abdominal wall. This increased intrauterine pressure is transmitted throughout the intrauterine cavity and on all parts of the fetus, including the head, neck, and the umbilical vessels. As a result parasympathetic discharges are transmitted to the medulla via the vagus nerve and excitation of the vagal centers then produce an efferent vasodepressor response. Our observations suggest that the transient bradycardia may be triggered by pressure via some fetal part after a rise in intrauterine pressure. This was evidenced by the rapid recovery of the pattern of bradycardia after manipulation of the transducer. We also noted marked susceptibility to bradycardia among the fetuses observed, especially those earliest in gestation. These differences in response of the fetal heart indicate that the vagal nerve activity increases with the course of gestation. This finding agrees also with the data presented by Wozniak and O'Rahilly, who showed by electron microscopic studies that myelination and organized nerve fiber arrangement of the human fetal vagus nerve increased from the seventh to the twenty-third postovulatory weeks, when the vagus nerve develops its mature structure. This confirms the individual differences in the vagal nerve tonus as pregnancy progresses. With improved perinatal care, ultrasonographic study to assess fetal status is used increasingly at an earlier gestational age. It is more likely to induce fetal bradycardia if the study is performed in the first trimester of pregnancy.

In summary, vagally mediated fetal bradycardia can be evoked reflexively during midpregnancy ultrasonographic or echocardiographic study of the fetus. Assessment of these cardioacceleration patterns should consider its benign nature. Sonographers should be cautious of the pressure of the ultrasonographic transducer applied to the pregnant mother's abdomen.

REFERENCES

Fetal heart rate transmission with the facsimile telecopier in rural areas

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Over a 30-month period, 24 portable facsimile telecopiers were placed in rural hospitals with delivery services, allowing 24-hour direct transmission of fetal heart rate tracings for consultation. An analysis of the first 209 intrapartum fetal heart rate strips is presented. Variable decelerations were the most frequent indication for consultation, but they were less commonly interpreted as indicating fetal distress. Such units have major advantages in terms of both cost and versatility over previously described systems and have proved extremely valuable to the rural practitioner of obstetrics. (Am J Obstet Gynecol 1989;160:1040-2.)

Key words: Facsimile transmission, electronic fetal heart rate monitoring, rural obstetrics

As our understanding of maternal and fetal medicine continues to expand, an increasing challenge for the obstetric community is to make available to patients in rural communities a level of care and expertise similar
to that found in major centers. Many referral centers serving rural areas have developed active outreach programs involving site visits by both physicians and nurses for education, consultation, and quality review. In addition, high-risk pregnancy hot lines have been established and allow rural physicians to contact a major medical center with questions 24 hours a day. Unfortunately some important areas of obstetric care do not readily lend themselves to scheduled outreach visits or telephone consultation. Fetal heart rate (FHR) interpretation, either of intrapartum tracings or of antepartum testing, is a prime example. A new generation of low-cost, portable facsimile telecopiers allows rapid 24-hour transmission of FHR data to major referral centers for consultation.

**Material and methods**

In 1985, Utah Valley Regional Medical Center was established as the perinatal referral center for large areas of central and southern Utah and surrounding states. In the following 30 months, facsimile telecopiers (Xerox model 7010, Sharp model 1810) have been placed in 24 rural hospitals and are used principally for transmission of intrapartum and antepartum FHR strips. Such a system is centered in the Department of Perinatology offices within the Medical Center. Tracings are received either at the Perinatal Center or by a unit in the home of the perinatal consultant. Because of the portable nature of these machines (size 12 x 18 x 5 inches), they may be readily transported and receive FHR tracings wherever a modular touch-tone phone is available. This feature allows the consultant to carry the small unit with him at all times and permits physicians in referral areas to avail themselves of true 24-hour, 7-day-a-week consultative services. Several hospitals have found it desirable to transmit all nonstress and contraction stress tests, as well as intrapartum tracings, to the perinatologist for formal interpretation and report.

