaired</th>
<th>Number Tested</th>
<th>Rate per Thousand</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCIH 5-min score</td>
<td>9</td>
<td>111</td>
<td>81.1</td>
</tr>
<tr>
<td>Either Utah Apgar score</td>
<td>47</td>
<td>2,408</td>
<td>19.5</td>
</tr>
<tr>
<td>Utah 1-min regardless of 5-min</td>
<td>42</td>
<td>2,137</td>
<td>19.7</td>
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<tr>
<td>Utah 5-min regardless of 1-min</td>
<td>31</td>
<td>991</td>
<td>31.3</td>
</tr>
<tr>
<td>Utah 1-min only (5 min &gt; 6)</td>
<td>16</td>
<td>1,517</td>
<td>10.5</td>
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<tr>
<td>Utah 5-min only (1 min &gt; 4)</td>
<td>5</td>
<td>271</td>
<td>18.5</td>
</tr>
<tr>
<td>Both Utah Apgar scores</td>
<td>26</td>
<td>620</td>
<td>41.9</td>
</tr>
</tbody>
</table>

Infants were classified as at risk by low Apgar scores only, using the JCIH criterion of zero through three at 5 minutes, and the Utah Apgar criteria of zero through four at 1 minute and/or zero through six at 5 minutes.
Figure 4  Illustration of infants identified as high risk by Apgar only (N = 47 hearing-impaired infants). The striped section illustrates the 9 hearing impaired infants identified on the basis of the 1990 JCIH criterion of an Apgar score of 0 to 3 at 5 minutes. The dotted section shows the 5 additional infants identified only by the more lenient Utah criterion of 4 to 6 at 5 minutes. The cross-hatched section shows the 17 additional infants identified by both Utah criteria of 0 to 4 at 1 minute and 4 to 6 at 5 minutes. The unmarked section illustrates the 16 additional infants identified only by the Utah criterion of 0 to 4 at 1 minute.

Of the 47 hearing-impaired infants identified on the basis of the Utah Apgar scores alone, only 9 (19.1%) would have been considered at risk by the 1990 JCIH Apgar recommendation (Fig. 4). Of the additional 38 hearing-impaired infants, 5 were identified only on the basis of their 5-minute score (5–10 @1 and 4–6 @5), 17 were identified on the basis of both scores (0–4 @1 and 4–6 @5), and 16 were identified only on the basis of their 1-minute score (0–4 @1 and 7–10 @5). The identification of these additional 38 hearing-impaired infants required the testing of 2,297 at-risk babies or about 22 per month during the study period.

DISCUSSION

Apgar scores are only one of several recommended JCIH criteria in high-risk hearing screening and this article is not meant to distract from the importance of the other criteria. The other JCIH factors have proven to be valuable, but an in-depth analysis of those factors would go well beyond the scope of this article. The one area of Utah's high-risk hearing screening program that has caused the most controversy is its lenient use of Apgar scores. Therefore, it was felt necessary to publish the importance of Apgar scores in isolation from the other risk criteria used in Utah.

Apgar scores are reported to be an exceptional predictive tool for neonates requiring cardiopulmonary resuscitative efforts (Schmidt et al, 1988). On the other hand, they are not synonymous with birth hypoxia; therefore, they may have reduced predictive value for long-term neurologic outcomes. Freeman (1985) reported that Apgar scores may be only an indicator of previous hypoxia and suggested that perhaps it is the duration of the intrapartum hypoxia, not its presence just prior to delivery, that determines the significance of the increased risk of damage. Depressed Apgar scores are often associated with neonatal hypoxia; however, they may also be depressed due to other prenatal and perinatal conditions. Many of these conditions, such as maternal anesthesia, resuscitational efforts, prolonged labor, and various neurologic and cardiorespiratory conditions of the newborn are not conventionally reported on the birth certificate. This does not detract from the validity of Apgar scores in high-risk screening, since it is the potential of Apgar index to identify SNHL that is of primary interest, not the exact cause of the low Apgar score.

