ABSTRACT

LABORCONSULT - AN EXPERT SYSTEM FOR EVALUATING FETAL HEART RATE AND THE PROGRESS OF LABOR

by
Wendy Raymond-Fink

LaborConsult is a rule-based expert system designed to aid the non-expert practitioner in monitoring the progress and fetal tolerance of labor. The expert system obtains from the user the values of the following labor variables: cervical dilatation, fetal station, and the time between and duration of uterine contractions. The rates of cervical dilatation and fetal descent are then calculated and compared to labor standards. Additionally, the consultation assists the user in the analysis of electronic fetal monitor tracings.

The expert system development tool VP-Expert allows the interfacing of the consultation with the spreadsheet Lotus 1-2-3. This enables the creation of a labor document showing the status and progress of the labor variables and Friedman curves displaying cervical dilatation or fetal descent versus time. The expert system is validated for two case studies and additional hypothetical data. It is concluded that LaborConsult is an effective expert system for the evaluation of the progress of labor and concurrently obtained fetal heart rate data.

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by
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APPROVAL PAGE

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This thesis is dedicated to my family.

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CHAPTER 1

EXPERT SYSTEMS AND THEIR USE IN THE FIELD OF MEDICAL DIAGNOSIS

1.1 Introduction

The objective of this chapter is to define and describe expert systems and to introduce the reader to their use in the field of medical diagnosis. Reasons are given to justify the use of an expert system to monitor the progress of labor and delivery. The objectives of the expert system are stated.

1.2 What is an Expert System?

Expert systems, such as that used in this project, are one of the products of rapid development in the field of artificial intelligence (1,2,15). They exist under that heading because when they are presented with a situation, they seem to mimic the responses that would be given by an intelligent human expert. Expert systems do not just mimic intelligence, however. Their primary usefulness is their ability, in the absence of a human expert, to solve specific problems which traditionally require human expertise (3,4).

The method with which expert systems solve problems differs from the traditional, algorithmic techniques commonly associated with computer programs. Rather, they employ heuristics, or "rules of thumb" (1,15). Ideally, an expert system turns a human expert's sometimes fuzzy "rules

of thumb" into coherent "rules of procedure" (4).
Specifically, a rule-based expert system is a model, usually
computerized, that contains a degree of expertise in a
particular subject that is comparable to a human expert in
that subject (1).

Expert systems can be created in several ways.
Originally they were written using list-processing languages
such as LISP or PROLOG (15). Both LISP and PROLOG are
higher-level computer languages that store with each piece
of information instructions about how to find associated
information (15). The large body of knowledge needed for an
expert system knowledge base strains the capabilities of
these languages. The breakthrough that enabled the
development of current expert systems was the separation of
the knowledge from the instructions for accessing the
knowledge (15). The first expert system designed in this way
was MYCIN (15). This expert system was developed by a group
of researchers who were investigating human cognition (15).
Thinking was modeled as the application of heuristics, which
in the expert system were written as if-then rules. MYCIN
was imparted with a knowledge base for the diagnosis of
blood infections (1,15). The logical use of these rules was
coded in a separate part of the system, and became the basis
for other rule-based systems with different knowledge bases.
This was the introduction of the expert system "shell",
several of which are commercially available.

In addition to rule-based shells, object-based shells are also useful for certain applications. Object-based expert systems organize information differently than rule-based expert systems, returning to the idea that information and the instructions for handling it are closely connected (2,15). In object-based systems, variables, called objects. are arranged in levels. Objects have one or more describing values, called attributes. The objects are related to each other by means of "inheritance". A "child" object inherits all of the attributes of the "parent" object (2). For example, a parent object may be "school". The attributes may be size, grade levels, budget. Objects which inherit these attributes, the "child" objects, may be social studies, math, reading, science. The next level down may include actual classes as objects, eg. Mrs. Smith's class. In practice, units of object-based systems can be used for specific tasks which are often repeated.

For this project, the rule-based shell VP-Expert was chosen because of its compatibility with available computer hardware and software, the availability of a knowledge base which translates well into if-then rules, and the ability to interconnect to a spreadsheet.

1.3 When to use Expert Systems

Expert systems are useful when a consistent outcome is desired despite varying situations. They are especially helpful when human experts are scarce or unavailable. Such a

system allows a non-expert to function in the desired area
of expertise. Thus, an expert system is an appropriate tool
to be developed and used in situations where all of the
following are true (1,2):

1) A well-defined problem or procedure is stated, for which
an expert exists. The expert should be highly regarded, and
ideally there would be several experts collaborating (1).

2) In actual practice, experts are scarce or unavailable,
leaving non-expert practitioners responsible for decision-
making. These non-experts should be able to be trained to
interact with the expert system (1).

3) The benefits of the expert system outweigh the costs, in
money and time, of creating and implementing the system and
training users (1).

1.4 How Expert Systems Work

An expert system is developed by the *knowledge engineer* (1).
This person interacts with the human expert to create the
expert system. A basic expert system contains three main
components, as shown in figure 1.1 (1). These components
are the knowledge base, the user interface, and the
inference engine. The *knowledge base* contains the
information obtained from the human expert. In the expert
system shell used in this project, VP-Expert, this
information exists as groupings of "if-then" rules which
make use of the logical operators AND and OR. The rules can
be written into VP-Expert's shell using English: "if A,
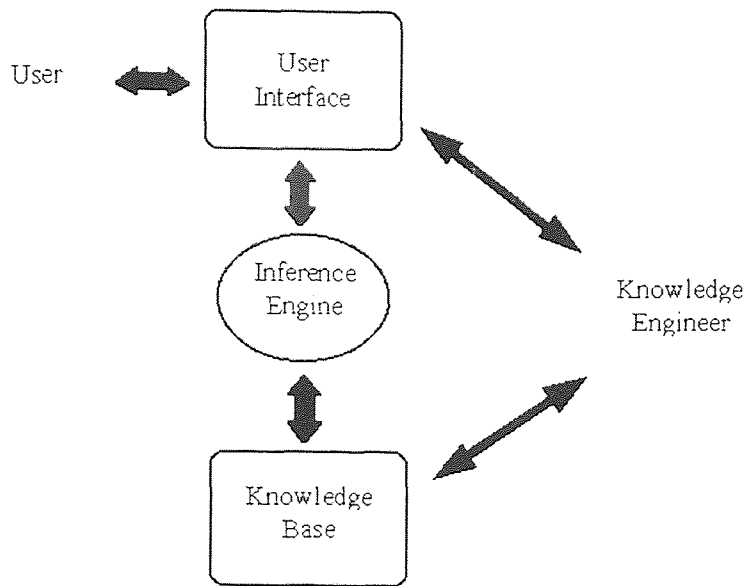
Figure 1.1 Main components of a rule-based expert system.

then B". Here is an example of a rule from LaborConsult:

(The complete LaborConsult expert system file

is located in appendix D.)

    Rule 12

        If DIL > 0 AND

        DIL < 3 AND

        TERM = YES

        THEN STATUS = LATENT

        DISPLAY " The Labor is in the latent phase,

                because dilatation is < 3 cm.

 1. Observe 12 hours, or until dilatation reaches 3 cm.

 2. If labor does not become active, rule out pregnancy

abnormalities, then consider administration of IV pitocin.

institution.";

In this rule, if the three conditions are all met, then the variable Status is assigned the value Latent, and the subsequent message is displayed.

Data is entered into the consultation at the *user interface*. In VP-Expert, the user simply responds to questions that appear on the screen, and the program assigns values to the appropriate variables. In VP-Expert, The question can be presented in one of two ways. One way is an open ended question. Here is an example from LaborConsult:

ASK PARITY: "How many of these previous pregnancies have ended in delivery?";

When the user responds to this question with the appropriate number, the variable Parity will be assigned that value. The second way a question can be presented is with choices for the user. Here is an example from LaborConsult:

ASK FHR: "Is a normal FHR tracing obtained by the monitor?;

Choices FHR: Yes, No;

When this question is put to the user, the choices also appear, and the user simply moves the arrow key to highlight the correct choice, which then becomes the value of the variable FHR, in this case.

Using VP-Expert, consultations are run by following a list of commands contained in a section of the program called the actions block (6). This section consists of a

list of statements and commands which are executed in order.
The commands tell the *inference engine* to find the value of
a particular variable. The inference engine first checks to
see if the value can be determined by questioning the user
directly. If the variable in question is not among those in
the questions block, then the inference engine starts
looking at the rules, starting with rule #1, to see if a
"Then" statement assigns a value to the variable it is
looking for. When it finds such a rule, it then must check
to see if all of the rule's conditions are met. One of
three things can happen at this point:

1) The conditions are met, and the value is found.

2) The conditions are not all met, and the inference
engine moves on to the next rule which will define the
variable in question.

3) One or more of the values of the conditions are not
known.

For example, in Rule 12 shown above, when trying to define
the value of Status, the inference engine must know the
values of Dil and Term. When assessing this rule, it does
not. It therefore must define these variable first, using
the same method that is being used to find the value of
Status. (These variables are both found in the questions
block.) This technique of determining values is called
backwards chaining (1,6).

1.5 How Expert Systems are Developed

The development of an expert system can be carried out using a tool such as VP-Expert. The steps to creating the system are as follows (2):

1) Define the problem or procedure for which an expert system is desired. Be sure the criteria in section 1.2 are met.

2) Acquire the knowledge base. Locate the expert or experts. Visit them on-site if possible. Record the heuristics needed for the system (1).

3) Transform the knowledge into rules. Return to the expert as needed for clarification. Work together to see if the rules give the desired outcome.

4) Organize the system commands for the inference engine. Design the user interface questions and responses.

5) Verify that the expert system can be implemented for real-life cases. Test the system with data from cases with known outcomes. Check with the expert (4).

6) Maintain and update the system as new information becomes available.

1.6 The Use of Expert Systems in Medicine

Expert systems have been in use since the 1960's. The first was DENDRAL, devised to identify the molecular structure of unknown compounds (1,15). In the 1970's, expert systems were applied to medicine. In addition to the previously mentioned MYCIN, other systems such as INTERNIST, PUFF and

QMR were written using rule-based systems (1). (see Table 1)
The area of medical diagnosis was and continues to be a
particularly successful field in which to apply expert
system technology (1). It seems counterintuitive that this
would be so, since medical diagnosis is very difficult, even
for the best human experts. However, once the subjective,
heuristic rules are placed in the knowledge base, they
become "if not objective, at least explicit and public" (4).
Case after case can be applied to the same set of rules,
lending consistency to decisions for treatment (4).

Table 1 Expert Systems in Medicine

NAME	PURPOSE
INTERNIST	DIAGNOSE INTERNAL MEDICINE DISEASES
MYCIN	DIAGNOSE BLOOD INFECTIONS
PUFF	DIAGNOSE PULMONARY DISORDERS
QMR	DIAGNOSE INTERNAL DISEASES

1.7 The Use of an Expert System to Monitor the Progress of Labor

It is proposed that the process of labor and delivery
constitutes an appropriate situation for which an expert
system may be used. The following is a list of reasons
which justify this statement:

1) There are a wide range of variables which are measured throughout the process of labor and delivery. These include cervical dilatation, station, contraction duration and interval, and fetal heart rate and its periodic behavior. While these variables will be defined and discussed in chapters 3 and 4, here they are presented to show that a non-expert can obtain a large amount of objective data. This data is necessary so that the values can be compared to the norms identified by the expert.

2) The expert participating in this project is Dr. Sidney A. Wilchins, MD, Clinical Associate Professor of Obstetrics and Gynecology, New Jersey Medical School, and Adjunct Research Professor, New Jersey Institute of Technology. According to Dr. Wilchins, there exist conditions in rural America and in Third-World countries where expert obstetricians or obstetrical nurses are not available to attend every labor and delivery. Therefore, a need exists for non-expert nursing personnel to have access to an expert's knowledge. It is actually easier for the aforementioned facilities to gain access to a microcomputer and the appropriate software than to a human expert. Dr. Wilchins states that these non-expert personnel are easily trained to make the required obstetrical measurements, and that a computerized expert system is better received than alternative methods of conveying expertise, such as a manual.

3) There also exists a use for this expert system in well-staffed hospitals. The system's treatment suggestions may serve as alerts or warning systems to the attending staff (5). Using VP-Expert, obstetrical data is entered in response to questions at the user interface. This data can then be entered into a worksheet or database without the user actually opening this additional file. This is in fact what occurs in the system described in this thesis, and this capability is discussed in detail in the following chapter. Data is automatically written on a 1-2-3 spreadsheet under appropriate headings. In addition to the values of the variables listed above, information such as patient name, age, gravidity, parity and date of admission are obtained and entered into the spreadsheet. When the case is completed, a hard copy of this spreadsheet can be added to the other records such as the fetal monitor strip and doctor and nurses notes to create the patient file. Such a file may be easier to refer to, should it become necessary. (5)

4) Computers are already in use in many aspects of hospital care in general (5) and obstetrical care specifically. While in the postpartum section of a hospital recently, I observed that nurses record data such as blood pressure and body temperature on computers placed in patient rooms. The use of a computerized expert system is a natural extension of many existing procedures.

Dr. Wilchins and other experts are able to provide a knowledge base. Human experts may not be available under certain circumstances, and when they are, other legitimate uses of the proposed system are recognized. The necessary technology is available and well tolerated by expert and non-expert. It is therefore concluded that it is appropriate and desirable to develop an expert system for the labor and delivery process.

1.8 The Objectives of LaborConsult

The expert system LaborConsult was developed using the expert system development tool: VP-Expert. *The purpose of this system is to analyze the variables of labor, diagnose the need for intervention and to suggest treatments*. The analysis has two components: the progress of labor, and the assessment of fetal tolerance of labor. The progress of labor is assessed by comparing the variables of labor to known standards. The variables examined include dilatation rate, rate of descent, time between contractions and contraction duration. These variables are discussed in detail in Chapter 3. The fetal well-being is assessed from the fetal heart rate and its characteristics. Fetal heart monitoring is discussed fully in chapter 4. The time frame covered by the consultation is from the onset of labor to the end of the second stage of labor or the birth of the newborn.

CHAPTER 2

SPECIAL VP-EXPERT FEATURES UTILIZED IN LABORCONSULT

2.1 Introduction

VP-Expert has the capability to interact with a spreadsheet
or database. The user may be transferred to the worksheet,
or the inference engine may carry out commands which require
interaction with the worksheet "behind the scenes", without
the user seeing the data transfer (1). (see figure 2.1)
These capabilities allow the addition of some special
features in the expert system LaborConsult.
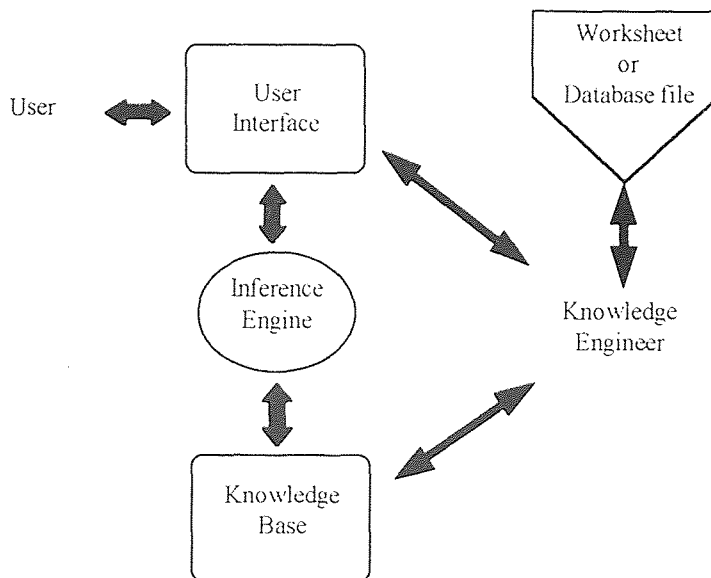
Figure 2.1 Components of an expert system having interface capability with worksheet or data files. This feature is available with the expert system development tool, VP-Expert.

These features include: 1) writing data on a spreadsheet to create an addition to the patient chart, 2) the capability to open an existing spreadsheet and resume the consultation where it was suspended, 3) the ability to transfer directly to the worksheet, so that the file can be printed or a graph created. The 1-2-3 spreadsheet was chosen because of its compatibility with VP-Expert and because it is widely used. The reader may refer to the actual consultation program located in appendix E. Numerous remark lines in the expert system file explain the sections described in this chapter.

2.2 Writing Data onto 1-2-3

LaborConsult makes use of the VP-Expert command PWKS (put into worksheet) to record data onto the spreadsheet. These commands, located in the actions block or in some rules, carry out the transfer of data without requiring the user to exit the consultation.

The command looks like this (6):

PWKS [variable, location , wks filename]

Variable refers to the data that is being transferred. The location refers to the cell, row, column or range in the worksheet. (In this expert system, only cells or columns are used.) The filename is always LaborRec, which is the name of the working 1-2-3 file during the consultation (6).

2.2.1 Patient Information

The first set of data that is written on the worksheet is
patient information. This includes the patient's name and
age, gravidity(sequence number of the current pregnancy),
parity(sequence number of the current live birth), and the
date and time of admission. This information is written
directly into predetermined cells on the 1-2-3 file
LaborRec. Figure 2.2 shows how this portion of the
spreadsheet may appear.

A1: [W8] 'PATIENT

	A	B	C	D	E	F
1	PATIENT NAME		JANE DOE	ADMISSION DATE		AUG 00 00
2	PATIENT AGE		25	TIME LABOR BEGAN:		PM 1200
3	GRAVIDA	3		STATUS: ACTIVE		
4	PARA	2				
5						
6	TIME	DILATATION	DIL_RATE	STATION	DESC_RATE	CONTRACTION
7	3.00	3.00	0.00	0.00	0.00	4.00
8	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2.2   Screen view of worksheet - patient information.

patient information is included to make this spreadsheet a document to be added to the patient's chart. The data is obtained from the first set of actions which are carried out by the inference engine.

2.2.2 Writing the Variables of Labor

Once the patient information is recorded, the consultation enters the second section of the actions block, the analysis loop. During each cycle through this loop, the values of elapsed time in labor, cervical dilatation, fetal station, the time between contractions and contraction duration are obtained from the user. Since these variables change as the consultation progresses, they are stored in VP-Expert as dimensioned variables. For example, the first value of cervical dilatation obtained is stored as DILATION[1]. During the analysis loop these variables are written onto the worksheet into a predetermined column, under the appropriate heading.

Once two consecutive values of time, dilatation, and station are known, LaborConsult calculates the rates of dilatation and of descent by carrying out the following calculations: (N is the number of the current loop cycle)

$$\text{Rate of Dilatation} = \frac{(\text{Dilation}[N] - \text{Dilation}[N-1])}{(\text{Time}[N] - \text{Time}[N-1])}$$

$$\text{Rate of Descent} = \frac{(Station[N] - Station[N-1])}{(Time[N] - Time[N-1])}$$

It is these variables which are used to determine the status of the labor being analyzed. This data is also then stored as dimensioned variables and written onto the spreadsheet in a a column format. Figure 2.3 is a sample spreadsheet with columns of data. The user may enter 1-2-3 directly to view the spreadsheet, or the expert system will display it if requested at appropriate stages during the consultation.

2.3 Reading Data From 1-2-3

In addition to writing data into a spreadsheet, VP-Expert also allows data to be read from a worksheet into its working memory. This is carried out using the WKS command (6):

WKS [variable, location, wks filename]

The command is similar to the PWKS command. The name that is placed in the position for the variable will be the variable name for the data in VP-Expert (6).

As mentioned previously, after obtaining patient information, this consultation enters a loop. During each run-through, the user is asked for the appropriate values. The dilatation and descent rates are calculated, and all this information is written under the appropriate column on the spreadsheet. At the end of each cycle, the user is asked if he desires to continue, or to stop. If stop is

	A	B	C	D	E	F
1	PATIENT NAME		JANE DOE	ADMISSION DATE		AUG 00 00
2	PATIENT AGE		25.00	TIME LABOR BEGAN:		PM 1200
3	GRAVIDA	3		STATUS: ACTIVE		
4	PARA	2				
5						
6	TIME	DILATATION	DIL_RATE	STATION	DESC_RATE	CONTRACTION
7	3.00	3.00	0.00	0.0	0.0	4.00
8	4.00	4.00	1.00	0.00	0.00	4.00
9	5.00	5.00	1.00	0.00	0.00	3.00
10	6.00	6.00	1.00	0.00	0.00	2.50
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	8.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2.3 Screen view of worksheet - data columns.

chosen, the loop is exited and the consultation is finished. However, the use of the WKS command allows a previously exited file to be reopened, and more data added as wished. This is accomplished by reading the patient information and dimensioned variables back into the consultation's working memory.

2.4 Transfer to 1-2-3 Worksheet from the Consultation

The use of PWKS and WKS allow the user to write to and read from the 1-2-3 worksheet. These commands are carried out "behind-the-scenes"; the user does not see the worksheet

while these commands are carried out. At the end of each analysis cycle, however, the user may be transferred to the worksheet (see figure 2.4) where the user can view it, print out a copy, or use 1-2-3 commands to create a graph. A graph may be useful to view dilatation vs. time or fetal station vs. time [11]. This transfer is carried out using the VP-Expert command CCALL. When the user quits out of 1-2-3, he or she is automatically returned to the consultation at the exact point where it was suspended.

The user may find it helpful to create a graph of cervical dilatation or fetal station versus time. This can be done while in 1-2-3, after viewing the spreadsheet containing the consultation data. The steps for doing this are as follows:

1. Type "/ Graph" to enter the graphing mode.

2. Set graph TYPE to XY.

3. Set X range. Do this by placing the cursor on the first entry in the TIME column. Type ".." to indicate that this is the first data point. Then move the cursor down to the last entry in the TIME column. This will highlight the desired range. Type ENTER.

4. Set the A (first data set) range. Choose either dilatation or station. Set the range as in the previous step.

5. Enter the OPTIONS mode and manually select the axis ranges. Choose 0-14 For the X-axis (time), and for the Y axis either 0-10 (cervical dilatation) or 0-4 (station).

(Standard Friedman curve ranges, discussed further in
Chapter 3.)