**Results**

Over a period of 30 months, 209 intrapartum FHR tracings were transmitted and analyzed. Of these, 147 (70%) were interpreted as reassuring and 62 (30%) as nonreassuring. Fetal scalp blood sampling was not available in the rural institutions, and recommendation for expeditious cesarean section was made in the latter patients. Table I lists the principal features of concern to the rural physician leading him to transmit a tracing. Although variable decelerations were the most common

**Table I. Principal features of FHR pattern leading to telecopier transmission**

<table>
<thead>
<tr>
<th>Indication*</th>
<th>No.</th>
<th>%</th>
<th>Surgical intervention recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable decelerations</td>
<td>111</td>
<td>53</td>
<td>20</td>
</tr>
<tr>
<td>Late decelerations</td>
<td>44</td>
<td>21</td>
<td>34</td>
</tr>
<tr>
<td>Fetal tachycardia</td>
<td>14</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Fetal bradycardia</td>
<td>13</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Decreased variability</td>
<td>24</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Fetal arrhythmia</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>209</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

*Thirty-one patients (15%) had a combination of features.
feature leading physicians to seek consultation, such strips were interpreted as nonreassuring in only 20 cases (18%), 15 of which exhibited other ominous features (decreased variability, fetal tachycardia, or fetal bradycardia).

In contrast, whereas only 44 tracings were transmitted because of late decelerations, 34 (77%) were interpreted as mandating operative intervention.

**Comment**

In the late 1970s, FHR monitoring systems were developed that allowed direct real-time telephone transmission of the FHR signal to receiving units. Although such real-time systems have found utility in perinatal outreach, their widespread use has been limited by several factors.

1. Such units are expensive and require the purchase of new major capital equipment by small rural hospitals whose budgets are often already under considerable strain.
2. Although such systems provide adequate transmission of real-time data, their use for educational purposes is limited because of limited capacity to transmit FHR strips that were obtained many hours or days before.
3. Such systems are limited to the transmission of one form of data, namely, FHR tracings.
4. There is no potential in such systems for two-way exchange of hard-copy data.

With the use of the facsimile telecopier, the above problems may be overcome. Technologic advances in the 1980s have resulted in low-cost facsimile units. The printed copy is clear and detail reproduction is excellent (Fig. 1). Such portable units now retail for under $2000, less than one third of the cost of most real-time transmission systems. These units may be interposed between a normal touch-tone telephone and the wall outlet. When operational, they allow any type of hard-copy transmission via telephone to a receiving unit anywhere in the world with a delay of only a few seconds. Currently available machines are equipped with a long document mode allowing continuous telephone transmission of a FHR strip of any length to the receiving unit. This feature represents a major advance over an earlier generation of telecopiers that required consecutive transmission of individual standard or legal-size segments of FHR tracings. Size and cost of the older units also limited their widespread acceptance into clinical practice.

**Other applications.** Electrocardiograms may be transmitted to central referral centers for cardiology consultation with the same instrument. In addition, transmission of laboratory reports to assist in telephone consultation has proved beneficial in a number of instances. Further, because of the two-way nature of communications possible with this telecopier, physicians in institutions without access to major libraries can request and rapidly receive articles from the medical literature that may be required for patient care. Numerous other applications are possible in the areas of nursing and physician education.

Since its introduction, the facsimile telecopier concept has received enthusiastic support from rural hospital care providers and institutions. Most feel that this use has resulted in improved patient care, as well as assisting them in reducing their medical-legal liability. Such symptoms have allowed some patients to be successfully managed in a local hospital who otherwise would have required transfer to a major medical center. As one physician explained, "The presence of a telecopier in our facility has made us feel like a part of the real world again rather than an isolated institution out of touch with help or assistance." It is anticipated that additional applications of this exciting technologic development will further contribute to improvement of perinatal care in rural areas.

**REFERENCES**