Both the 1- and 5-minute Apgar scores are recorded on nearly all birth certificates in the United States. By virtue of their standardized wide application and their ease of computer management, Apgar scores are very attractive as one of the risk criteria in high-risk hearing screening. According to data analyzed from the National Center for Health Statistics (1991), the 1990 JCIH Apgar recommendation (0–3 @5) would place approximately one half percent (0.5%) of all births in the United States at risk. The more lenient Utah criteria would increase the national figure to only 3.8 percent and this
prevalence is a high estimate; since it does not consider infants at risk by Apgar in combination with other risk factors. Even with the more lenient Apgar criteria, the overall high-risk group selected by the Utah register, using all seven 1982 JCIH risk criteria, was still a very manageable 9.2 percent of the total newborn population for this public health program. The typical yield from a hearing high-risk register is reported to be about 11 percent of the newborn population (Downs and Gerkin, 1991).

It is estimated that 1 in 750 to 800 infants are born with mild to profound SNHL (Downs, 1986; Pickard, 1988). Assuming the lower prevalence figure, infants in this study that were at risk by both Utah Apgar scores, with no other known risk criteria, were over 31 times more likely to have SNHL than the general newborn population. Those infants tested with a low Utah 5-minute score were over 23 times more likely to have SNHL, and those with a low Utah 1-minute score were nearly 15 times more likely to have hearing impairment. This is not meant to distract from the sensitivity of the JCIH Apgar recommendation. In fact, those infants (0–3 @5) were over 60 times more likely to have hearing impairment than the general newborn population.

It might be argued that the infants tested in this study represent a biased sample, because only certain concerned parents chose to have their infants screened by the Bureau. If the prevalence of SNHL in infants with low Utah Apgar scores was no higher than the general newborn population (1 in 750), one would expect to find only 12 to 13 affected infants in the total group of 9,565 at risk by Apgar alone. Even assuming that there was not a single case of SNHL in the remaining 7,157 infants not tested—a virtual impossibility—the resultant prevalence of hearing impairment (47 out of 9,565) would still be over three and one half times higher than the general newborn population.

In this study, both Utah Apgar score criteria were found to be highly predictive of SNHL in infants. The JCIH Apgar recommendation (0–3 @5) would have only identified 9 of 47 infants with SNHL, although only 111 infants would have been tested. Had Utah implemented this recommendation, over 80 percent (38 of 47) of the infants found with SNHL on the basis of their Apgar scores alone would not have been classified as being at risk and consequently would not have been tested. The Utah 1-minute criterion (0–4 @1) identified nearly 90 percent (42) of the total of 47 infants identified with SNHL, while the Utah 5-minute criterion (0–6 @5) identified nearly two thirds (31) of these same infants. While it appears the Utah 1-minute score has a higher sensitivity for SNHL identification, this must be tempered by its apparent lower specificity. By implementing both criteria, the 5-minute Utah score (5–10 @1 and 0–6 @5) identified an additional 5 SNHL cases while only testing an additional 271 infants.

To obtain an exact sensitivity and specificity for Apgar scores and an accurate analysis of cost effectiveness, the exact number of SNHL infants in the population who fail the risk factor screening and the number who pass the screening must be known (Turner and Cone-Wesson, 1992). All infants in a large sample would have to be followed and evaluated, not just those who had risk factors. This protocol is not practical in most health care settings in the United States. A limitation of the Utah program and most other follow-up programs is the inability to test all the infants on a risk register. The role of this public health agency is to inform parents of the high risk status of their infant and to offer screening at no charge. Many parents chose alternative testing, were unable to be contacted, were lost to follow-up, or chose not to respond to the notification for various reasons (Mahoney et al, 1992). In spite of this limitation, the overall cost of the program, including audiologic screening, is approximately $1.50 per live birth and about $3,500 per infant identified with SNHL. These estimates compare very favorably with the costs of other early identification protocols (Turner 1991; Turner and Cone-Wessen, 1992).

Risk criteria for hearing impairment have been in existence for many years, often with insufficient documentation regarding appropriateness and prevalence. The evidence presented in this article strongly suggests that the JCIH seriously consider including both Apgar scores as risk criteria, and further, they consider expanding the Apgar cut-off criterion of their 1990 position statement.

Inherent problems are associated with using a risk register to search for hearing-impaired infants. The primary obstacle is that the procedure may miss up to half of the infants with SNHL in the total newborn population (Elssman et al, 1987; Mauk et al, 1991). Consequently, there is currently a national emphasis toward universal screening of all newborns, which is supported by proposed congressional legislation, a position statement of the American Academy of Audiology (1988), and a state-
ment pending from the JCIH. However, until universal hearing screening protocols are improved and can be applied in most health care settings, continued efforts should be made to make high-risk hearing screening as effective as possible.

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REFERENCES