6. Select VIEW to see the graph.

7. SAVE the graph using a specific name.

8. Print the graph by exiting 1-2-3 and entering the command
PGRAPH.EXE. Simply choose your saved graph by name and
enter the command GO. (More recent versions of 1-2-3 allow
printing directly from the spreadsheet screen.) See figure
2.5 for a sample dilatation vs. time curve printed using
PGRAPH and sample 1-2-3 data.

```
Do you wish to view the worksheet data and/or
     create a graph of the data gathered so far?
  NO                          YES
```

Figure 2.4   Screen view of 1-2-3 transfer query.
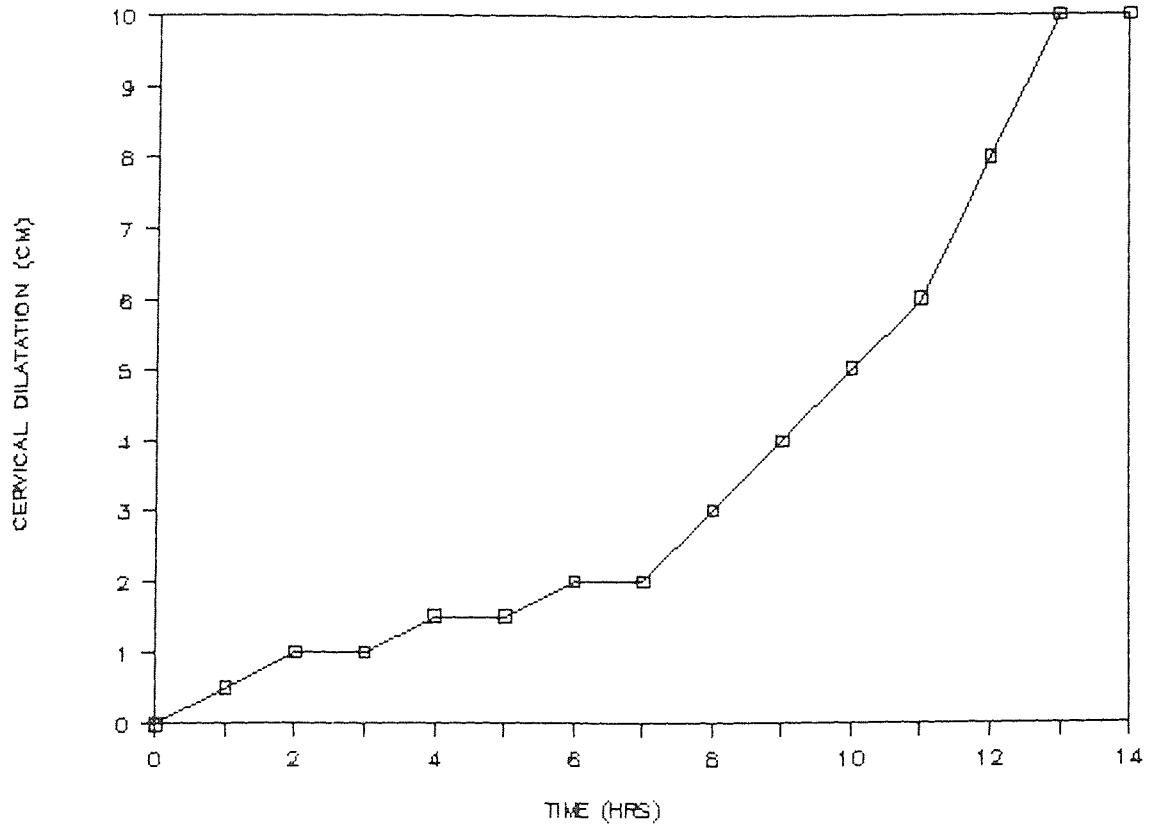
Figure 2.5 Sample graph created using 1-2-3 and PGRAPH.

CHAPTER 3

THE VARIABLES OF LABOR

3.1 Introduction

The intent of this project is to develop an expert system
which will alert the practitioner when any of the variables
of labor fall out of the normal range. The system will also
suggest an appropriate course of action. The variables of
labor assessed by this expert system, LaborConsult, include
dilatation of the cervix and it's rate of change, station of
the fetus and the rate of descent, the time between
contractions and the contraction duration, and the fetal
heart rate and it's characteristics. Figure 3.1 displays
the order and flow of the decision making for this
consultation. Each assessment box represents a group of
rules pertaining to the variable or variables being
assessed. In this chapter, the variables relating to
dilatation, fetal position and descent, and contractions are
examined. A flowchart is presented for each to display how
the expert system makes decisions. The fetal heart
variables are discussed in the following chapter.

3.2 The Friedman Curve

Of great importance in clinical decision making are the
variables plotted on the Friedman curve: cervical dilatation
and fetal station. This graph was developed by Dr. Emmanuel
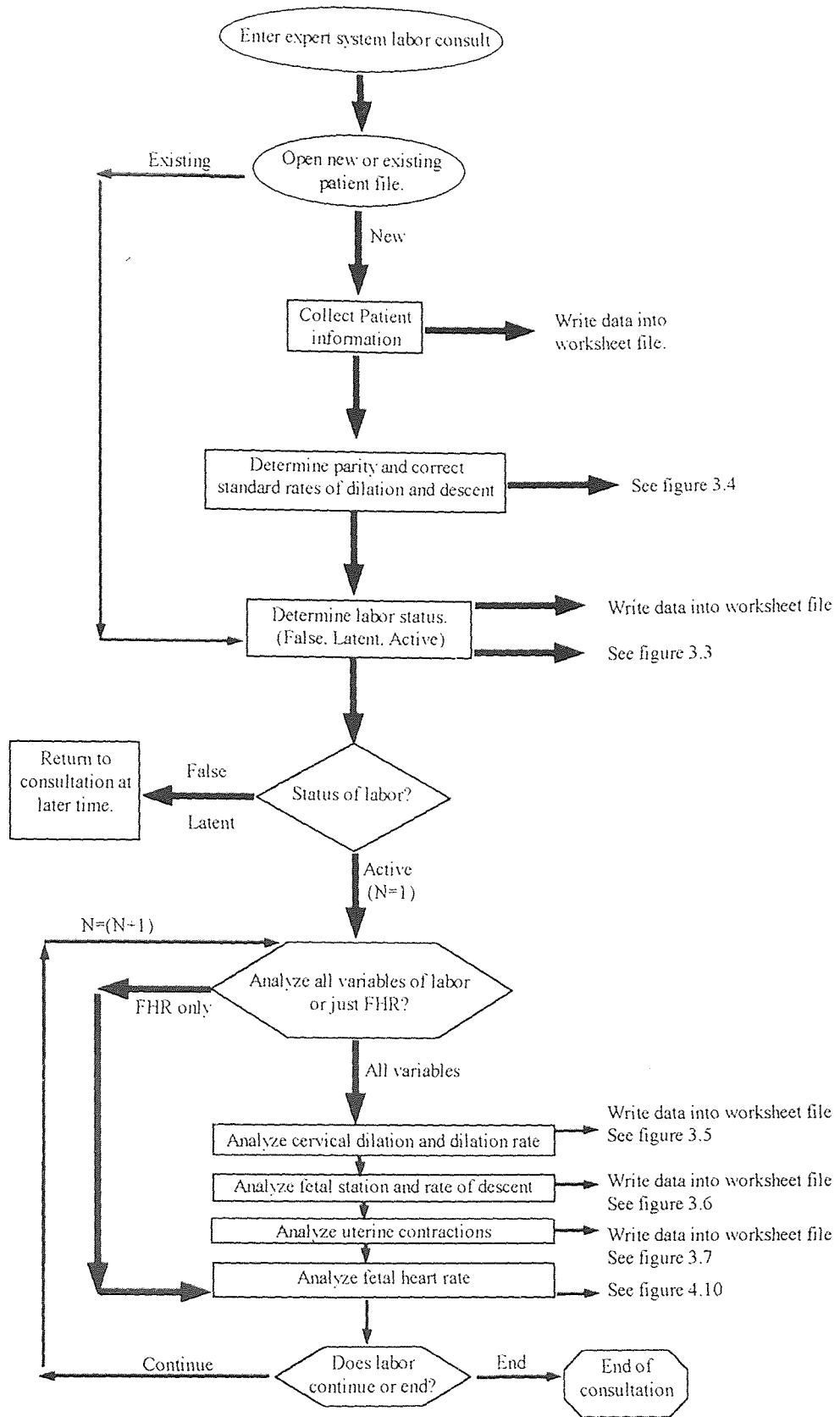
Figure 3.1 Expert System Labor Consult

Friedman to objectify and standardize the definition of
"normal labor". He also hoped that a graphical presentation
of labor data would help clinicians more easily identify
abnormal progress of labor, allowing for earlier
intervention (8,14). (See figure 3.2)

Labor is divided into three stages. The first stage
starts when contractions first begin and ends when the
cervix is fully dilated at 10 cm. The second stage begins
at 10 cm dilation and ends with the birth of the baby. The
third stage of labor covers the expulsion of the placenta
and is not included in this consultation (7,13). During the
second stage, this consultation deals only with the
assessment of the fetal heart rate. This is because the
quantifiable variables, especially cervical dilatation, have
stopped changing. Therefore this chapter deals with changes
that are occurring during the first stage of labor.
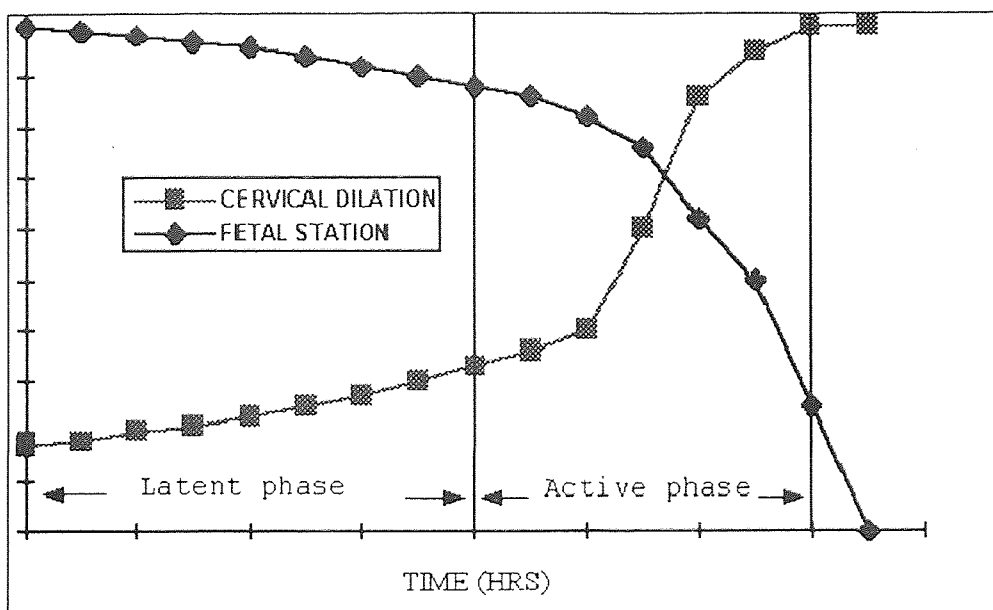
Figure 3.2 The Friedman Curve

Table 2 Determining labor status and subsequent action.

Cervical Dilatation	Pregnancy Length	Labor Status	Subsequent Action
< 3 cm	< 38 weeks	False	End consultation
< 3 cm	term (>= 38 weeks)	Latent	Observe 12 hours or until dilatation = 3 cm.
>= 3 cm	< 38 weeks	Active – pre-term	Treat for pre-term labor
>= 3 cm	term (>= 38 weeks)	Active	Continue with consultation

3.2.1 The Stages of Labor

The first stage of labor is broken down further into two
phases, the latent phase and the active phase (8,13,14).
Analysis of figure 3.2 shows that the latent phase of labor
is characterized by a slow change in cervical dilatation and
fetal station. The end of the latent phase is reached when
the cervix has dilated to 3-4 cm (7). At this time, the
rates of change increase, indicating that active labor has
begun. If the pregnancy is at term (>= 38 weeks duration),
and the dilatation is less than 3 cm, the status of labor is
latent.   If the patient is not at term (<38 weeks), and is
dilated to less than 3 cm, the diagnosis is Braxton-Hicks
false labor. Any patient in labor with a cervical
dilatation of 3 cm or more is in active labor, regardless of
the duration of the pregnancy. Table 2 shows how
LaborConsult evaluates the status of labor and the
recommended courses of action.

3.2.2 Cervical Dilatation

The rate of cervical dilatation in the active phase of labor
is one of the most important indicators of normal or
abnormal progress. Along with failure of the fetus to
descend, it is the most common reason for emergency cesarean
section (7). One of the factors on which the dilatation rate
depends is the obstetrical history of the mother, who in the
clinical setting is called the gravida. If the gravida is
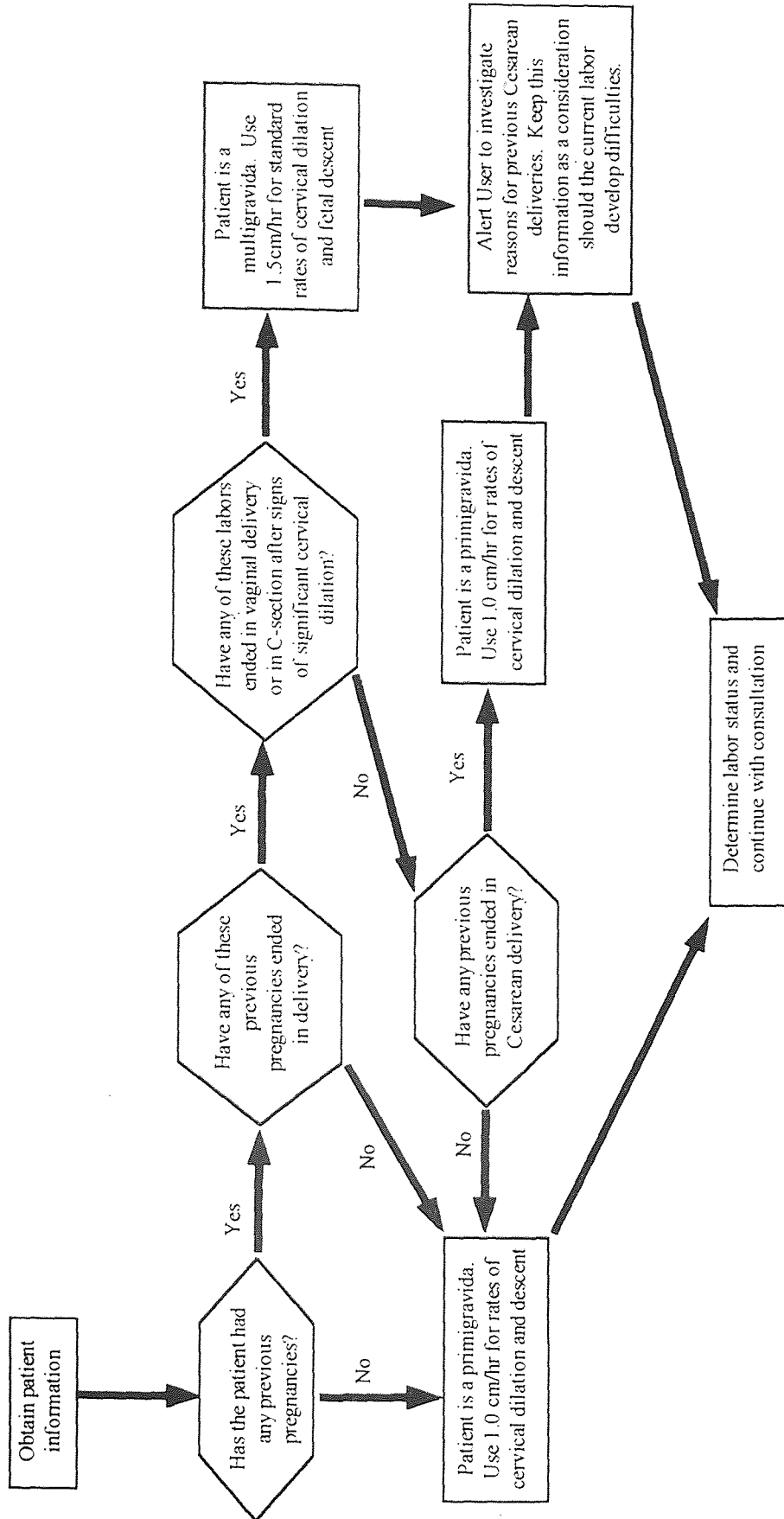
Figure 3.3 Flowchart to determine the correct standard rates of cervical dilatation and fetal descent.

experiencing her first labor and/or childbirth, she is
called a primigravida or nulliparas. This grouping
includes the gravida who may have delivered previously, but
only by cesarean section, with no active labor having taken
place.

The distinction is made between the nulliparas and the
multiparas, who has had active labor as the culmination of
one or more previous pregnancies. The cervix and birth
canal of the multigravida will accommodate stretching more
quickly during second and subsequent labors (7). During
active labor, the dilatation rate of the primigravida should
be not less than 1.2 cm/hr, and for the multigravida not
less than 1.5 cm/hr (7,8). Dr. Wilchins suggested relaxing
the rate for the primigravida to 1.0 cm/hr. If the rate is
too slow, assessment of contractions should be closely
examined. The presence of insufficient contractions leads
to the suspicion that the uterus is not providing enough
force to cause acceptable dilatation. This is an indication
for pitocin administration. If, however, the dilatation
rate is slow yet the contractions are normal, cephalopelvic
disproportion (CPD) or malpresentation is suspected.
Pitocin should not be used, and the fetal heart monitor
tracing should be watched closely for signs of fetal stress
or distress. If progress continues to stagnate, and/or the
fetal heart rate is showing a less favorable turn, a
cesarean section is often required.

All variables of labor
are being analyzed

Obtain the current values of cervical dilation and elapsed time. Place these values into the dimensioned variables: Dilation [N] and Time [N] respectively.

Is N>1?

Yes

No

Calculate the rate of cervical dilation:

$$Rate = \frac{(Dilation[N]-Dilation[N-1])}{(Time[N]-Time[N-1])}$$

A cervical dilatation rate cannot be calculated using only one data point

Is the calculated dilation rate ≥ the standard rate?

No

Yes

Progress is not acceptable. Check for abnormalities such as fetopelvic disproportion. Evaluate uterine contractions. If they are inadequate consider the use of pitocin

Progress is acceptable

Analyze fetal station and descent rate.

Continue with consultation.

Figure 3.4   Determining the progress of cervical dilatation

To decide if the rate of cervical dilatation is adequate, LaborConsult must first determine whether the current patient is a primigravida or a multigravida. The flowchart in Figure 3.3 shows how this is accomplished. Figure 3.4 then demonstrates how LaborConsult handles the assessment of dilatation rate.

3.2.3 Station of the Fetus

At the start of active labor, the fetal presenting part should be engaged in the pelvis. This corresponds with a station value of zero. A negative station value means that the fetus is still not engaged, while a positive value indicates that the fetus has begun to descend into the birth canal.

Examination of the Freidman curve shows that the rate of fetal descent is rather slow until the active stage of labor is well under way. The change in slope of the descent curve occurs at a cervical dilation of about 7 cm (7). At this time , Friedman reports the normal descent rate for nulliparas to be greater than or equal to 1 cm/hr, and for multiparas greater than or equal to 2 cm/hr (7). Dr. Wilchins has here recommended a multiparas rate of 1.5 cm/hr. If the rate is too slow, again special attention should be paid to the contractions. Inadequate contractions may be augmented with pitocin. A slow descent rate with adequate contractions, alternatively, leads to the suspicion of CPD. The presence of CPD usually necessitates a
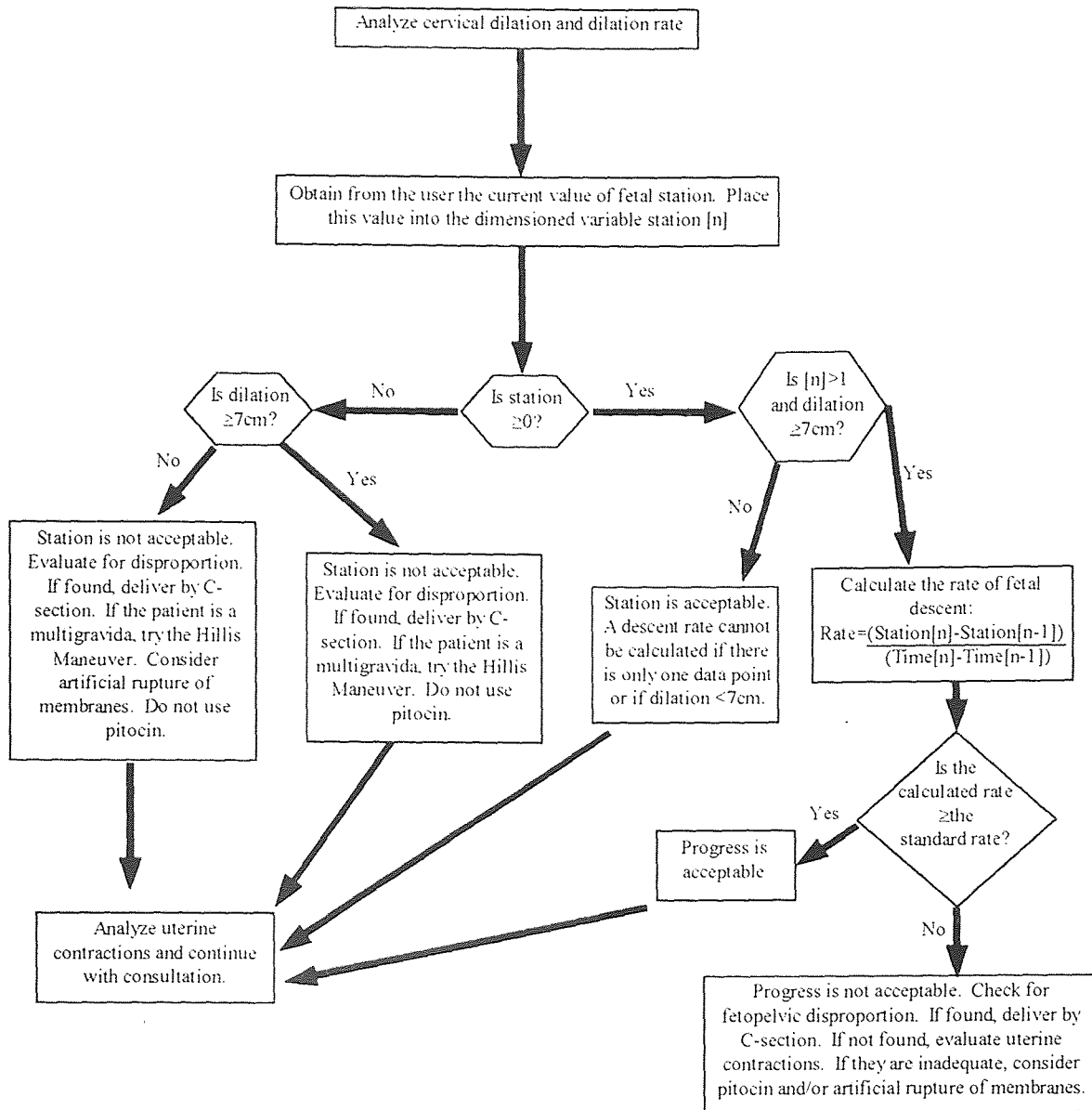
Figure 3.5 Determination of the status of fetal station and descent

cesarean delivery. Any time the descent rate is found to be too slow, the fetal heart monitor should be observed closely in case the fetus has trouble compensating for the delayed descent. Continued protracted descent despite pitocin, especially if the fetus begins to show stress, indicates the need for the delivery to be expedited. The flow-chart in Figure 3.5 displays how LaborConsult addresses station and rate of descent.

3.3 Uterine Contractions

During labor, cervical dilatation and fetal descent are accomplished in response to uterine contractions. Throughout pregnancy, the uterus remains mostly passive, but during active labor must exert force enough to produce an intrauterine pressure of at least 40 - 50 mm Hg (7). As labor progresses, the time between contractions should decrease while the duration of each contraction should increase. This change in the contractions is expected at about 7 cm dilation, corresponding with the increased rate of fetal descent.

The nature of contractions needed for a successful labor and delivery vary from woman to woman (7), so evaluation of uterine contractions is not as clear-cut as evaluation of cervical dilatation, station and descent. A contraction pattern that presents out of average ranges, combined with too slow dilatation and/or descent, can point strongly to a need for artificial labor augmentation as
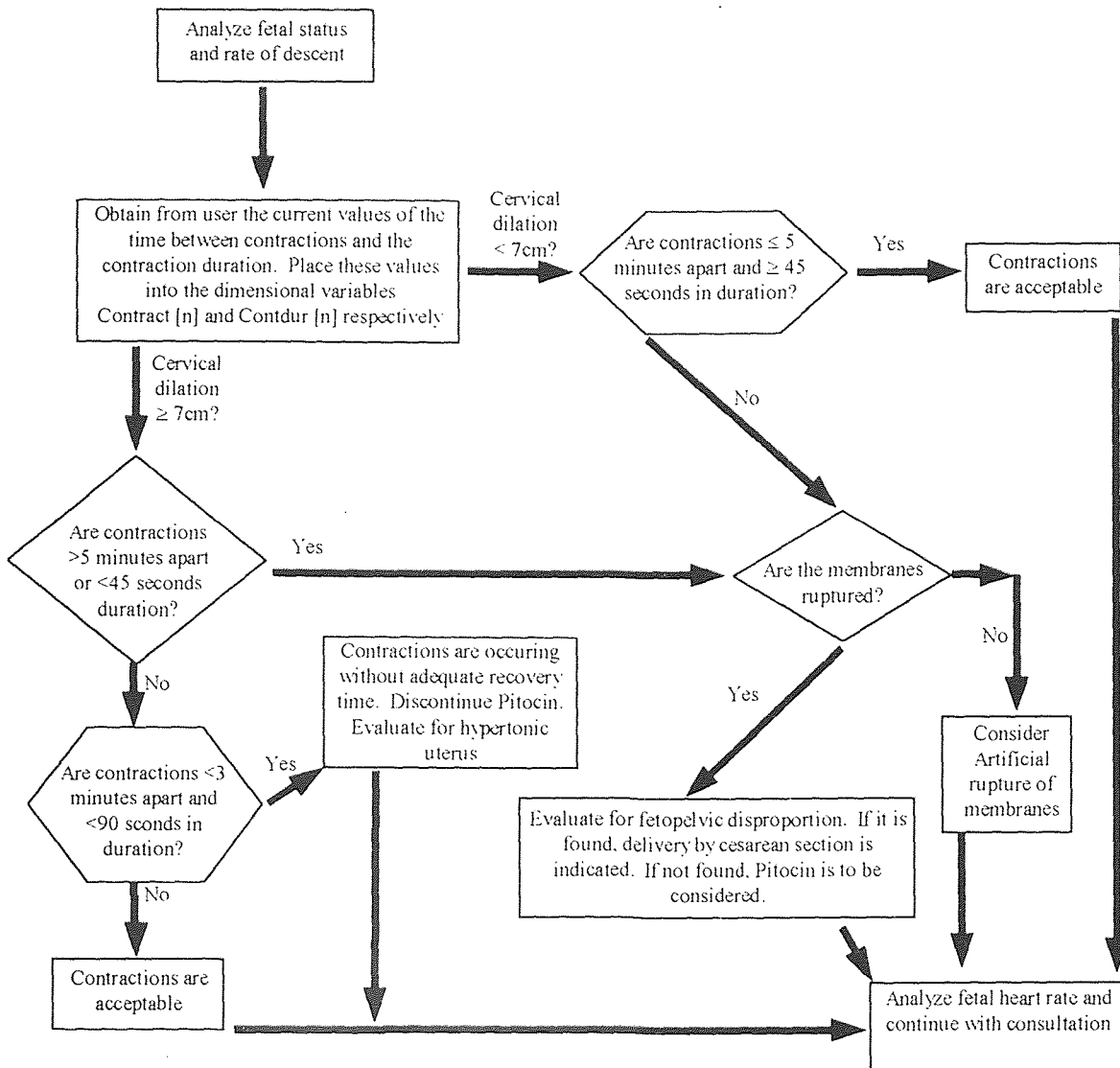
Figure 3.6 Flowchart to determine the adequacy of uterine contractions

provided by the administration of IV pitocin. Care must be taken, however, not to cause the contractions to become too strong or close together, as this may have an adverse effect on fetal oxygenation. Figure 3.6 displays the contraction evaluation component of LaborConsult.

CHAPTER 4

FETAL HEART MONITORING

4.1 Introduction

The variables examined in the previous chapter give a
picture of how labor is progressing. They can alert the
practitioner if the rates of dilatation or descent are
protracted or if pitocin augmentation is suggested. The
evaluation of the fetal heart rate (FHR) tells the
practitioner how the fetus is responding to the labor and
it's progress. The purpose of this chapter is to discuss
the basics of how electronic fetal monitors work and how
LaborConsult aids in the interpretation of fetal monitor
strips.

4.2 Electronic Fetal Monitoring

The nature of the fetal heart rate is a guide to fetal
well-being (9). If a prolonged labor, attempts to augment
labor using pitocin, or other factors are adversely
affecting the fetus, changes in the heart rate can alert one
to that fact. The best way to monitor the FHR is to use an
electronic fetal heart rate monitor. While periodic manual
auscultation can detect a seriously abnormal rate, the fetal
monitor allows the practitioner to see and often hear the
FHR as a function of time and of contractions. The FHR is
an indicator of the degree of oxygenation of the fetus (9).

Examination of the FHR can thus enable the practitioner to alter any conditions that can be altered and allow for better fetal oxygenation. If it becomes apparent that fetal oxygenation is poor due to unalterable factors, the delivery can be expedited.

In electronic monitoring, the fetal heart rate is plotted on a graph as a function of time. The paper is set to move forward 3 cm for every minute. The standard range on the vertical axis is from 30 - 240 beats per minute. Underneath and parallel to the FHR tracing is a graph of the intrauterine pressure as a function of time. This positioning of the two graphs enables the practitioner to see how the FHR is affected by the uterine contractions, as well as aiding in the recognition of contraction abnormalities. The vertical range for contractions is from 0 - 100 mmHg. The appropriate data can be obtained by internal or external methods. Refer to figure 4.4 to view a normal fetal heart rate tracing.

4.2.1 Internal Monitoring

Internal monitoring of the fetal heart is carried out by attaching an electrocardiogram (ECG) electrode to the fetal scalp, while the other electrodes are attached to the mother (9). The fetal ECG signal appears the same that of an adult or child, though it has a faster rate. Figure 4.1 shows an example of an ECG signal. The ECG signal is amplified and fed into a cardiotachometer. This device calculates a

series of heart rates by measuring the time between each R-
wave (chosen for their high-definition)in seconds and
dividing this into 60 sec/min. The output of the
cardiotachometer is a series of square waves, the amplitude
of which corresponds to each calculated rate (9).
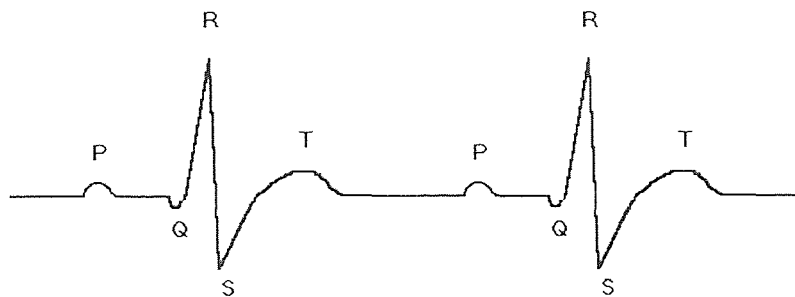
Figure 4.1 Sample ECG signal

The rate, and thus the amplitude of the square wave,
changes each time a new R-wave interval is measured (9).
Since for an average fetal heart rate the interval between
R-waves is approximately 0.5 sec, and there is 3 cm of paper
for every minute, there are about 40 square waves per
centimeter, or 0.25 mm for each square wave. Therefore, the
square waves appear smoothed out into a tracing on the
graph.

If an internal electrode is used for obtaining the
FHR, the intrauterine pressure can also be measured
internally using a fluid-filled catheter containing a
pressure transducer (9). This proportional signal is

amplified for use by the graphing recorder. Internal monitoring gives a very accurate picture of the FHR, it's changes, and the uterine contractions. It is the method of choice when any labor abnormalities are detected. However, it is an invasive procedure that requires the amniotic membranes to be ruptured. If this is not possible, external monitoring may suffice.

4.2.2 External Monitoring

Ultrasound has become an indispensable tool for the obstetrician today. In addition to producing a visual picture of the fetus, doppler ultrasound devices convert the doppler shift caused by fetal heart movement into an audible and electrical signal. The most common method of external monitoring uses doppler ultrasound to generate an electrical signal containing peaks which are counted as heart beats (9). These are then fed into a cardiotachometer, where the output is the same as in internal monitoring.

Other, less common techniques that can be used to generate a signal are abdominal ECG (weak fetal signal and too much interference from maternal ECG), and phonocardiography (too much interference from internal and external sounds) (9).

The signal produced by the external transducer is prone to error and interference. This can be caused by improper positioning, maternal obesity and fetal movement (9).
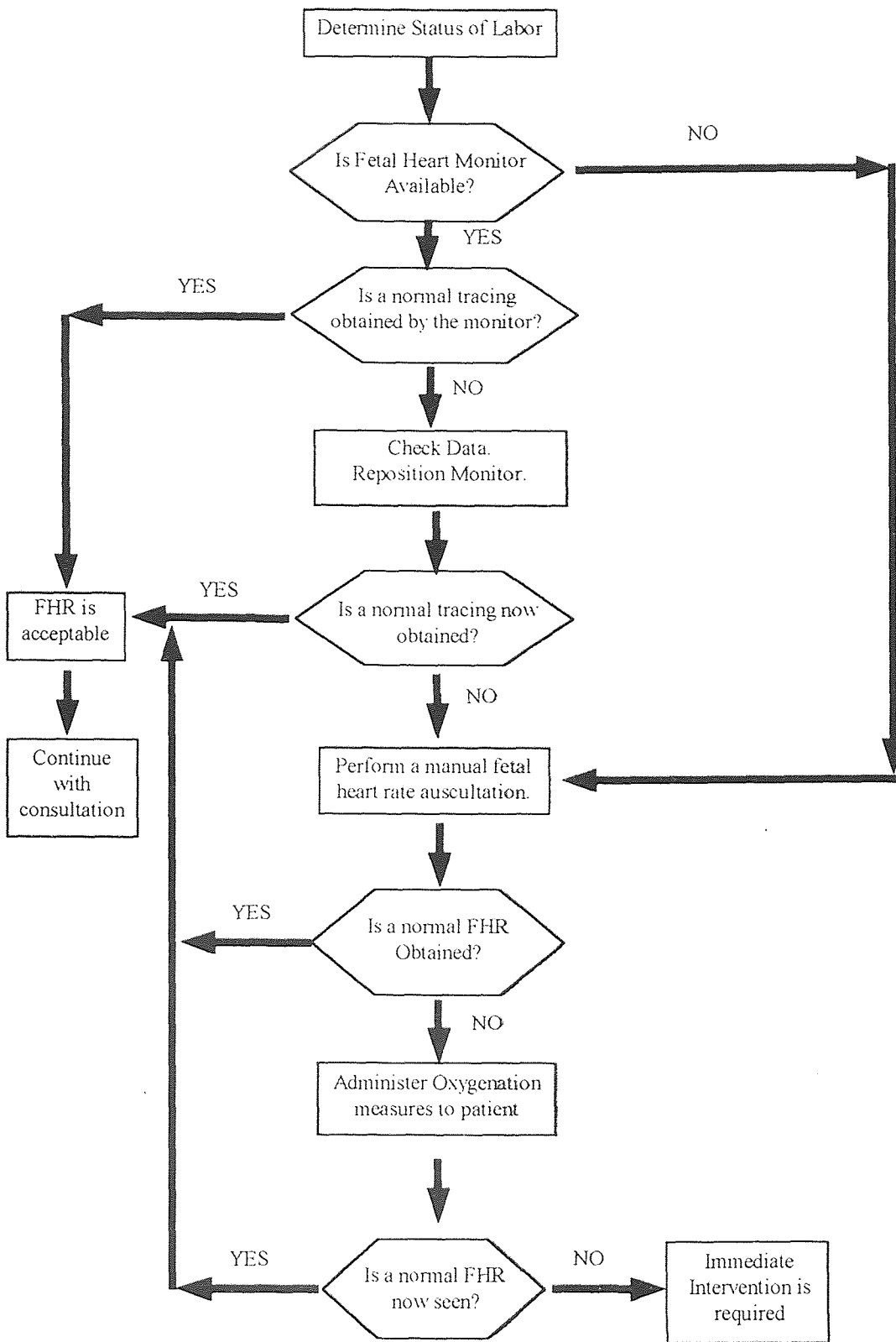
Figure 4.2 Flowchart displaying the initial evaluation of the fetal heart rate.

Uterine contractions are monitored externally with a tocodynometer. This device is a weighted pressure transducer which is strapped on to the abdomen (9). The pressure readings which appear during external monitoring are not as absolute as those obtained internally, however relative readings serve well for most situations.

4.3 LaborConsult and the Fetal Heart Rate

The LaborConsult expert system addresses FHR in two parts. First, when the consultation has just begun and all patient information has been gathered, LaborConsult asks the user to obtain a FHR, either manually or with the electronic monitor. This rough check is just to ensure that the fetus is alive and that the monitor is hooked up properly. If there is a serious abnormality with the FHR, then there is no purpose in continuing the consultation; immediate intervention is needed. Figure 4.2 shows the decision chart for this rough beginning check. The second section where the FHR is examined involves helping the user interpret the fetal monitor strip. This group of rules determine the value of the variable Condition, which can range from "good" to "monitor" to "expedite" and possibly "emergency". The determination depends upon the baseline heart rate, heart rate variability, and the nature of any periodic changes in heart rate. These variables are discussed in detail in the next section.

4.4 Interpreting the Fetal Heart Monitor Tracing

LaborConsult asks the user to examine the current tracing in regards to three variables: the baseline heart rate, how the heart rate changes (called variability), and any periodic features, such as accelerations (peaks) and decelerations (dips). While the status of these variables are entered into the consultation separately, they are actually somewhat interdependent. LaborConsult recognizes 10 different sets of conditions with appropriate actions. Generally, a given tracing will represent a fetus in one of three states: normal, stressed but compensating, and distressed (10).

4.4.1 The Normal Fetus

Defining what is meant by a "normal" fetus is difficult. For the purposes of this consultation, a normal fetus is one that needs no intervention during the labor process. The labor may be allowed to continue unaltered. The normal baseline heart rate is defined to be 120-160 beats per minute (9). Heart rates below this, down to 100 or even 90 beats per minute, while considered below normal, are still acceptable if the other heart rate variables are reassuring. The baseline should be nearly steady, a dropping or rising baseline is not reassuring, and a wandering baseline is a very ominous sign (9,10).

The fetal heart rate is controlled by both the parasympathetic and sympathetic nervous systems (9). While the parasympathetic signals the heart to beat slower, the

sympathetic signals it to beat faster. This push-and-pull
causes the heart rate to constantly vary. A normal fetal
monitor tracing shows this variability, resulting in a wavy,
rather than a straight line. Variability comes in two
types, long-term and short-term. Parasympathetic control
mainly affects short-term variability, while the
sympathetic system primarily affects long-term variability
(9). Both types cause a waviness to the tracing, resulting
in a wavy line which meanders as much as 20 bpm from the
mean. Figure 4.3 shows examples of fetal heart tracings. A
normal heart rate should have good long and short-term
variability.

Normal short and long term variability:

Normal short term, decreased long term variability:

Normal long term, decreased short term variability:

Decreased variability-significant indicator of stress:
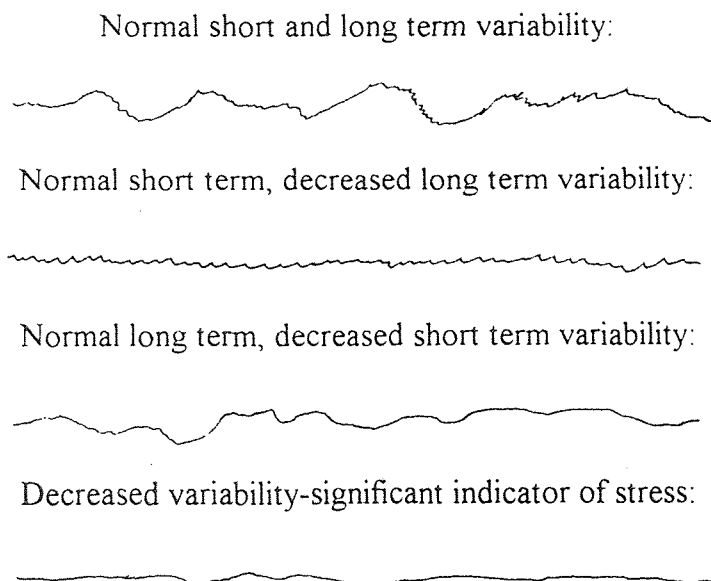
Figure 4.3 Fetal heart rate variability

Figure 4.4 Normal fetal heart tracing
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

In addition to this small-scale variability, which is caused by the fetal nervous system, the fetal heart rate may also vary due to external factors. Uterine contractions can have a tremendous affect on the FHR, depending on the positioning of the fetal head and the umbilical cord, as well as on the strength and time between contractions. Analgesics, anesthetics, pitocin, and certain maternal positions and conditions can also alter fetal oxygenation and therefore fetal heart rate. Catastrophic events, such as umbilical cord prolapse, uterine rupture or placental abruption can certainly cause fetal oxygen deficiency and thus alter the FHR (9,10).

Periodic changes in FHR are manifested by peaks (called accelerations) or dips (called decelerations) in the FHR tracing. These changes may be due to external factors such as those described above or to fetal anomalies. The classic normal FHR may show no accelerations or decelerations, or may show occasional accelerations. (see figure 4.4) The rise in heart rate is indicative of a moving, healthy fetus.

Certain deceleration patterns also fall into the normal range. "Early" decelerations occur at the same time as uterine contractions. They look like mirror images of the simultaneous contractions. To meet the definition of "early", these decelerations must return to the baseline before the end of the contraction (9,10). (see figure 4.5) Early decelerations are believed to be caused by a vagal
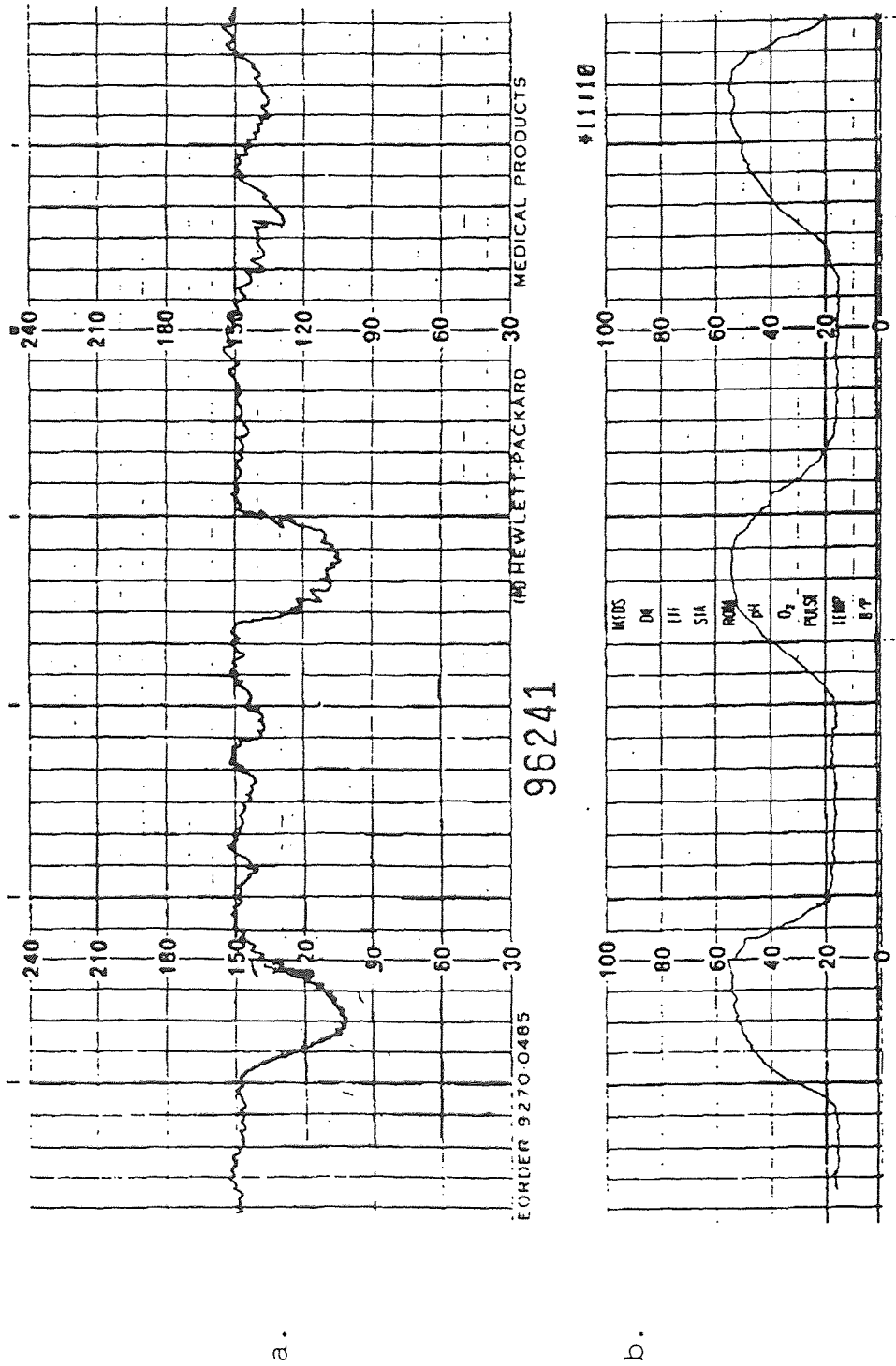
Figure 4.5 Fetal heart tracing showing early decelerations
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

response to fetal head compression during uterine contractions (9).

Also considered normal are mild "variable" decelerations. These decelerations occur at random throughout the tracing. Mild variable decelerations includes those that last less than 30 seconds, or that do not dip below 80 beats per minute. Variable decelerations which last longer than 30 seconds but less than 60 seconds are also considered mild if the do not dip below 70 beats per minute (10). Mild decelerations also return to the baseline without delay. (see figure 4.6) Variable decelerations are thought to be caused by a vagal response due to compression or stretching of the umbilical cord, and mild variable decelerations often appear during the second stage of normal courses of labor (9,10).

To summarize, a normal fetus has the following characteristics: a stable baseline heart rate between 100 and 160 beats per minute, ; normal short and long-term variability; occasional accelerations, or early or mild variable decelerations, or no periodic changes at all.

4.4.2 The Stressed Fetus

There are several conditions which could cause stress in the fetus. This consultation concerns itself with the stressed fetus that is compensating for decreased oxygenation. This compensation appears as changes in the fetal heart rate. The appropriate course of action has two components: try to
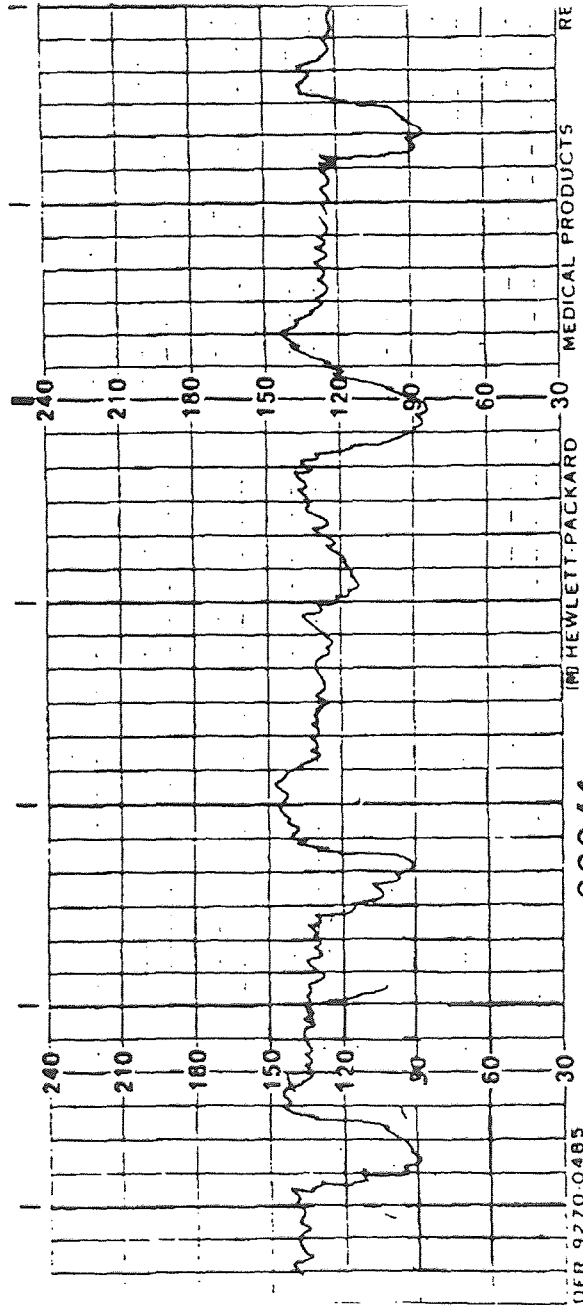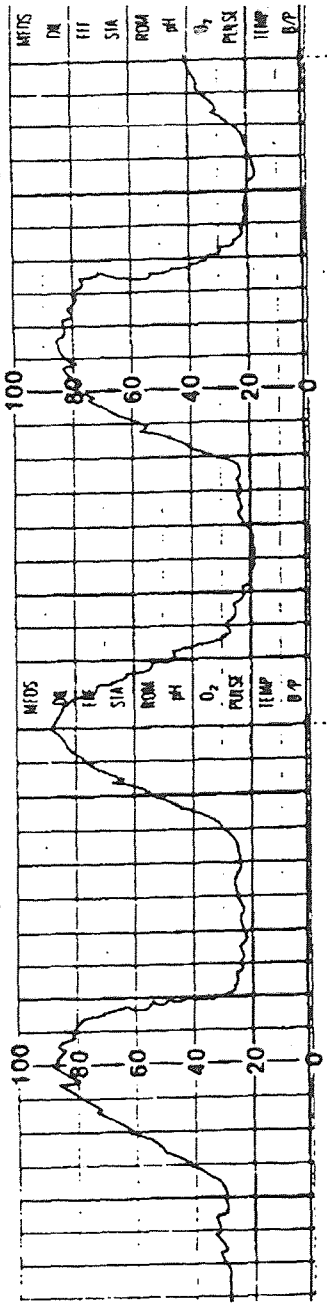
Figure 4.6 Fetal heart tracing showing variable decelerations
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

decrease the stress on the fetus by increasing oxygenation, and monitor closely in case the fetus' compensatory mechanisms begin to fail.

Techniques to increase fetal oxygenation include (9,10):

a) Stopping pitocin, so the fetus has more time to recover between contractions.

b) Placing the mother in the left lateral position to relieve any blood vessel occlusion.

c) Giving the mother oxygen and IV fluids to increase the volume of oxygenated blood available to the uterus.

LaborConsult suggests these measures in response to the following heart rate characteristics:

Tachycardia

Fetal tachycardia is defined as a heart rate greater than 160 beats per minute. While fetal hypoxia may cause tachycardia, so can other conditions such as maternal fever, drugs such as atropine and vistaril, maternal hypothyroidism, fetal anemia and amnionitis (9). If any of these conditions are known to exist, and tachycardia is the only symptom of stress, then there is likely no cause for additional concern. However, in the absence of these conditions, fetal hypoxia is suspected, and intervention is the suggested course of action. Tachycardia as an isolated symptom indicates mild fetal stress. If it occurs in the presence of other stress signs, severe hypoxia may be present.
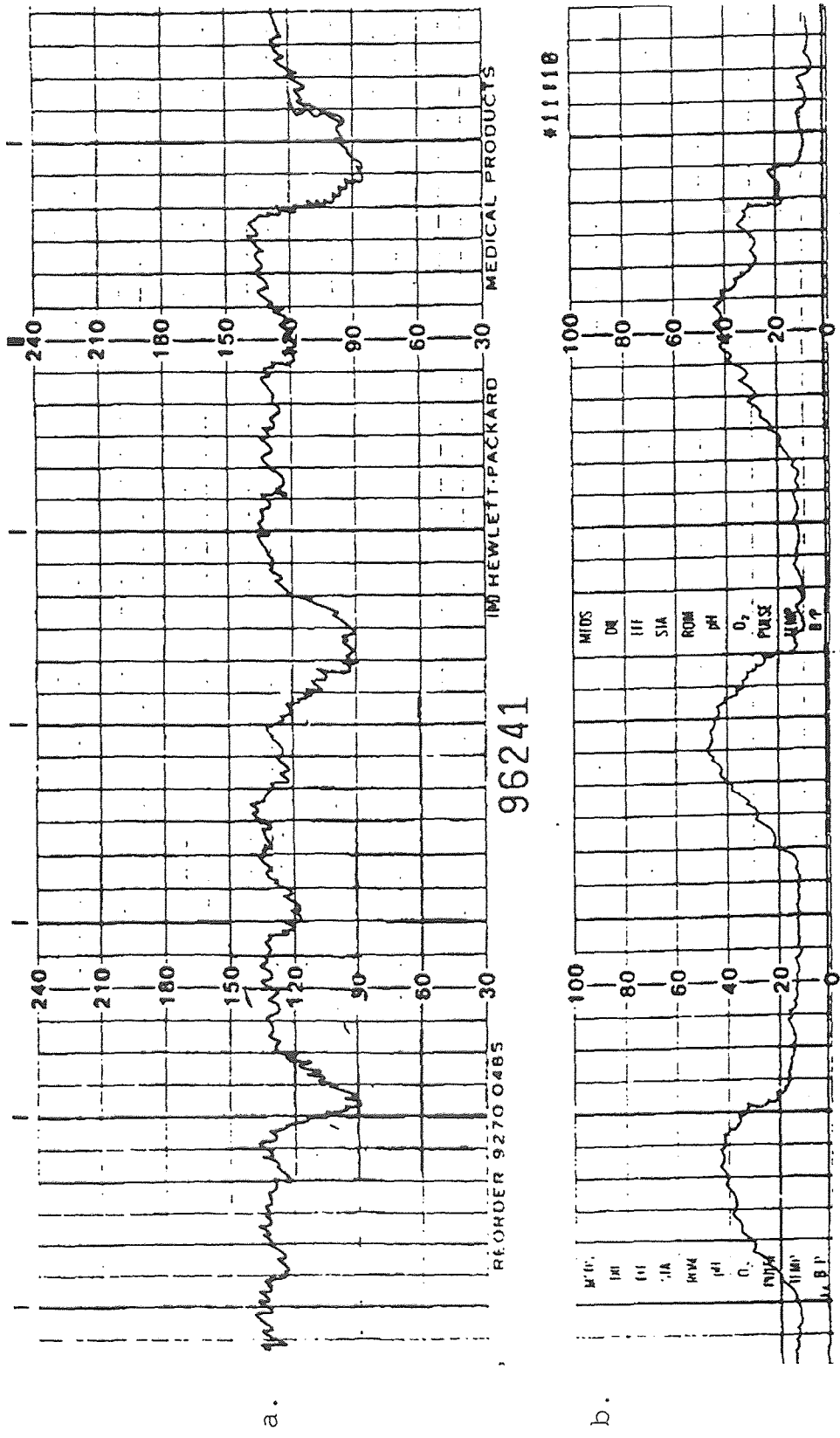
Figure 4.7 Fetal heart tracing showing late decelerations
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

Increased Variability

In the presence of mild hypoxia, the heart rate variability will become increased. This is a sign of fetal compensation (9). Because increased variability is hard to distinguish for the non expert practitioner, LaborConsult does not utilize this sign. The user will not be alerted unless the variability has decreased, a sign of fetal distress.

Decelerations

Fetal heart rate decelerations are caused by episodes of fetal hypoxia. These episodes can be mild, as seen in the normal fetus. They can also be moderate or severe. Short-term episodes of hypoxia cause no damage to the fetus, but prolonged or recurrent episodes may lead to low apgar scores and fetal insult.

An early warning sign that hypoxia is developing is often "late" decelerations with normal heart rate variability (9,10). These decelerations have the same shape as early and variable decelerations. However, late decelerations start after the uterine contraction has begun and return to the baseline after the contraction is complete (10). (see figure 4.7)

Late decelerations have a different cause than early or variable decelerations. They are caused by a parasympathetic response to decreased uteroplacental oxygen transfer to the fetus (9) . Refer to Table 3 for a comparison of early, variable and late decelerations.

Table 3 Causes of fetal heart rate decelerations (9)

Type of deceleration	Causative Mechanism
Early	Vagal response to fetal head compression during uterine contraction.
Variable	Vagal response to umbilical cord compression or stretching.
Late	Parasympathetic response to decreased uteroplacental oxygen transfer.

excessive uterine activity (9). The pressure of uterine contractions causes the arteries which supply the placenta to be momentarily constricted (9). Under normal conditions, the fetus tolerates these brief episodes well, and no heart rate decelerations develop. However, if contractions occur too close together, or if the uterus maintains a high pressure, as in tetanic uterus, the blood supply to the placenta may be insufficient. Thus, these conditions may cause late decelerations. This situation can be diagnosed by observing uterine contractions. The next step would be to cut back on or stop administering pitocin, and to observe the patient and the fetal monitor closely.

Late decelerations can also be caused by hypoxia due to maternal position. When the mother is in the supine position, the uterus has sufficient weight to squeeze large

maternal blood vessels between it and the spine (9). This will cause hypotension in the mother and decrease blood flow to the placenta. Therefore, it is preferable for the mother to avoid the supine position during the intrapartum and late antepartum periods (9).

In addition to uterine contractions and the supine position, late decelerations may appear following the administration of anesthesia, in the presence of placental abruption or in an aged or otherwise deficient placenta (9). Maternal hypotension or anemia can also decrease the blood supply to the placenta and fetus (10). Late decelerations with good variability are a sign that the fetus is stressed, and that action must be taken. Placing the mother in the left lateral position, stopping pitocin, hydrating the mother and administering oxygen are all methods of trying to correct the stress. If despite these actions the late decelerations persist, delivery must be expedited to prevent the situation from worsening and causing harm to the fetus.

The fetus may also become stressed from the umbilical cord compression that may occur due to uterine contractions, abnormal cord positioning, or in the second stage of labor, when the cord may be stretched or trapped between the fetus and the narrowing birth canal. These conditions will cause variable decelerations to appear on the fetal monitor tracing (10).
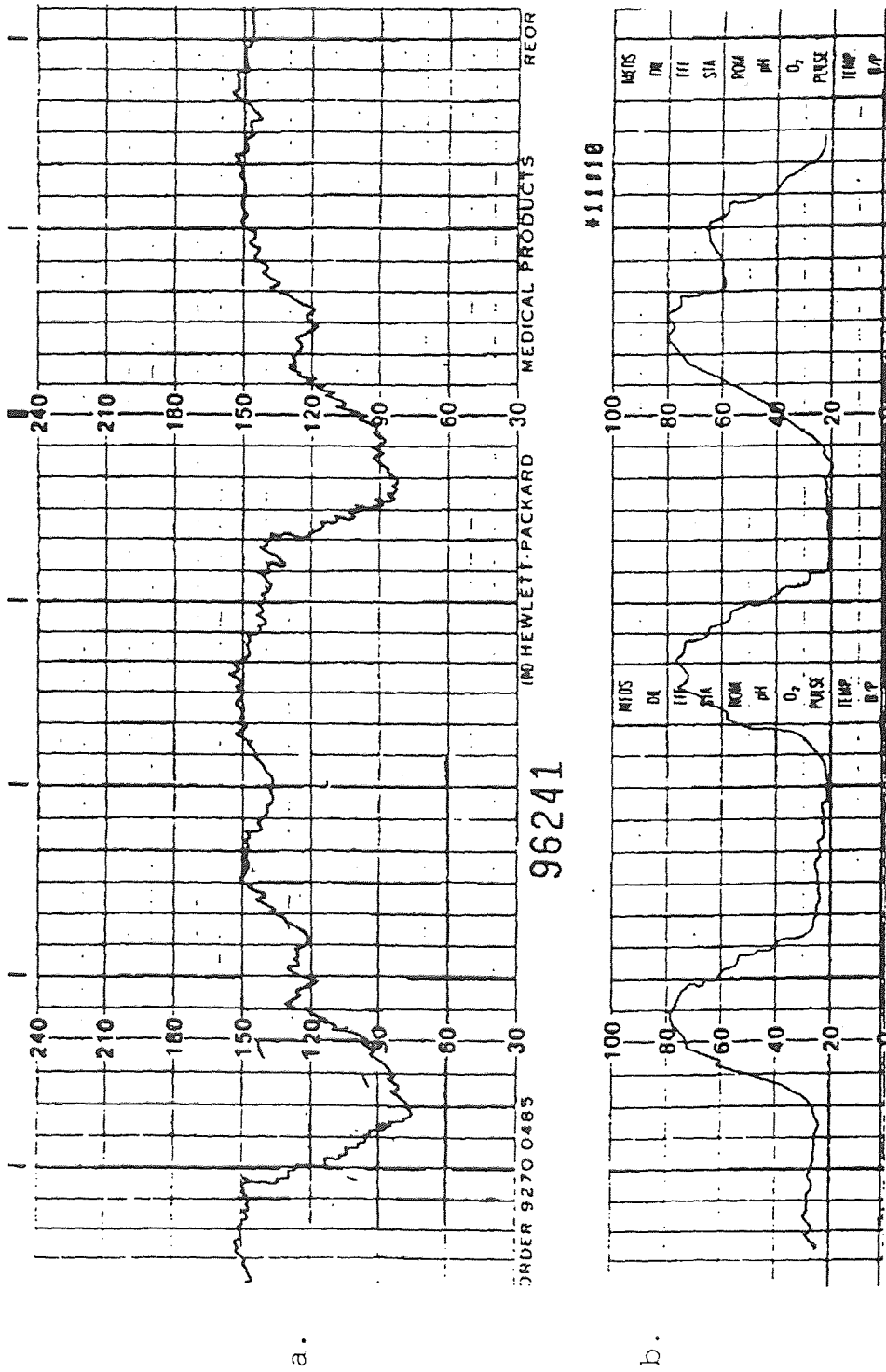
Figure 4.8 Fetal heart tracing showing a delayed return to baseline; compare to figure 4.6
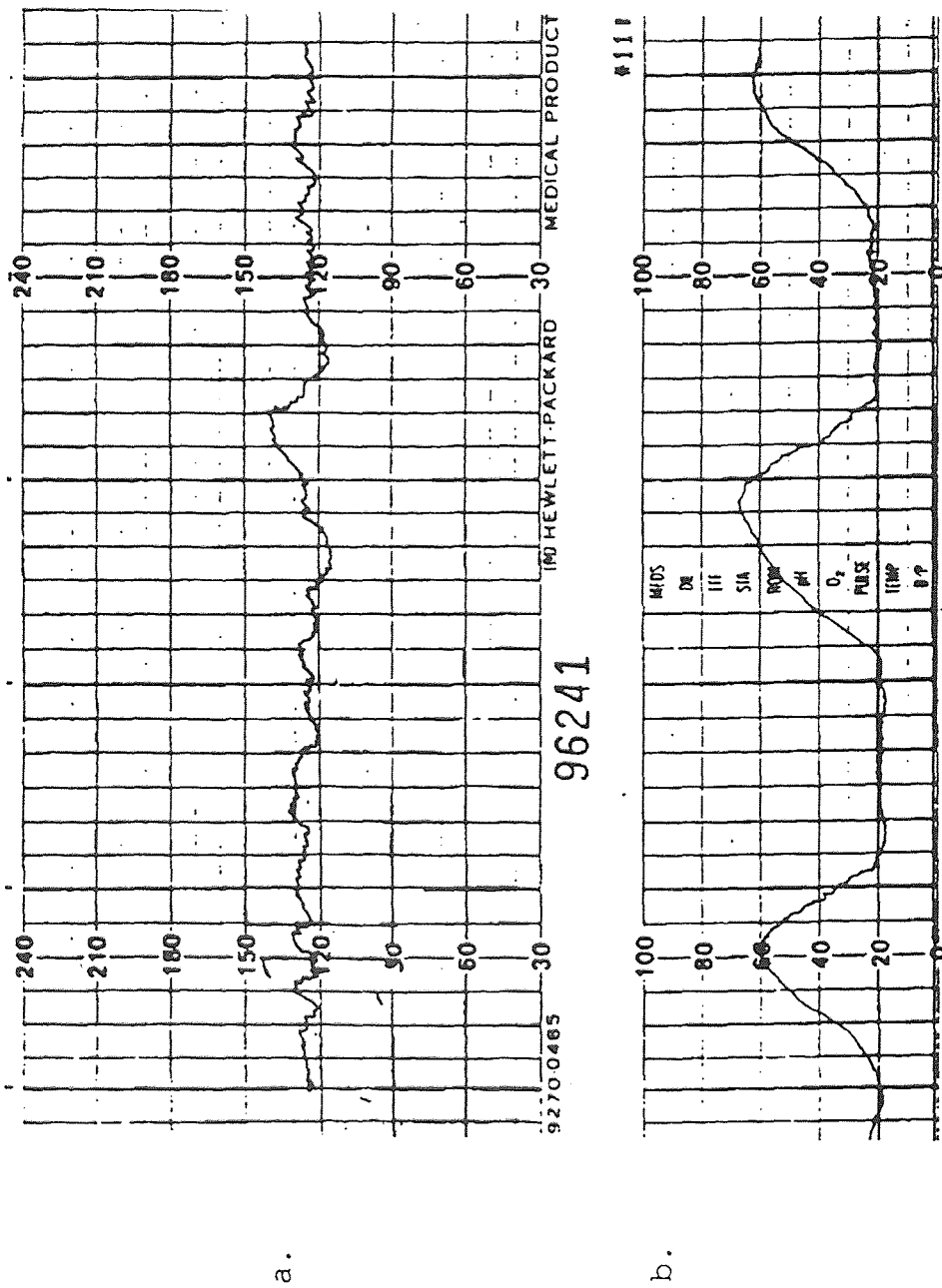a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

While mild variable decelerations are normal, especially during second stage labor, moderate and even more severe variable decelerations represent the stressed-but-compensating fetus, provided heart rate variability is normal. Variable decelerations are considered moderate if they last less than 60 seconds, or if they last longer, they do not dip below 70 beats per minute. Severe variable decelerations are those that last longer than 60 seconds and dip below 70 beats per minute (10). It is also important to observe the way the FHR returns to the baseline after each deceleration. A rapid return is consistent with fetal compensation; a delayed return indicates greater distress. (fig. 4.8)

There is somewhat less cause for concern when variable decelerations appear on the monitor tracing than when late decelerations are seen. As long as the variable decelerations have sharp edges and are not rounded, the situation is not as prone to deterioration, as opposed to the situation present with late decelerations. However, the user of LaborConsult is a non-expert. Therefore, the consultation assumes that a change in the nature of the variable decelerations, such as a rounding of the edges and a slowed return to baseline, may be missed. It also may be difficult to distinguish variable decelerations from the more serious late decelerations. The consultation thus treats moderate to severe variable decelerations as seriously as late decelerations. The final deceleration

pattern which LaborConsult recognizes as a stress pattern is the prolonged deceleration with full recovery (10). A prolonged deceleration lasts for one to two minutes or longer. Prolonged decelerations can be caused by several serious or even catastrophic situations such as umbilical cord prolapse, placental abruption, uterine rupture, maternal convulsion or cardiorespiratory collapse. They may also be caused by routine situations such as a vaginal exam, the application of the scalp electrode to the fetus, or the administration of epidural anesthesia or paracervical block (9,10). A prolonged deceleration may also occur in response to the same factors that produce late decelerations, or during rapid fetal descent.

If a prolonged deceleration occurs in the presence of normal variability, normal baseline heart rate, and a return to baseline that does not overshoot, the fetus is most likely compensating satisfactorily with the stress that caused the deceleration. The response of the practitioner to the prolonged deceleration is to increase the blood flow to the uterus (lateral positioning, administration of oxygen and IV fluids, cessation of pitocin), and to check for any of the serious conditions which may have precipitated the deceleration. The presence of these conditions necessitates immediate surgical delivery and intervention to prevent maternal and/or fetal injury or death (9,10). Alternatively, if a relatively benign reason has been found and the situation reverts to normal, there is no cause for

alarm.   The observation of a prolonged deceleration then is cause for an immediate investigation of possible causes, and close monitoring after the return to a normal FHR pattern.

4.4.3   The Fetus in Distress

The distressed fetus is one in which the compensatory mechanisms are failing or have failed. Significant insult to the fetus is occurring or is likely to occur unless intervention is undertaken. Appropriate intervention includes immediate measures to increase placental oxygenation (lateral positioning, stopping pitocin, administration of oxygen and IV fluids). In the stressed fetus, these measures are carried out in an attempt to relieve the stress while the FHR was observed further to see if these measures were successful. In a fetus displaying a distress FHR pattern, these measures are probably a quick first step in an aggressive attempt to prevent fetal and/or maternal harm (10). Unless the FHR returns to normal almost immediately, more drastic measures must be taken. This is likely to include expediting delivery; with forceps if delivery is imminent, or with a cesarean section.

Loss of heart rate variability (figure 4.6), with or without decelerations, is often a sign of fetal distress. This can be caused by severe hypoxia, necessitating immediate intervention. Loss of variability always precedes fetal death (10), or can be caused by fetal neurologic or cardiac abnormalities or prematurity (10). However it can
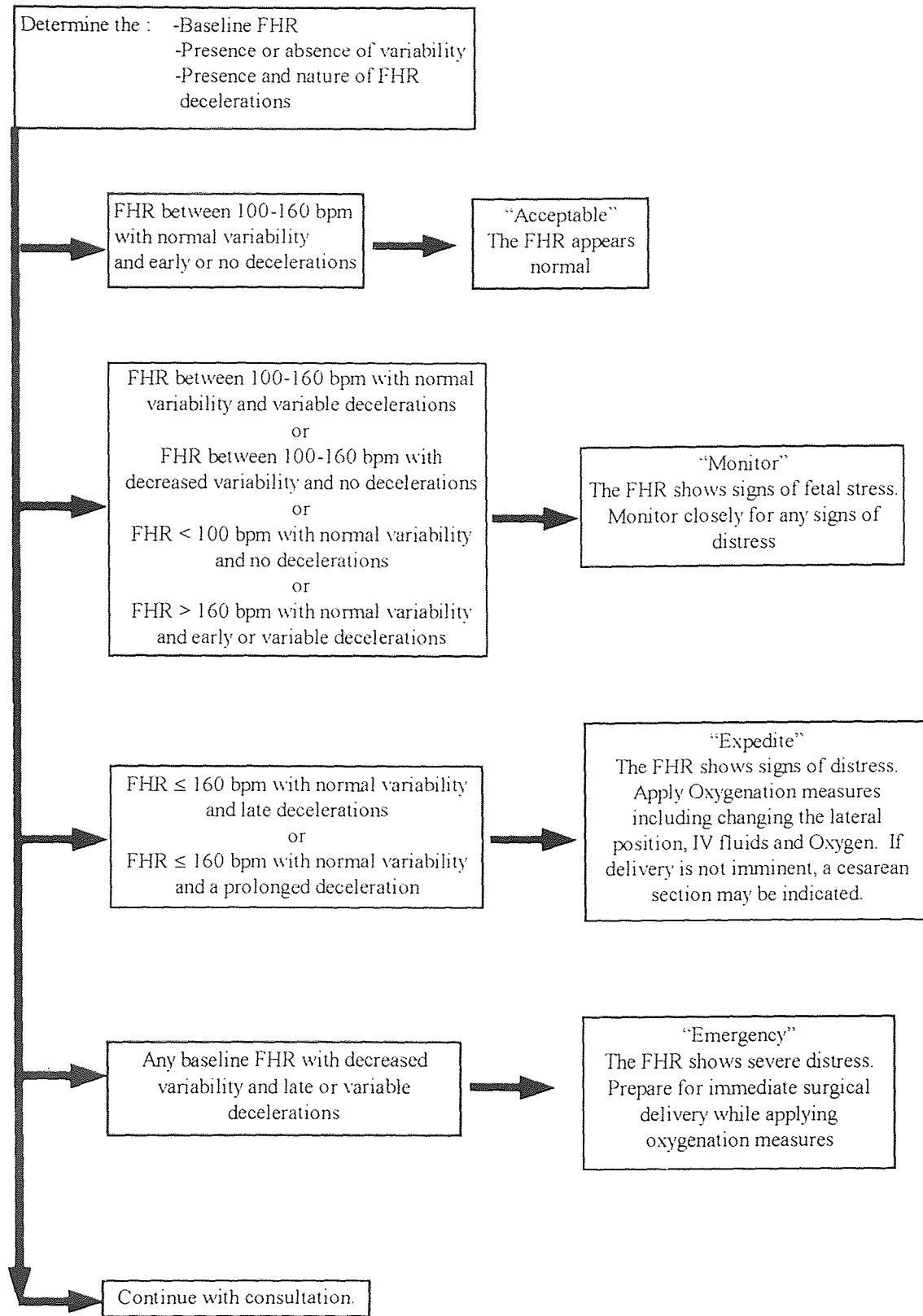
Figure 4.9 Flowchart to determine fetal condition

also occur during fetal sleep and inactivity or due to unknown cause (10). If the variability loss is caused by sleep or inactivity, it will return within a reasonable time. If it is caused by one of the other conditions the non-expert practitioner can not alter the outcome significantly. Therefore, LaborConsult reacts to loss of variability as if it were due to hypoxia, and the appropriate steps are suggested to increase fetal oxygenation. If the variability does not return within 15 minutes, delivery must be expedited. In the situation where an expert is available, the consultation can be overruled.

The monitor tracing with late or variable decelerations with little or no variability is representative of a fetus in distress. This pattern is most often caused by hypoxia and immediate measures should be taken to increase oxygenation. Should a favorable pattern not resume, delivery will be carried out by cesarean section (10).

Figure 4.9 displays the flow chart used by LaborConsult in assessing the fetal monitor data. Since the consultation was designed for the non-expert, the worst case is inferred from the data and the appropriate course of action is suggested. This may result in unnecessary surgical intervention (9). In practice, where an expert is available, the difficult to interpret tracing may be better responded to. In fetal heart monitoring, there is a high correlation between good patterns and favorable outcomes, but a non reassuring pattern does not always predict a poor

outcome (9). In situations where the use of Labor Consult is indicated, it is better to treat for the worst and hope for the best.

CHAPTER 5

VALIDATION OF LABOR CONSULT

5.1 Introduction

The figures that were displayed in the previous two chapters
represented groups of rules located in the consultation's
knowledge base. The text explained the scientific rationale
behind the rules. Now, the knowledge engineer must ask: Is
this consultation valid for the purpose it was designed?
Validation is assessed in several stages: Debugging, user
interface validation, knowledge base validation, and case
studies (1,2).

5.2 Debugging

The first phase of validation is debugging. This is the
process of checking syntax, spelling, and punctuation. The
development tool VP-Expert has a built-in debugging system.
This system alerts the knowledge engineer to errors in
syntax such as absent or misplaced punctuation. However,
inconsistencies such as misspelled variables must be found
manually. Even small errors can prevent a rule from
triggering. For example, the variable RATEDIL[N] is used in
LaborConsult to represent the current value of the rate of
dilatation. A simple misspelling such as RATDIL[N] or
leaving off the brackets such as in RATEDILN may be hard to
spot, but will certainly prevent that rule from being found
true.

5.3 Validation of the User Interface

This phase of validation examines the expert system from the user's point of view. Are the questions presented in a logical order? The messages that appear in LaborConsult should leave no doubt as to the status of the labor and the appropriate courses of action.

LaborConsult has three main types of messages: status messages, instructions, and warning messages. Status messages inform the user that the labor is currently normal. This type of message is important, because the user is reassured that all is well. Instructional messages appear when LaborConsult needs further information before the status can be concluded. Finally, warning messages are those which alert the user that one or more of the variables of labor are out of normal range. Many warning messages also contain instructions. Appendix A contains most of the messages that may be displayed during a consultation. Figures A.1 - A.9 are status messages, figures A.10 - A.12 are instructions, and figures A.13 - A.20 are warning messages. Additional messages are shown in the case studies to follow, and which appear during the analysis of the FHR are discussed in detail in section 5.6.

5.4 Validation of the Knowledge Base

In this phase of validation, the rules must be checked for logic, consistency, contradictions and completeness (1). the consultation's rules block is grouped so that rules

Table 4 Data for rule base validation – variables of labor.

Diagnosis	Dilatation	Station	Rate of Dilatation	Rate of descent	Time between contractions	Contraction duration
Latent phase	< 3cm	any	any	any	any	any
Fetal presenting part not engaged	>= 3 cm	< 0	any	any	any	any
Protracted Dilatation	>= 3 cm	>= 0	< 1.0 cm/hr for nulliparas <1.5 cm/hr for multiparas	any	any	any
Protracted Descent	>= 7 cm	>=0	any	< 1.0 cm/hr for nulliparas s <1.5 cm/hr for multiparas s	any	any
Inadequate Contractions: Too far apart Inadequate duration	>= 3 cm >= 3 cm	>=0 >=0	any any	any any	> 5 min any	any < 45 seconds
Too active contractions	7 - 10 cm	>= 0	any any	any any	< 3 min	> 90 seconds

assessing each variable of labor are together and numbered consecutively. They are then analyzed to be sure that there are no redundant or conflicting rules, or rules with unattainable values. All rules must be able to be triggered by a possible set of circumstances, *and* all possible sets of circumstances must be reflected by a rule. That is, the rule base must not have unattainable or redundant rules, and it must be complete (1). Evaluating the rule base involved two steps. First, a table was made which represented all the possible values of a particular variable. Using a hard copy of the rule base, the consultation was "run" manually, checking off each rule as it was used. Notations were made regarding missing and seemingly redundant rules; these situations were rectified with the input of the expert.

The second step for rule validation required actual consultations on the computer. The attempt was made to evaluate every reasonable value of each data point. Table 4 shows a sample of the test data used for evaluation of the rules regarding the variables of labor.

5.5 Case Studies

After carrying out the first three stages of validation, presumably the expert system is consistent with its original objectives. The final test, however, is to compare the output of the consultation with that of human experts, preferable using real data, such as case studies. Two such cases were obtained for this purpose.

Obtaining data to test this consultation was difficult. Ideally, a fetal monitor strip is needed, along with doctor's and nurse's notes about vaginal exams, medications given, and the use of oxygen or IV fluids. Also necessary is information regarding the mother's obstetrical history and the outcome of the labor and delivery, such as apgar scores and newborn progress. Unfortunately, such exhaustive information was not available. Data was acquired for two cases in sufficient amounts for appropriate case studies.

5.5.1 Case A - Good Outcome

Case A represents a labor which ended in a satisfactory outcome for the fetus. Available data included a complete fetal monitor strip with 6 recorded measurements of cervical dilatation. Notes were obtained regarding pitocin administration and changing of maternal position. It is known that the gravida had one previous labor which ended in delivery, and is thus a multigravida. The apgar scores for this newborn were 3 at 1 minute and a much improved 9 at 5 minutes. One important variable of labor that was unavailable was fetal station. Consequently, evaluation of station and the rate of descent could not be included in this case study.

Evaluation of this labor begins in the latent phase, at 2 cm dilation. Since pitocin was being administered at this time, it is assumed that more than 12 hours had passed since the labor had begun. Table 5 shows data obtained from the

Table 5 Data obtained from labor – Case A

TIME	DILATATION	CONTRACTIONS	DURATION	FETAL HEART RATE
PM 310	2 cm	Latent labor		140 bpm accelerations, good variability
PM 415	2.5 cm	Latent labor		135 bpm acceleractions, good variability
PM 515	-	Latent labor		140 bpm good variability
PM 538	3 cm	1 min.	50 sec.	135 bpm good variability
PM 640	-	-	-	135 bpm good variability
PM 700	-	-	-	135 bpm two early decelerations, good variability
PM 725	3 cm	1.5 min.	60 sec.	150 bpm good variability
PM 731	-	-	-	150 bpm late and variable decelerations patient was placed on left side
PM 754	5 cm	1 min	50 sec.	140 bpm variable decelerations
PM 800	10 cm	1.5 min.	60 sec.	140 bpm late decelerations
PM 820	delivery of newborn			

patient monitor strip and accompanying notes. An attempt
was made to take data in a fashion similar to that which
would be done by the non-expert user of this expert system.
All of the variables of labor (except station and decent)
were evaluated after each vaginal exam, which resulted in 6
cycles through the entire loop. The FHR tracing was also
evaluated at the appearance of FHR changes, and, in the
absence of changes, every one hour. A printout of the
screen view of the consultation for this data is located in
Appendix C.

5.5.2 Case B - Poor Outcome

Case B represents a labor which ended in the emergency
cesarean delivery of a compromised newborn which did not
survive. Available data included a complete fetal monitor
strip, but only 2 recorded measurements of cervical
dilatation. There is some information regarding positioning
and the administration of oxygen. There is no information
regarding the use of pitocin or any other drugs, It was
known that this labor was an attempted vaginal birth
following a pervious cesarean section was done due to a
failure to progress. Again, the status of fetal station was
unavailable and thus no evaluation of fetal descent can be
carried out.

Since only two values of dilatation were available, no
graphing of data can be done for this case. The
consultation relies heavily on FHR evaluation, which is

facing 52

Table 6 Data obtained from labor – Case B

TIME	DILATATION	CONTRACTIONS	DURATION	FETAL HEART RATE
AM 10:19	3 cm	2 min	50 sec.	145 bpm good variability
AM 11:00	-	1.5 min	50 sec.	145 bpm good variability
PM 12:40	-	2 min	40 sec.	145 bpm good variability
PM 12:55	5 cm	1.5 min	35 sec	145 bpm good variability shallow early decelerations
PM 2:20	-	1.5 min	30 sec	140 bpm good variability variable decelerations patient was placed on left side
PM 2:35	-	1.5 min	30 sec	135 bpm good variability late decelerations prolonged deceleration with good recovery
PM 2:50	-	1.5 min	35 sec	135 bpm good variability late decelerations - oxygen was given
PM 3:10	-	1.5 min	35 sec	135 bpm good variability two prolonged decelerations with poor recovery
PM 320	-	1.5 min	35 sec	very prolonged deceleration (6 min) with decreased variability

appropriate since in this case, fetal stress and distress is reflected by the monitor tracings. FHR assessment was done twice along with the other variables, and then every hour or when FHR changes were apparent. Table 6 shows the data chosen to be included in the consultation. There were two complete cycles, along with 7 evaluations of just the FHR. Following the last data point, at about 3:30 pm, an emergency cesarean section was performed. Refer to Appendix D for the screen view of this consultation.

5.5.3 Validation of LaborConsult for Cases A and B.

A review of LaborConsult's performance involves answering the questions posed in this chapter's introduction. Proof of LaborConsult's questions and messages are found in the screen views located in the appendices A and B.

1) Within the constraints of data availability, LaborConsult suggests many of the same courses of action that were taken during the actual labors.

Case A

When the course of this labor appeared normal, LaborConsult gave reassuring messages. (Screens 7, 18, 22, 25, 27, 31, 35, 39, 41) At 7:20 PM, the doctor ordered the rate of pitocin administration to be increased. At 7:25, following the vaginal exam, LaborConsult also suggests pitocin administration. At 7:31, the patient was placed on her left side, as was advised in screen 46.

Case B

Early in the labor, when all appeared to be going well, LaborConsult offered reassuring messages. (Screens 5, 7, 11, 15) Starting at about 12:55 PM, the duration of the contractions becomes insufficient. LaborConsult suggests augmentation with pitocin. (Screen 18) At around 2:20 PM, the fetus begins to show some stress, which progresses until at 3:10 PM a true distress pattern emerges. LaborConsult advises hydration, position change and oxygen starting at 2:35 PM. (Screen 29) During the labor, the left side position was tried at 2:00 PM and oxygen was administered a few minutes before 3:00 PM. At 3:20, (Screen 44) LaborConsult sends a distress message, and at approximately 3:30 PM an emergency cesarean section was performed.

2) The questions and messages in LaborConsult follow a logical order.

In developing this expert system, it was recognized that the user needs to analyze the FHR more often than the other variables of labor. Therefore, at the start of each consultation cycle, the user can choose to analyze all of the variables of labor or just the FHR. This flexibility was very important in case B, where the FHR analysis was the main indicator that the fetus was not tolerating the labor. Refer to screens 9 - 12 of case B for a typical FHR-only analysis and to screens 24 - 28 of case A for a typical analysis of the variables of active labor.

5.6 Validation of Fetal Heart Rate Analysis

LaborConsult relies on the user to view the fetal heart tracing, determine the baseline FHR and recognize such features as variability and decelerations. According to the experts overseeing this project, a non-expert user can be easily trained to see these features. Perhaps in the future a system could be designed which would detect this data electronically and send this information directly to a computer and expert system.

The case studies discussed in the previous sections go a long way in validating the FHR analysis section of LaborConsult. The performance of the FHR assessment component of LaborConsult was checked further by analyzing some representative FHR tracings. The text Fetal Monitoring Interpretation by Cabaniss was used as a source of two normal tracings, two tracings showing fetal stress, and two showing fetal distress. The data was then used in sample consultations. The resulting screen views, along with the fetal monitor tracings and information about newborn outcome, are displayed in Appendix B. Analysis of these figures shows an excellent match between the text's recommended course of action and the actions suggested by LaborConsult. Refer to Appendix B for figures B.1 - B.6. (All tracings are re-drawn from Cabaniss, Fetal Monitoring Interpretation, Lippicott Co. 1991)

CHAPTER 6

IMPLEMENTATION AND FUTURE CONSIDERATIONS

6.1 Introduction

An expert system such as LaborConsult can only make sound
suggestions if accurate data is regularly obtained from a
competent user. LaborConsult relies heavily upon the user's
ability to measure the variables of labor such as cervical
dilatation and fetal station, to read from the fetal monitor
strip the baseline heart rate and to recognize FHR
variability and decelerations. In this chapter these
difficulties and future considerations are discussed.

6.2 The Labor and Delivery Setting

As noted in chapter one, there are two possible labor and
delivery settings in which LaborConsult may be implemented.
One is in the setting where an expert is not readily
available to monitor the progress of labor. In this
situation, the non-expert user is responsible for measuring
the variables of labor and operating a fetal heart monitor,
if one is available. Presumably, an expert can be called
upon should the situation require intervention.

The second setting where LaborConsult could be utilized
is in a well-staffed hospital, where it could serve as a
warning device and a supplement to existing patient records.

One difficulty encountered when gathering patient information was the scarcity of measurements of cervical dilatation and fetal station. The frequency of vaginal exams is kept down to decrease the risk of infection; this results in a limited number of dilatation values with which to compute a rate and determine progress. In the two cases examined in this paper, no values of fetal station were found in the labor documents. These facts hinder attempts to compare the progress of labor with data standards. It is suggested that with the utilization of LaborConsult, labor variables, especially fetal station, will be assessed with greater frequency at the prompting of the expert system.

6.3 Positives and Negatives of Electronic Fetal Monitoring

The technology and use of electronic fetal heart monitoring is based on the observation that the FHR seems to react to varying states of oxygenation (9). It is known that the process of labor can induce various stresses on the fetus, so it is logical to want to have some sort of picture of how the fetus is tolerating the labor. A great amount of work has gone in to correlating outcomes such as umbilical cord or scalp blood pH and apgar scores with recorded FHR tracings (9,10). Two problems with fetal monitoring have been reported:

1. There is a tremendous range of observer interpretation of monitor tracings (12).

2. Correlation of tracings to outcomes has not been strongly supported by the evidence (12). While the correlation is strong for reassuring tracings and good outcomes, it seems that non-reassuring tracings do not always correlate with poor outcomes [10]. This finding may help explain the high incidence of cesarean delivery in this country.

6.4 Conclusion

The expert system LaborConsult is a first step toward a system to aid the non-expert practitioner in analyzing the progress of labor and its effect on the fetus. It derives its strengths from combining an examination of the rates of cervical dilatation and fetal descent, uterine contractions, and the fetal heart rate. Should the future bring stronger correlation of FHR data to newborn outcomes, this system would benefit from interfacing the fetal monitor directly to the computer. This would allow the computer to determine the baseline FHR, extent of variability, and presence of decelerations from existing signal processing technology.

This consultation benefits from the capability of VP-Expert to interface with the spreadsheet 1-2-3. This allows for the creation of a document which can be added to the patient's hospital chart. The ambitious user can use some simple 1-2-3 commands to create a graph of cervical dilatation and fetal descent versus time. A visual display of the data may aid one familiar with the Friedman curves. An improvement in this would be the ability for an automatic

graphical display to be created as the data was entered into the spreadsheet. These improvements would result in an expert system able to satisfactorily analyze the progress of labor in either setting.

SCREEN VIEWS OF LABORCONSULT MESSAGES:
FIGURES A.1 - A.20

```
You are now entering record #1.
     Do you wish to STAY with this record, skip
     straight to the Fetal Heart MONITOR ananlysis, or CHANGE
     to a different record number?
 STAY                        MONITOR                     CHANGE


What is the elapsed time since labor began?
     (In hours)
  1


What is the dilatation of the cervix in cm?
  2


Is the patient at term? (38 - 42 weeks
 YES                        NO


 This is Braxton Hicks false labor.
```

Figure A.1 Status Message: Braxton-Hicks False Labor

```
What is the elapsed time since labor began?
     (In hours)
  1

What is the dilatation of the cervix in cm?
  2

Is the patient at term? (38 - 42 weeks)
 YES                        NO


    The labor is in the latent phase, because dilatation is <3 cm.

    1. Observe 12 hours, or until dilatation of cervix reaches 3 cm.

    2. If labor does not become active, rule out pregnancy abnormalities
    then consider IV pitocin.

    NOTE: If you use pitocin, observe the protocol of your institution
```

Figure A.2 Status Message: Latent Phase Labor

```
You are now entering record #2.
     Do you wish to STAY with this record, skip
     straight to the Fetal Heart MONITOR ananlysis, or CHANGE
     to a different record number?
  STAY                      MONITOR                    CHANGE

What is the elapsed time since labor began?
     (In hours)
  3

What is the dilatation of the cervix in cm?
  3

The patient is in active labor, since dilatation is >3 cm.
```

Figure A.3   Status Message: Active Phase Labor

```
     The dilatation rate is 1, which is acceptable,
     because dilatation rate is >=1.0 cm/hr for the first delivery.
```

Figure A.4   Status message: Acceptable Rate of Cervical Dilatation

```
  What is the station of the fetus?
   2

  Fetus is engaged, station is acceptable, because
     station>=0 for the first delivery.
```

Figure A.5   Status Message: Acceptable Fetal Station

What is the station of the fetus?
  1

  Progress is acceptable, because station is >=0 and
      descent rate is 1cm/hr. It should be >=1.0cm/hr
      for the first delivery.

Figure A.6 Status Message: Acceptable Descent Rate for Dilatation <10 cm

What is the station of the fetus?
  2

  Fetus is engaged, station is acceptable, because
      station>=0 for the first delivery.

      The patient is fully dilated at >=10 cm. Progress is
      acceptable because descent rate is 1 cm/hr.

Figure A.7 Status Message: Acceptable Descent Rate for Dilatation >=10 cm

How far apart are the contractions? (in minutes)
  4

How long do the contractions last? (in seconds)
  50

      Contraction and contraction duration are acceptable, because
      contractions are 5 or less minutes apart and last for 45 or
      more seconds.

Figure A.8 Status Message: Acceptable Uterine Contractions for Dilatation <7 cm

```
How far apart are the contractions? (in minutes)
 2

How long do the contractions last? (in seconds)
 70

Contractions and contraction duration are acceptable,
    because contractions are less than 3 minutes apart and last
    for less than 90 seconds.
```

Figure A.9 Status Message: Acceptable Uterine Contractions for Dilatation >=7 cm

```
How many previous pregnancies has this patient had?
    (Including those that did not end in delivery.)
 2

How many of these previous pregnancies have ended
    in delivery?
 2

Have any of these previous pregnancies ended
    in delivery via cesarean section?
NO                        YES

    Attempt to determine why a C-section was performed
    on this patient in the past.  Keep this information as a
    consideration, should this delivery develop difficulties.
    (Type any key to continue)
```

Figure A.10 Instructions for Previous Cesarean Section

Do you have a Fetal Heart Monitor?
YES   NO

Do a manual fetal heart auscultation.
IS A NORMAL FETAL HR OBTAINED?
 YES   NO

Turn patient to left lateral recumbent position,
     start IV fliuds, administer oxygen. Recheck in fifteen minutes.

Figure A.11 Instructions for Abnormal FHR Following Manual
Auscultation

Do you have a Fetal Heart Monitor?
 YES   NO

IS A NORMAL FHR TRACING OBTAINED BY THE MONITOR?
 YES   NO

Check accuracy of FHR data, resposition monitor
     if necessary
AFTER ADJUSTING THE MONITOR, IS A MORMAL FHR TRACING SEEN?
 YES   NO

Do a manual fetal heart auscultation
IS A NORMAL FETAL HR OBTAINED?
 YES   NO

Turn patient to left lateral recumbent position,
     start IV fliuds, administer oxygen. Recheck in fifteen minutes.

Figure A.12   Instructions for Abnormal Initial Fetal Monitor
Tracing

```
IS A NORMAL FHR TRACING OBTAINED BY THE MONITOR?
 YES                        NO

Check accuracy of FHR data, resposition monitor
      if necessary
AFTER ADJUSTING THE MONITOR, IS A MORMAL FHR TRACING SEEN?
 YES                        NO

Do a manual fetal heart auscultation
IS A NORMAL FETAL HR OBTAINED?
 YES                        NO

Turn patient to left lateral recumbent position,
      start IV fliuds, administer oxygen.  Recheck in fifteen minutes.
DOES THE FHR REVERT TO NORMAL WITHIN 15 MINUTES?
 YES                        NO

THE FETAL HEART RATE REMAINS ABNORMAL!!!
      DELIVER VIA CESAREAN IMMEDIATELY
```

Figure A.13 Warning Message: Persistent Abnormal FHR Tracing Following Instructions from Figure A.11

```
What is the station of the fetus?
 -1


      Presenting part is not engaged, because station is negative.
      Rule out fetopelvic disproportion, do not use pitocin.
      If fetopelvic disproportion is present, deliver via
      cesarean section.
```

Figure A.14 Warning Message: Negative Fetal Station

What is the station of the fetus?
1

The rate of descent, 0cm/hr, is too slow,
because the rate of descent is 0 cm/hr, which is less
than 1 cm/hr. Evaluate conraction strength and duration.
If contractions are not adequate, check for pregnancy abnormalities
and consider pitocin. If there is no response to increased levels
of pitocin, a surgical delivery must be considered.

If contractions are acceptable, but the rate of deacent decreases,
fetopelvic disproportion or malpresentation likely exist.
A C-section may be required.

Figure A.15 Warning Message: Inadequate Descent Rate for
Dilatation <10 cm

What is the station of the fetus?
2

Fetus is engaged, station is acceptable, because
station>=0 for the first delivery.

The patient is fully dilated, but progress is not acceptable,
because descent rate is 0cm/hr, which is less than
1 cm/hr for the first delivery. Rule out fetopelvic
disproportion and uterine inertia. Consider pitocin if
no disproportion. If disproportion is found, deliver
via cesarean section.

Figure A.16 Warning Message: Inadequate Descent Rate for
Dilatation >=10 cm

The progress of dilatation is not acceptable,
        because dilatation rate is 0, which is less than
        1 cm/hr for the first delivery. Evaluate contraction strength
        and duration. If contractions are not adequate, rule out
        pregnancy abnormalities, then consider pitocin.
        If there is no response to increased
        levels of pitocin, a surgical delivery must be considered.

        If contractions are acceptable, but the dilatation is decreasing,
        fetopelvic disproportion or malpresentation likely exist.
        A C-section may be required.

Figure A.17   Warning Message: Inadequate Rate of Cervical
Dilatation

How far apart are the contractions? (in minutes)
 6

Are the membranes ruptured?
 YES   NO

The time between contractions is greater than
        5 minutes, which is not acceptable. Rule out pregnancy
        abnormalities, then consider pitocin.

Figure A.18 Warning Message: Inadequate Time Between Uterine
Contractions

```
How far apart are the contractions? (in minutes)
 3

How long do the contractions last? (in seconds)
 30

Contractions are less than adequate for this phase
     of labor.  Rule out uterine inertia and pregnancy
     abnormalities, consider stimulation with pitocin.
```

Figure A.19 Warning Message: Inadequate Duration of Uterine Contractions

```
How far apart are the contractions? (in minutes)
 2

How long do the contractions last? (in seconds)
 100

 Contractions are not acceptable, because they are
     less than 3 minutes apart and last for 90 seconds or more.
     Discontinue pitocin, if running, check for
     hypertonic uterus.
```

Figure A.20 Warning Message: Too Vigorous Uterine Contractions

APPENDIX B

VALIDATION OF FETAL HEART RATE EVALUATION
FIGURES B.1 - B.6

Figure B.1a and **Figure B.1b** Normal Tracing Sample A and Screen View of LaborConsult Response

Text recommendations: Allow labor to continue as it is, the situation predicts a healthy fetus (10).

LaborConsult suggestions: None, the tracing is reassuring.

Outcome: Apgar score 8/9, normal newborn course (10).

Figure B.1a Normal fetal heart tracing — sample A
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
  Horizontal scale = 3 cm per minute (one division = 0.5 cm)

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 130

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE ◄   EARLY   LATE
 VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Figure B.1b Screen view of LaborConsult response to Normal
Fetal Heart Tracing Sample A.

Figure B.2a and **Figure B.2b** Normal Tracing Sample B and Screen view of LaborConsult Response

Text recommendations: Reposition mother, observe closely. A healthy fetus is the likely outcome (10).

LaborConsult suggestions: Monitor closely.

Outcome: Apgar score 7/9. The cord was wrapped around the infant's neck and the infant required oxygen at delivery. The remaining newborn course was normal (10).
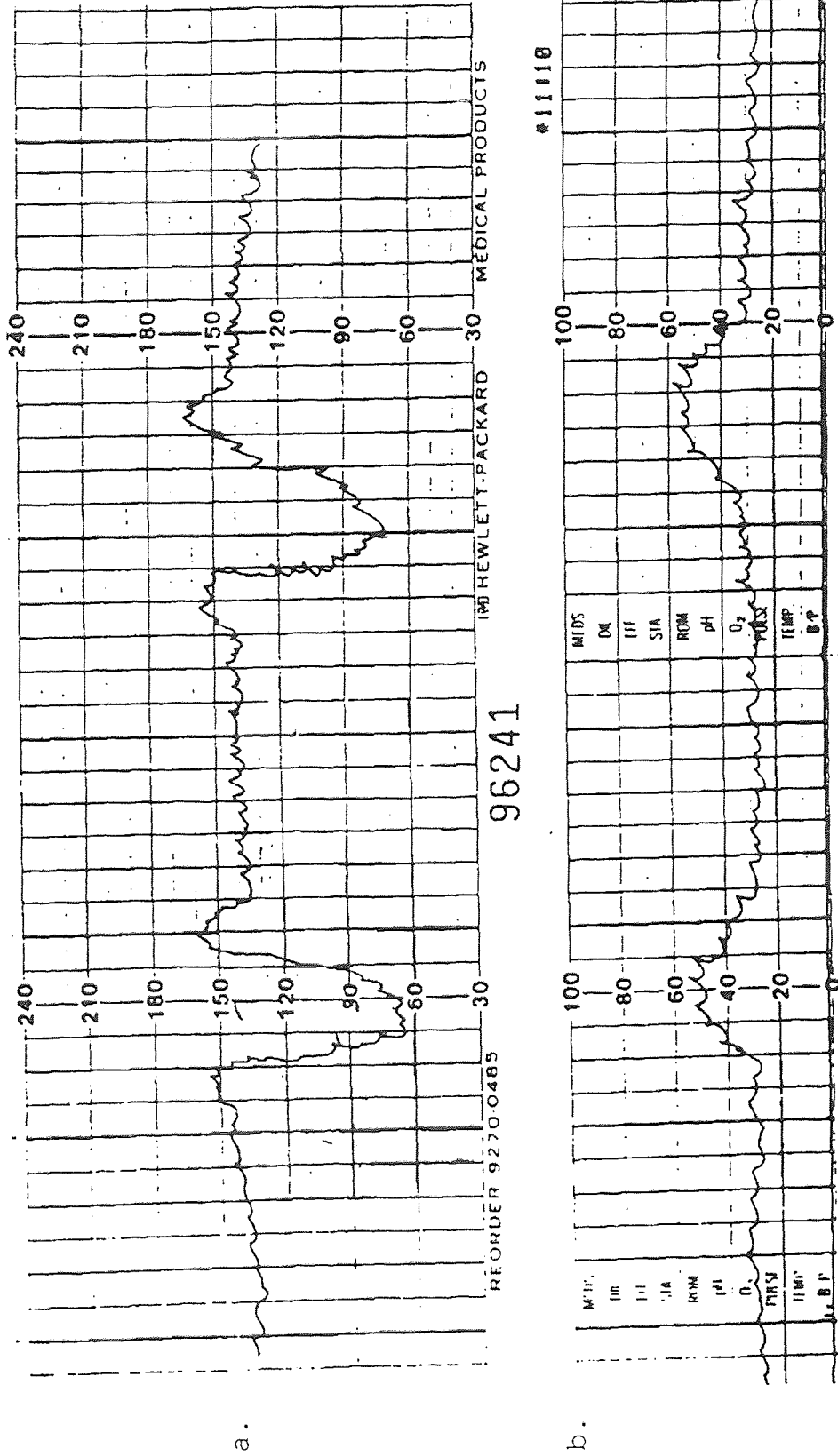
Figure B.2a Normal fetal heart tracing – sample B
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◀   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE
  VARIABLE

Figure B.2b Screen view of LaborConsult response to Normal
Fetal Heart Tracing Sample B.

CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY   LATE
 VARIABLE ◄

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
 NO ◄   YES

 THE MONITOR SHOWS SOME FHR DECELERATIONS.
    THIS MAY BE A COMPENSATORY REACTION TO STRESS. MONITOR CLOSELY.

Figure B.2b Continued

Figure B.3a and **Figure** B.3b Fetal Stress Sample A and Screen View of LaborConsult Response

Text recommendations: Mildly stressed fetus, try to reduce stress and observe closely in case the situation deteriorates (10).

LaborConsult suggestions: Monitor closely.

Outcome: Apgar score 9/9, normal newborn course (10).
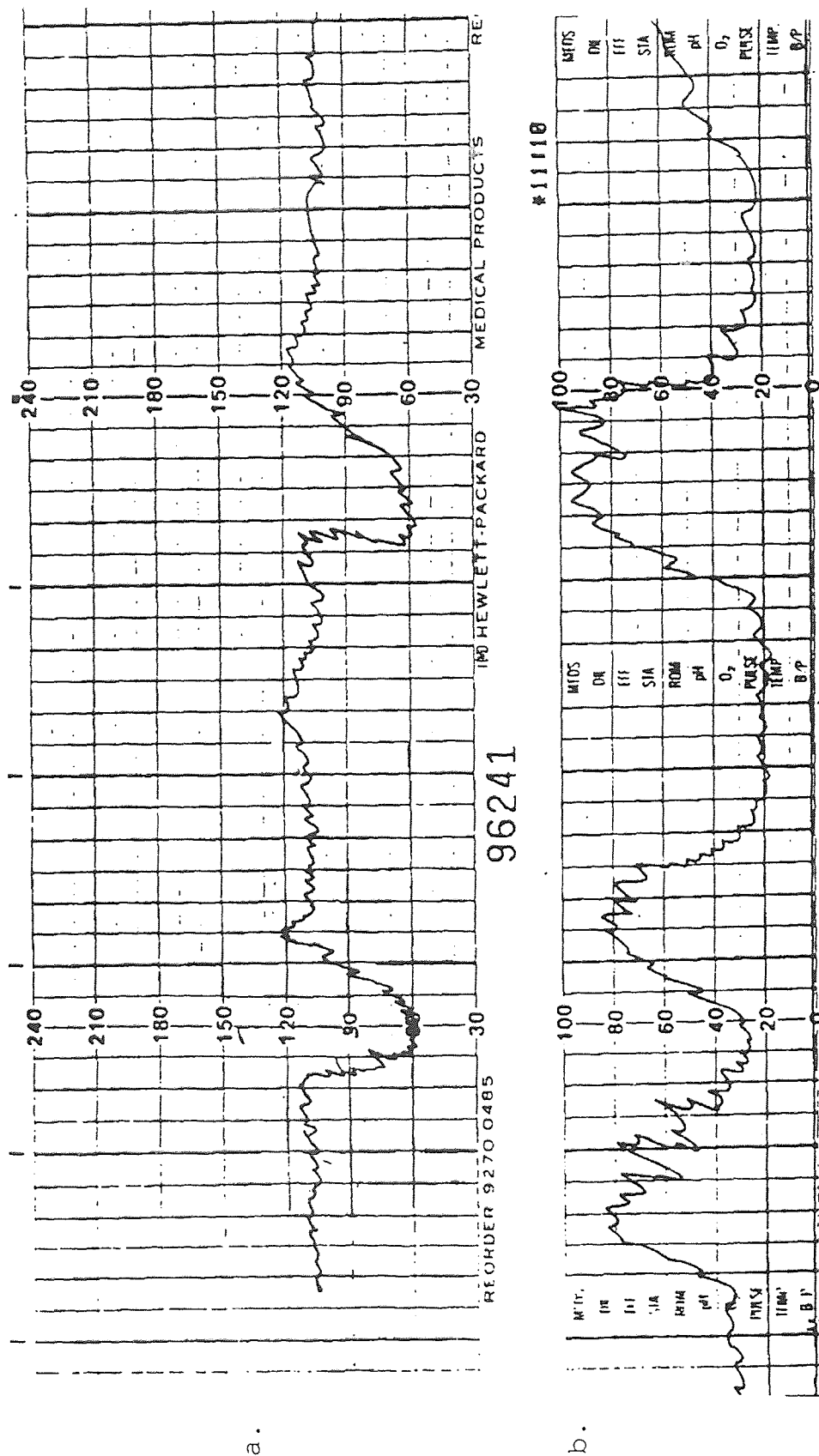
Figure B.3a Fetal stress - sample A
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  110

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE
  VARIABLE

Figure B.3b Screen view of LaborConsult response to Fetal
Stress Sample A.

CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout. (VARIABLE)
NONE   EARLY   LATE
VARIABLE ◀

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
OR LONGER?
NO ◀   YES

THE MONITOR SHOWS SOME FHR DECELERATIONS.
   THIS MAY BE A COMPENSATORY REACTION TO STRESS. MONITOR CLOSELY.

Figure B.3b Continued

Figure B.4a and **Figure B.4b** Fetal Stress Sample B and Screen View of LaborConsult Response

Text recommendations: Tachycardia is a healthy fetus' compensatory response. Check for maternal fever and the effects of any recently administered drugs (10).

LaborConsult suggestions: Evaluate for maternal fever, the effect of drugs, and amnionitis. Monitor closely.

Outcome: Maternal fever was present and subsequently controlled. Apgar score 8/9, normal newborn course (10).
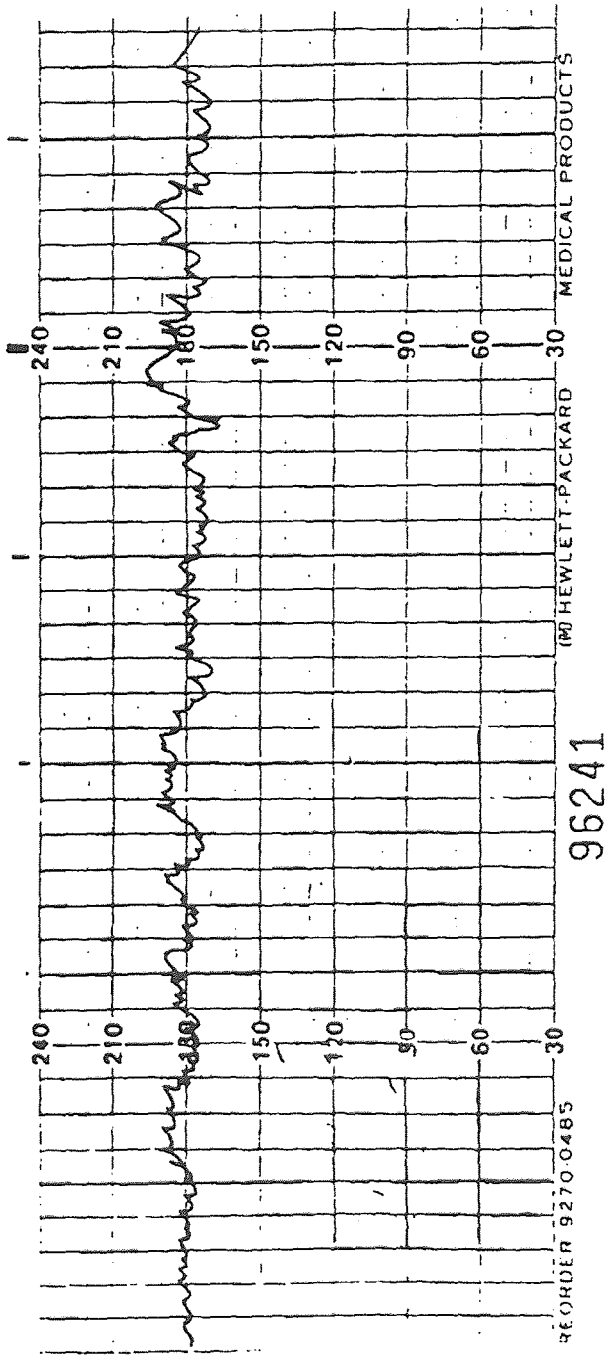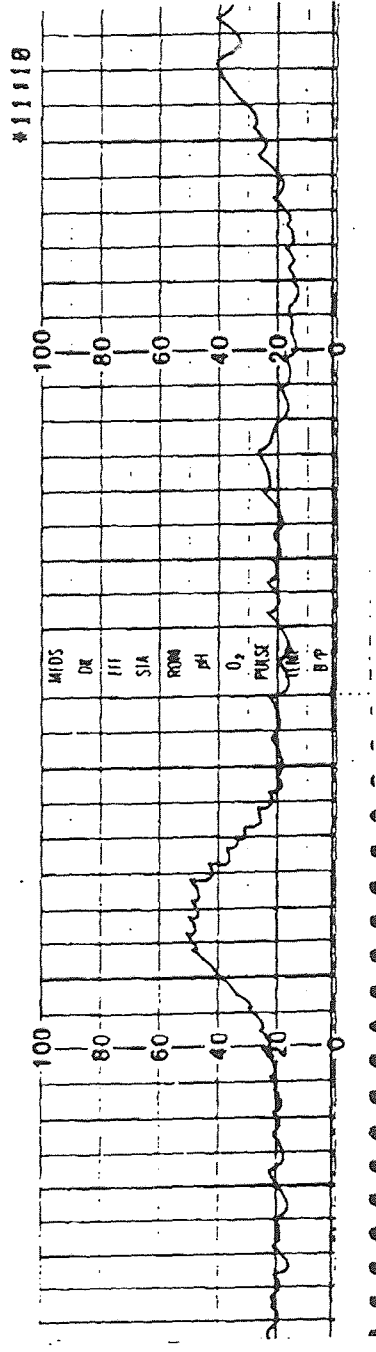
Figure B.4a Fetal stress - sample B
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
   Horizontal scale = 3 cm per minute (one division = 0.5 cm)

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 180

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

.

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL ◀   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY   LATE
 VARIABLE

Figure B.4b Screen view of LaborConsult response to Fetal
Stress Sample B.

B) Decelerations are seen that start and stop SIMULTANEOUS with the contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout. (VARIABLE)

NONE ◄	EARLY	LATE
VARIABLE		

THE FETUS IS IN TACHYCARDIA.
    POSSIBLE REASONS FOR FETAL TACHACARDIA INCLUDE:
     MATERNAL FEVER
     DRUGS SUCH AS ATROPINE AND VISTARIL
     MATERNAL HYPOTHYROIDISM
     AMNIONITIS

     THE TACHYCARDIA COULD ALSO BE A SIGN OF A MORE SERIOUS PROBLEM, SUCH AS FETAL HYPOXIA, ANEMIA, CARDIAC ARRHTHMIA OR HEART FAILURE. MONITOR CLOSELY FOR OTHER SIGNS OF FETAL DISTRESS.

Figure B.4b Continued

Figure B.5a and **Figure B.5b** Fetal Distress Sample A and
Screen View of System Response

Text recommendations: The tracing probably reflects "chronic
and significant fetal jeopardy". Improve oxygenation and
deliver promptly (10).

LaborConsult suggestions: Evaluate for fetal hypoxia, cord
prolapse, reaction to anesthesia, placental abruption.

Place patient in lateral positions, administer IV fluids and
oxygen. Monitor closely, if the situation persists, deliver
immediately.

Outcome: Apgar 2/4, the newborn survived (10).
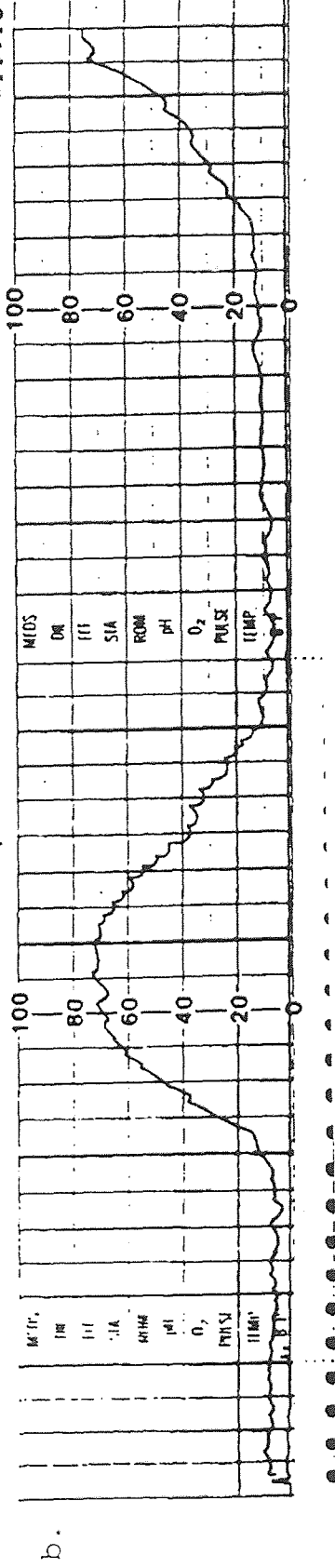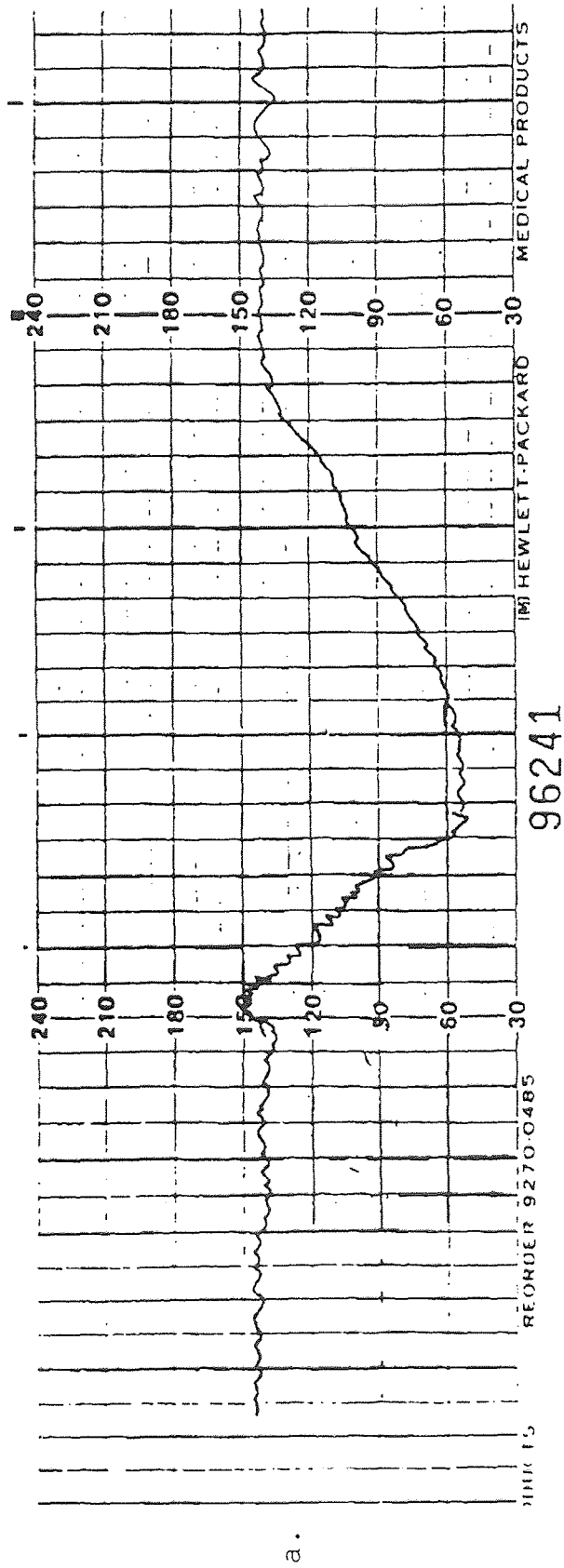
Figure B.5a Fetal distress - sample A
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
         HEART RATE THAT EXTEND BELOW 120 BPM.
         CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
 (VARIABLE)
 NONE   EARLY   LATE
 VARIABLE

Figure B.5b Screen view of LaborConsult response to Fetal
Distress Sample A.

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
NONE   EARLY   LATE
 VARIABLE ◀

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
OR LONGER?
NO   YES

NO   YES ◀

THE FETAL HEART RATE HAS UNDERGONE A PROLONGED
   DECELERATION. POSSIBLE CAUSES INCLUDE:
        FETAL HYPOXIA
        UMBILICAL CORD PROLAPSE
        MATERNAL SUPINE HYPOTENSION
        ADMINISTRATION OF EPIDURAL, SPINAL OR
        PARACERVICAL ANESTHESIA
        CONTRACTIONS LASTING TOO LONG OR TOO CLOSE TOGETHER
        PLACENTAL ABRUPTION
        PELVIC EXAM
        RAPID FETAL DESCENT

   PLACE PATIENT IN LEFT LATERAL POSITION,
   ADMINISTER OXYGEN AND IV FLUIDS AND STOP PITOCIN IF RUNNING.
   EXAMINE FOR POSSIBLE CAUSES. MONITOR CLOSELY. IN THE CASE OF
   CORD PROLAPSE OR ABRUPTION, REPEATED PROLONGED DECELERATIONS,
   OR INADEQUATE RECOVERY TO THE BASELINE HEART RATE PLAN
   AN IMMEDIATE DELIVERY.

Figure B.5b Continued

Figure B.6a and **Figure B.6b** Fetal Distress Sample B and Screen View of LaborConsult Response

Text recommendations: The pattern is "non reassuring". Prompt delivery is appropriate, increase oxygenation while preparing for delivery (10).

LaborConsult suggestions: The pattern is very non reassuring. Place patient in lateral position, administer IV fluids and oxygen. If the situation does not improve within 15 minutes, deliver by cesarean section.

Outcome: Apgar 3/6. Meconium present, the newborn survived (10).
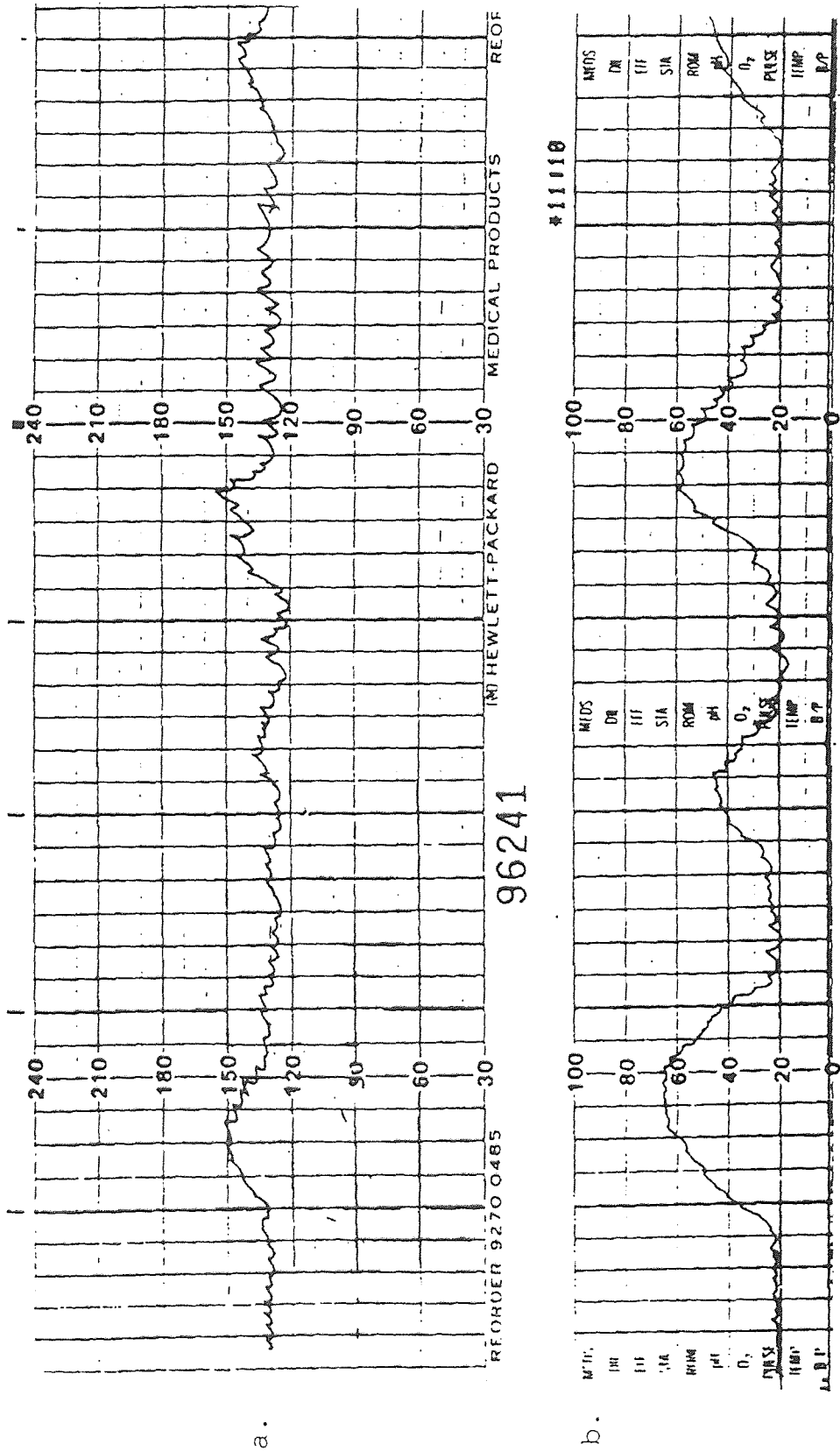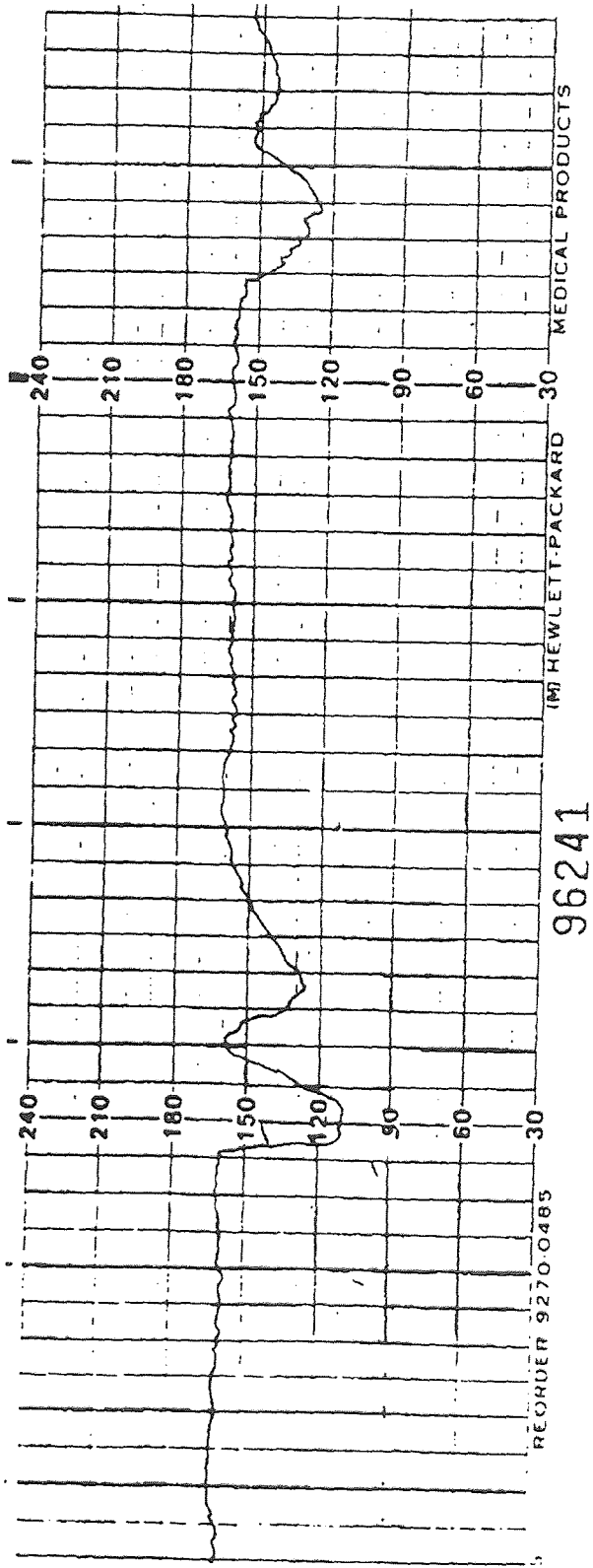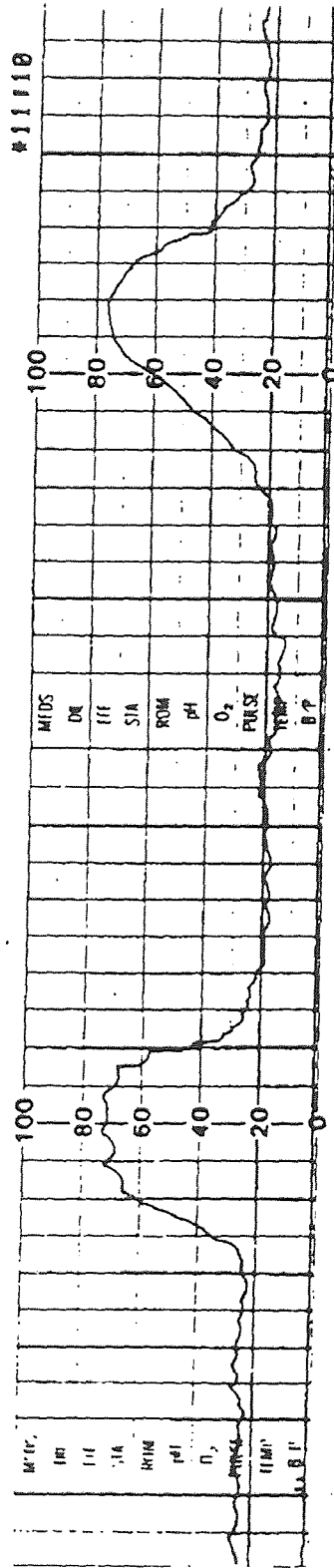
Figure B.6a Fetal distress - sample B
a. Tracing of fetal heart rate in beats per minute
b. Tracing of intrauterine pressure in mmHg
Horizontal scale = 3 cm per minute (one division = 0.5 cm)

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  160

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE ◄

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE
  VARIABLE

Figure B.6b Screen view of LaborConsult response to Fetal
Distress Sample B.

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout. (VARIABLE)

NONE   EARLY   LATE ◄
VARIABLE

THE LACK OF VARIABILITY COMBINED WITH THE PRESENCE.
   OF DECELERATIONS IS A VERY NONREASSURING PATTERN.
   PLACE PATIENT IN LEFT LATERAL RECUMBANT POSITION,
   ADMINISTER OXYGEN AND IV FLUIDS
   AND STOP PITOCIN IF RUNNING. MONITOR CAREFULLY
   IF DECELERATIONS CONTINUE, OR IF THE VARIABILITY DOES
   NOT RETURN WITHIN 15 MINUTES, DELIVER VIA CESAREAN SECTION.

Figure B.6b Continued

APPENDIX C

SCREEN VIEWS - CASE A

Welcome to the LaborConsult program. This consultation
          will aid you in analyzing data collected during labor
          and delivery. Do you wish to
          a) Start a new consultation; or
          b) Continue with an existing consultation saved on file.
    NEW ◄   EXISTING

Please enter patient name (Last, First):
  PATIENT A

Please enter patient age:
  40

What is the date of admission? (ex. AUG 2 93)
  NOV 00 00

What time did labor begin? (ex: PM 1230)
  PM 1200█

How many previous pregnancies has this patient had?
      (Including those that did not end in delivery.)
  1

How many of these previous pregnancies have ended
      in delivery?
  1

Have any of these previous pregnancies ended
      in regular vaginal deliveries?
    YES   NO

Screen Views 1&2

You are now entering record #1.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
  STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
    (In hours)
  3.2

What is the dilatation of the cervix in cm?
  2

Is the patient at term? (38 - 42 weeks)
  YES   NO

  STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
    (In hours)
  3.2

What is the dilatation of the cervix in cm?
  2

Is the patient at term? (38 - 42 weeks)
  YES ◄   NO

    The labor is in the latent phase, because dilatation is <3 cm.

    1. Observe 12 hours, or until dilatation of cervix reaches 3 cm.

    2. If labor does not become active, rule out pregnancy abnormalities
    then consider IV pitocin.

    NOTE: If you use pitocin, observe the protocol of your institution

Screen Views 3&4

Do you have a Fetal Heart Monitor?
YES ◄   NO

IS A NORMAL FHR TRACING OBTAINED BY THE MONITOR?
 YES   NO

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 5&6

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE ◄   EARLY   LATE
  VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
     create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
     permanently exit the consultation and save data.

     Also choose 'EXIT' if the labor is latent and you do not
     wish to analyze the FHR at this time.

     If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT ◄

  You will now be transferred to the worksheet.
     Open the file 'LABOREC'. Then you may save this worksheet and
     print a copy to be added to the patient file.

Screen Views 7&8

A1: [W8] 'PATIENT

	A	B	C		D	E	F
1	PATIENT NAME		PATIENT A		ADMISSION DATE		NOV 00 00
2	PATIENT AGE			40	TIME LABOR BEGAN:		PM 1200
3	GRAVIDA	2			STATUS:	LATENT	
4	PARA	1					
5							
6	TIME	DILATATION	DIL_RATE		STATION	DESC_RATE	CONTRACTION
7	3.20	2.00	0.00		0.0	0.00	0.00
8	0.00	0.00	0.00		0.00	0.00	0.00
9	0.00	0.00	0.00		0.00	0.00	0.00
10	0.00	0.00	0.00		0.00	0.00	0.00
11	0.00	0.00	0.00		0.00	0.00	0.00
12	0.00	0.00	0.00		0.00	0.00	0.00
13	0.00	0.00	0.00		0.00	0.00	0.00
14	0.00	0.00	0.00		0.00	0.00	0.00
15	0.00	0.00	0.00		0.00	0.00	0.00
16	0.00	0.00	0.00		0.00	0.00	0.00
17	0.00	0.00	0.00		0.00	0.00	0.00
18	0.00	0.00	0.00		0.00	0.00	0.00
19	0.00	0.00	0.00		0.00	0.00	0.00
20	0.00	0.00	0.00		0.00	0.00	0.00
26							NUM CAPS

Press any key to exit. Thank you!

Screen Views 9&10

Welcome to the LaborConsult program. This consultation
          will aid you in analyzing data collected during labor
          and delivery. Do you wish to
          a) Start a new consultation; or
          b) Continue with an existing consultation saved on file.
     NEW   EXISTING ◄

You will now be transferred to the worksheet files where
     your consultation data is saved in the file named 'LABORREC'.
     Determine which record number you wish to continue with, and make
     and save any changes to the file. It is VERY important to save
     the file before returning to the consultation, even if no changes
     are made.

A1: [W8] 'PATIENT

	A	B	C	D	E	F
1	PATIENT NAME		PATIENT A	ADMISSION DATE		NOV 00 00
2	PATIENT AGE		40	TIME LABOR BEGAN:		PM 1200
3	GRAVIDA	2		STATUS: LATENT		
4	PARA	1				
5						
6	TIME	DILATATION	DIL_RATE	STATION	DESC_RATE	CONTRACTION
7	3.20	2.00	0.00	0.0	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
26						NUM CAPS

Screen Views 11&12

Reading data from file...

You are now entering record #1.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
 STAY   MONITOR   CHANGE ◄

What record number do you wish to enter?
 2

What is the elapsed time since labor began?
    (In hours)
 4.25

What is the dilatation of the cervix in cm?
 2.5

Is the patient at term? (38 - 42 weeks)
 YES   NO

Screen Views 13&14

2

What is the elapsed time since labor began?
     (In hours)
 4.25

What is the dilatation of the cervix in cm?
 2.5

Is the patient at term? (38 - 42 weeks)
 YES ◄   NO

     The labor is in the latent phase, because dilatation is <3 cm.

     1. Observe 12 hours, or until dilatation of cervix reaches 3 cm.

     2. If labor does not become active, rule out pregnancy abnormalities
     then consider IV pitocin.

     NOTE: If you use pitocin, observe the protocol of your institution

 Do you have a Fetal Heart Monitor?
 YES ◄   NO

 IS A NORMAL FHR TRACING OBTAINED BY THE MONITOR?
 YES   NO

Screen Views 15&16

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◀   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE ◀   EARLY   LATE
  VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Screen Views 17&18

Do you wish to view the worksheet data and/or
        create a graph of the data gathered so far?
    NO ◄   YES

If the delivery is complete, choose 'EXIT' to
        permanently exit the consultation and save data.

        Also choose 'EXIT' if the labor is latent and you do not
        wish to analyze the FHR at this time.

        If active labor is ongoing, choose 'CONTINUE'
    CONTINUE   EXIT

You are now entering record #3.
        Do you wish to STAY with this record, skip
        straight to the Fetal Heart MONITOR ananlysis, or CHANGE
        to a different record number?
    STAY   MONITOR ◄   CHANGE

        The labor is in the latent phase, because dilatation is <3 cm.

        1. Observe 12 hours, or until dilatation of cervix reaches 3 cm.

        2. If labor does not become active, rule out pregnancy abnormalities
        then consider IV pitocin.

        NOTE: If you use pitocin, observe the protocol of your institution

Screen Views 19&20

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE ◄   EARLY   LATE
 VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Screen Views 21&22

Do you wish to view the worksheet data and/or
     create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
     permanently exit the consultation and save data.

     Also choose 'EXIT' if the labor is latent and you do not
     wish to analyze the FHR at this time.

     If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT

You are now entering record #3.
     Do you wish to STAY with this record, skip
     straight to the Fetal Heart MONITOR ananlysis, or CHANGE
     to a different record number?
  STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
     (In hours)
  5.6

What is the dilatation of the cervix in cm?
  3

The patient is in active labor, since dilatation is >3 cm.

Screen Views 23&24

How far apart are the contractions? (in minutes)
 1

How long do the contractions last? (in seconds)
 50

    Contraction and contraction duration are acceptable, because
    contractions are 5 or less minutes apart and last for 45 or
    more seconds.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 25&26

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
   NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE ◄   EARLY   LATE
   VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
   NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

Screen Views 27&28

You are now entering record #4.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
 STAY   MONITOR ◀   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 29&30

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
   NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE ◄   EARLY   LATE
   VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
   NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

Screen Views 31&32

You are now entering record #4.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
 STAY   MONITOR ◄   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 33&34

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
           HEART RATE THAT EXTEND BELOW 120 BPM.
           CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY ◄   LATE
 VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
     create a graph of the data gathered so far?
 NO ◄   YES

If the delivery is complete, choose 'EXIT' to
     permanently exit the consultation and save data.

     Also choose 'EXIT' if the labor is latent and you do not
     wish to analyze the FHR at this time.

     If active labor is ongoing, choose 'CONTINUE'
 CONTINUE   EXIT

Screen Views 35&36

You are now entering record #4.
Do you wish to STAY with this record, skip
straight to the Fetal Heart MONITOR ananlysis, or CHANGE
to a different record number?
STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
(In hours)
7.4

What is the dilatation of the cervix in cm?
3

The patient is in active labor, since dilatation is >3 cm.

The progress of dilatation is not acceptable,
because the dilatation rate is 0, which is less than
1.5 cm/hr for the multi delivery. Evaluate contraction strength
and duration. If contractions are not adequate, rule out
pregnancy abnormalities, then consider pitocin.
If there is no response to increased levels of pitocin,
a surgical delivery must be considered.

If the contractions are acceptable, but the dilatation rate
decreases, fetopelvic disproportion or malpresentation likely
exist. A C-section may be required.

Screen Views 37&38

How far apart are the contractions? (in minutes)
 1.5

How long do the contractions last? (in seconds)
 60

     Contraction and contraction duration are acceptable, because
     contractions are 5 or less minutes apart and last for 45 or
     more seconds.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 150

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 39&40

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
   NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
       HEART RATE THAT EXTEND BELOW 120 BPM.
       CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE ◄   EARLY   LATE
   VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
   NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

Screen Views 41&42

You are now entering record #5.
     Do you wish to STAY with this record, skip
     straight to the Fetal Heart MONITOR ananlysis, or CHANGE
     to a different record number?
 STAY   MONITOR ◄   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 150

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 43&44

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE ◀
  VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
  OR LONGER?
  NO   YES

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE ◀
  VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
  OR LONGER?
  NO ◀   YES

LATE DECELERATIONS MAY BE AN EARLY WARNING SIGN OF FETAL
    HYPOXIA. PLACE PATIENT IN LEFT SIDE POSITION, ADMINISTER OXYGEN
    IV FLUIDS AND STOP PITOCIN IF RUNNING. MONITOR CAREFULLY.
    IF THE DECELERATIONS WORSEN, EXPEDITE DELIVERY.

Screen Views 45&46

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT

You are now entering record #5.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
  STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
    (In hours)
  7.9

What is the dilatation of the cervix in cm?
  5

The patient is in active labor, since dilatation is >3 cm.

Screen Views 47&48

The dilatation rate is 4, which is acceptable,
because dilatation rate is >=1.5 cm/hr for the multi delivery

How far apart are the contractions? (in minutes)
 1

How long do the contractions last? (in seconds)
 50

    Contraction and contraction duration are acceptable, because
    contractions are 5 or less minutes apart and last for 45 or
    more seconds.

Screen Views 49&50

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE
  VARIABLE ◄

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
  OR LONGER?
  NO   YES

Screen Views 51&52

CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE   EARLY   LATE
   VARIABLE ◄

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
  OR LONGER?
  NO ◄   YES

  THE MONITOR SHOWS SOME FHR DECELERATIONS.
     THIS MAY BE A COMPENSATORY REACTION TO STRESS. MONITOR CLOSELY.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
    NO   YES

Screen Views 53&54

A1: [W8] 'PATIENT

	A	B	C	D	E	F
1	PATIENT NAME		PATIENT A		ADMISSION DATE	NOV 00 00
2	PATIENT AGE		40	TIME LABOR BEGAN:		PM 1200
3	GRAVIDA	2		STATUS: ACTIVE		
4	PARA	1				
5						
6	TIME	DILATATION	DIL_RATE		STATION	DESC_RATE CONTRACTION
7	3.20	2.00	0.00	0.00	0.00	0.00
8	4.25	2.50	0.00	0.00	0.00	0.00
9	5.60	3.00	0.00	0.00	0.00	1.00
10	7.40	3.00	0.00	0.00	0.00	1.50
11	7.90	5.00	4.00	0.00	0.00	1.00
12	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00

NUM CAPS

Screen Views 55

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

You are now entering record #6.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
 STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
    (In hours)
 8

What is the dilatation of the cervix in cm?
 10

The patient is in active labor, since dilatation is >3 cm.

Screen Views 56&57

The dilatation rate is §0, which is acceptable,
because dilatation rate is >=1.5 cm/hr for the multi delivery

How far apart are the contractions? (in minutes)
 1.5

How long do the contractions last? (in seconds)
 60

Contractions and contraction duration are acceptable,
     because contractions are less than 3 minutes apart and last
     for less than 90 seconds.

Screen Views 58&59

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE   EARLY   LATE ◄
  VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
  OR LONGER?
  NO   YES

Screen Views 60&61

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
NONE   EARLY   LATE ◄
VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
 NO ◄   YES

LATE DECELERATIONS MAY BE AN EARLY WARNING SIGN OF FETAL
    HYPOXIA. PLACE PATIENT IN LEFT SIDE POSITION, ADMINISTER OXYGEN
    IV FLUIDS AND STOP PITOCIN IF RUNNING. MONITOR CAREFULLY.
    IF THE DECELERATIONS WORSEN, EXPEDITE DELIVERY.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
    NO   YES

Screen Views 62&63

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT ◄

You will now be transferred to the worksheet.
    Open the file 'LABOREC'. Then you may save this worksheet and
    print a copy to be added to the patient file.

A1: [W8] 'PATIENT

	A	B	C	D	E	F
1	PATIENT NAME		PATIENT A	ADMISSION DATE		NOV 00 00
2	PATIENT AGE		40	TIME LABOR BEGAN:		PM 1200
3	GRAVIDA	2		STATUS: ACTIVE		
4	PARA	1				
5						
6	TIME	DILATATION	DIL_RATE	STATION	DESC_RATE	CONTRACTION
7	3.20	2.00	0.00	0.0	0.00	0.00
8	4.25	2.50	0.00	0.0	0.00	0.00
9	5.60	3.00	0.00	0.0	0.00	1.00
10	7.40	3.00	0.00	0.0	0.00	1.50
11	7.90	5.00	4.00	0.0	0.00	1.00
12	8.00	10.00	50.00	0.0	0.00	1.00
13	0.00	0.00	0.00	0.0	0.00	0.00
14	0.00	0.00	0.00	0.0	0.00	0.00
15	0.00	0.00	0.00	0.0	0.00	0.00
16	0.00	0.00	0.00	0.0	0.00	0.00
17	0.00	0.00	0.00	0.0	0.00	0.00
18	0.00	0.00	0.00	0.0	0.00	0.00
19	0.00	0.00	0.00	0.0	0.00	0.00
20	0.00	0.00	0.00	0.0	0.00	0.00

NUM CAPS

Screen Views 64&65

Press any key to exit. Thank you!

Screen Views 66

APPENDIX D

SCREEN VIEWS - CASE B

Welcome to the LaborConsult program. This consultation
          will aid you in analyzing data collected during labor
          and delivery. Do you wish to
          a) Start a new consultation; or
          b) Continue with an existing consultation saved on file.
     NEW ◄   EXISTING

Please enter patient name (Last, First):
 PATIENT B

Please enter patient age:
 27

What is the date of admission? (ex. AUG 2 93)
 NOV 00 00

What time did labor begin? (ex: PM 1230)
 AM 600█

How many previous pregnancies has this patient had?
     (Including those that did not end in delivery.)
 1

How many of these previous pregnancies have ended
     in delivery?
 1

Have any of these previous pregnancies ended
     in regular vaginal deliveries?
 YES   NO

Screen Views 1&2

You are now entering record #1.
     Do you wish to STAY with this record, skip
     straight to the Fetal Heart MONITOR ananlysis, or CHANGE
     to a different record number?
  STAY ◄   MONITOR   CHANGE

What is the elapsed time since labor began?
     (In hours)
  4.3

What is the dilatation of the cervix in cm?
  3

The patient is in active labor, since dilatation is >3 cm.

  Do you have a Fetal Heart Monitor?
  YES ◄   NO

IS A NORMAL FHR TRACING OBTAINED BY THE MONITOR?
  YES   NO   .

Screen Views 3&4

How far apart are the contractions? (in minutes)
  2

How long do the contractions last? (in seconds)
  50

        Contraction and contraction duration are acceptable, because
        contractions are 5 or less minutes apart and last for 45 or
        more seconds.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
  145

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
NORMAL   NONE

Screen Views 5&6

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE ◄   EARLY   LATE
  VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT

Screen Views 7&8

You are now entering record #2.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
 STAY   MONITOR ◀   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 145

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 9&10

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE ◄   EARLY   LATE
  VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT

Screen Views 11&12

You are now entering record #2.
      Do you wish to STAY with this record, skip
      straight to the Fetal Heart MONITOR ananlysis, or CHANGE
      to a different record number?
  STAY   MONITOR   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 145

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL   NONE

Screen Views 13&14

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
  NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
  NONE ◄   EARLY   LATE
  VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT

Screen Views 15&16

You are now entering record #2.
     Do you wish to STAY with this record, skip
     straight to the Fetal Heart MONITOR ananlysis, or CHANGE
     to a different record number?
  STAY ◀   MONITOR   CHANGE

What is the elapsed time since labor began?
     (In hours)
  6.9

What is the dilatation of the cervix in cm?
  5

The patient is in active labor, since dilatation is >3 cm.

     The progress of dilatation is not acceptable,
     because the dilatation rate is 0.769231, which is less than
     1.5 cm/hr for the multi delivery. Evaluate contraction strength
     and duration. If contractions are not adequate, rule out
     pregnancy abnormalities, then consider pitocin.
     If there is no response to increased levels of pitocin,
     a surgical delivery must be considered.

    If the contractions are acceptable, but the dilatation rate
     decreases, fetopelvic disproportion or malpresentation likely
     exist. A C-section may be required.

Screen Views 17&18

How far apart are the contractions? (in minutes)
 1

How long do the contractions last? (in seconds)
 35

Are the membranes ruptured?
 YES ◀   NO

Contraction duration is less than 45 seconds, which is
     not acceptable. Rule out pregnancy abnormalities and consider
     pitocin.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 145

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 19&20

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
   NORMAL ◄   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE   EARLY ◄   LATE
   VARIABLE

THE FHR TRACING IS REASSURING AT THIS TIME.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
   NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

Screen Views 21&22

You are now entering record #3.
        Do you wish to STAY with this record, skip
        straight to the Fetal Heart MONITOR ananlysis, or CHANGE
        to a different record number?
    STAY   MONITOR ◄   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 140

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
    NORMAL   NONE

Screen Views 23&24

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY   LATE
 VARIABLE ◄

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
 NO   YES

          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY   LATE
 VARIABLE ◄

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
 NO ◄   YES

 THE MONITOR SHOWS SOME FHR DECELERATIONS.
   THIS MAY BE A COMPENSATORY REACTION TO STRESS. MONITOR CLOSELY.

Screen Views 25&26

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

You are now entering record #3.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
STAY   MONITOR ◄   CHANGE

The patient is in active labor, since dilatation is >3 cm.

Screen Views 27&28

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
         HEART RATE THAT EXTEND BELOW 120 BPM.
         CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY   LATE ◄
 VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
 NO   YES

Screen Views 29&30

NO   YES ◄

THE FETAL HEART RATE HAS UNDERGONE A PROLONGED
    DECELERATION. POSSIBLE CAUSES INCLUDE:
            FETAL HYPOXIA
            UMBILICAL CORD PROLAPSE
            MATERNAL SUPINE HYPOTENSION
            ADMINISTRATION OF EPIDURAL, SPINAL OR
            PARACERVICAL ANESTHESIA
            CONTRACTIONS LASTING TOO LONG OR TOO CLOSE TOGETHER
            PLACENTAL ABRUPTION
            PELVIC EXAM
            RAPID FETAL DESCENT

    PLACE PATIENT IN LEFT LATERAL POSITION,
    ADMINISTER OXYGEN AND IV FLUIDS AND STOP PITOCIN IF RUNNING.
    EXAMINE FOR POSSIBLE CAUSES. MONITOR CLOSELY. IN THE CASE OF
    CORD PROLAPSE OR ABRUPTION, REPEATED PROLONGED DECELERATIONS,
    OR INADEQUATE RECOVERY TO THE BASELINE HEART RATE PLAN
    AN IMMEDIATE DELIVERY.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
    NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

Screen Views 31&32

You are now entering record #3.
   Do you wish to STAY with this record, skip
   straight to the Fetal Heart MONITOR ananlysis, or CHANGE
   to a different record number?
 STAY   MONITOR ◀   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 33&34

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
        HEART RATE THAT EXTEND BELOW 120 BPM.
        CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
NONE   EARLY   LATE ◄
VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
NO   YES

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
NONE   EARLY   LATE ◄
VARIABLE

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
NO ◄   YES

LATE DECELERATIONS MAY BE AN EARLY WARNING SIGN OF FETAL
    HYPOXIA. PLACE PATIENT IN LEFT SIDE POSITION, ADMINISTER OXYGEN
    IV FLUIDS AND STOP PITOCIN IF RUNNING. MONITOR CAREFULLY.
    IF THE DECELERATIONS WORSEN, EXPEDITE DELIVERY.

Screen Views 35&36

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
 NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
 CONTINUE   EXIT

You are now entering record #3.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
 STAY   MONITOR ◄   CHANGE

The patient is in active labor, since dilatation is >3 cm.

Screen Views 37&38

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
 NONE   EARLY   LATE
 VARIABLE ◄

DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?
 NO   YES

Screen Views 39&40

NO   YES ◄

THE FETAL HEART RATE HAS UNDERGONE A PROLONGED
    DECELERATION. POSSIBLE CAUSES INCLUDE:
              FETAL HYPOXIA
              UMBILICAL CORD PROLAPSE
              MATERNAL SUPINE HYPOTENSION
              ADMINISTRATION OF EPIDURAL, SPINAL OR
              PARACERVICAL ANESTHESIA
              CONTRACTIONS LASTING TOO LONG OR TOO CLOSE TOGETHER
              PLACENTAL ABRUPTION
              PELVIC EXAM
              RAPID FETAL DESCENT

    PLACE PATIENT IN LEFT LATERAL POSITION,
    ADMINISTER OXYGEN AND IV FLUIDS AND STOP PITOCIN IF RUNNING.
    EXAMINE FOR POSSIBLE CAUSES. MONITOR CLOSELY. IN THE CASE OF
    CORD PROLAPSE OR ABRUPTION, REPEATED PROLONGED DECELERATIONS,
    OR INADEQUATE RECOVERY TO THE BASELINE HEART RATE PLAN
    AN IMMEDIATE DELIVERY.

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
    NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
CONTINUE   EXIT

Screen Views 41&42

You are now entering record #3.
    Do you wish to STAY with this record, skip
    straight to the Fetal Heart MONITOR ananlysis, or CHANGE
    to a different record number?
STAY   MONITOR ◀   CHANGE

The patient is in active labor, since dilatation is >3 cm.

WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?
 135

EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
 NORMAL   NONE

Screen Views 43&44

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness? (NONE)
   NORMAL   NONE ◀

EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE   EARLY   LATE
   VARIABLE

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
(VARIABLE)
   NONE   EARLY   LATE
   VARIABLE ◀

   THE LACK OF VARIABILITY COMBINED WITH THE PRESENCE.
      OF DECELERATIONS IS A VERY NONREASSURING PATTERN.
      PLACE PATIENT IN LEFT LATERAL RECUMBANT POSITION,
      ADMINISTER OXYGEN AND IV FLUIDS
      AND STOP PITOCIN IF RUNNING. MONITOR CAREFULLY
      IF DECELERATIONS CONTINUE, OR IF THE VARIABILITY DOES
      NOT RETURN WITHIN 15 MINUTES, DELIVER VIA CESAREAN SECTION.

Screen Views 45&46

Do you wish to view the worksheet data and/or
    create a graph of the data gathered so far?
  NO ◄   YES

If the delivery is complete, choose 'EXIT' to
    permanently exit the consultation and save data.

    Also choose 'EXIT' if the labor is latent and you do not
    wish to analyze the FHR at this time.

    If active labor is ongoing, choose 'CONTINUE'
  CONTINUE   EXIT ◄

You will now be transferred to the worksheet.
    Open the file 'LABOREC'. Then you may save this worksheet and
    print a copy to be added to the patient file.

A1: [W8] 'PATIENT

	A	B	C		D	E	F	
1	PATIENT NAME		PATIENT B		ADMISSION DATE		NOV 00	00
2	PATIENT AGE			27	TIME LABOR BEGAN:		AM 600	
3	GRAVIDA	2			STATUS: ACTIVE			
4	PARA	1						
5								
6	TIME	DILATATION	DIL_RATE		STATION	DESC_RATE	CONTRACTION	
7	4.30	3.00	0.00		0.00	0.00	2.00	
8	6.90	5.00	0.77		0.00	0.00	1.00	
9	0.00	0.00	0.00		0.00	0.00	0.00	
10	0.00	0.00	0.00		0.00	0.00	0.00	
11	0.00	0.00	0.00		0.00	0.00	0.00	
12	0.00	0.00	0.00		0.00	0.00	0.00	
13	0.00	0.00	0.00		0.00	0.00	0.00	
14	0.00	0.00	0.00		0.00	0.00	0.00	
15	0.00	0.00	0.00		0.00	0.00	0.00	
16	0.00	0.00	0.00		0.00	0.00	0.00	
17	0.00	0.00	0.00		0.00	0.00	0.00	
18	0.00	0.00	0.00		0.00	0.00	0.00	
19	0.00	0.00	0.00		0.00	0.00	0.00	
20	0.00	0.00	0.00		0.00	0.00	0.00	

                                                        NUM CAPS

Screen Views 47&48

Press any key to exit. Thank you!

Screen Views 49

LABORCONSULT FILE

```
!LaborConsult
ENDOFF ;
RUNTIME;
EXECUTE;
BKCOLOR = 1;
ACTIONS
!      The actions block contains the commands that VPX carries out
! in a step-by-step manner.  Each command is completed by
! asking for user input, going into the rules block, doing a
! calculation, or writing data to the worksheet.  After each command
! is completed, VPX continues with the next command.
!      The actions block has two components. In the first section,
! a set of commands is executed which obtain the patient information
! such as name, age, date, parity, etc.  These commands are only
!  executed at the start of a new consultation.
! The next section contains a set of commands that are executed in a
! loop as each new set of data is entered.  It is this section which
! analyzes the variables of labor.

!      ACTIONS BLOCK - SECTION ONE - PATIENT INFORMATION
!       This first set of actions resets all variables and sets up
the
! screen and print color. It determines the values of variables thA
! do not change throughout labor and delivery.  These include the !
patient name, age and obstetrical history. Rules 1-8 are accessed.
        COLOR=15
        RESET ALL
        FIND DECISION
        FIND NAME
        PWKS NAME,C1,LABOREC
        FIND AGE
        WFORMAT fixed,0
        PWKS AGE,C2,LABOREC
        FIND DATE
        PWKS DATE,F1,LABOREC
        FIND BEGTIME
        PWKS BEGTIME,F2,LABOREC
        CLS
        FIND GRAV
        WFORMAT fixed,0
        GRAVIDA = (GRAV + 1)
        PWKS GRAVIDA,B3,LABOREC
        FIND WOMAN
        WFORMAT fixed,0
        PWKS PARITY,B4,LABOREC
        FIND WARNING
        N=0

!      ACTIONS BLOCK - SECTION TWO - ANALYSIS LOOP
! This loop will continue while the variable "continue" is known.
! The counter N will increase by one if all the variables are assessed.
```

```
      WHILEKNOWN CONTINUE
      COLOR=15
      N=(N+1)
      RESET RATE
      RESET DILRATE
      RESET STAVALUE
      RESET DESRATE
      RESET CONTRD
      RESET CONTRA
      RESET CONDUR
      RESET MEM
      RESET ELTIME
      RESET DIL
      RESET STA
      RESET CHANGE
      RESET NEWREC
      RESET CONTINUE
      RESET CONT
      RESET SRATE
      RESET GPH
      RESET ZERO
      RESET BPM
      RESET VAR
      RESET DEC
      RESET CONDITION
      RESET DUR
      RESET ANALGESIC
      RESET GRAPH
      RESET STATUS
      CLS
! The following command allows the user to change the current record number, !
in case the wrong data was entered or an existing consultation is
! being re-entered. This command accesses rules 9-11.

      FIND NEWREC
! The user is asked for the elapsed time in hours:
      FIND ELTIME
! The status of the labor is determined using rules 12-13.  The status
! can be active, latent, or false. The result is written onto the
! worksheet.
      FIND STATUS
      PWKS STATUS,E3,LABOREC
! Elapsed time and dilation are made into dimensioned variables and
! written to the worksheet:

      TIME[N] = (ELTIME)
      DILATION[N] = (DIL)
      WFORMAT FIXED,2
      PWKS TIME,COLUMN=TIME,LABOREC
      PWKS DILATION,COLUMN=DILATATION,LABOREC


! This command determines if a fetal heart monitor is available,
! and if so, is giving a valid tracing that falls roughly within
! normal limits.  If no monitor is available, the user is asked
! to auscultate the fetal heart manually; a C-section is suggested
! if poor results are found. Rules 14-18 are assessed.

      CLS
      FIND FETAL
```

```
        CLS

!       These commands access rule 12, where the rate of dilitation is
!  calculated, and rules 20 - 23, where the calculated data is
!  compared to norms and instructions are given:
        Z=(N-1)
        FIND RATE
        PWKS RATEDIL,COLUMN=DIL_RATE,LABOREC
        FIND DILRATE
        CLS

!  These commands ask the user to measure the current station of the fetus.
!  It is then written to the worksheet, and compared to norms in rules
!  24-28.

        FIND STAVALUE
        STATION[N] = (STA)
        WFORMAT FIXED,1
        PWKS STATION,COLUMN=STATION,LABOREC

!  These commands access rule 29, which calculated the rate of descent,
!  and rules 30-37, which compare the rate to norms:

        FIND SRATE
        FIND DESRATE
        CLS

!  These commands ask the user for the time between contractions
!  and the contraction duration. These data are then compared to norms
!  using rules 38-47:

        FIND CONTRD
        CONTRACT[N] = (CONTRA)
        CONTDUR[N] = (CONDUR)
        WFORMAT FIXED,2
        PWKS CONTRACT,COLUMN=CONTRACTION,LABOREC
        PWKS CONTDUR,COLUMN=DURATION,LABOREC
        CLS

!  In the next command and the rules it accesses, the user is asked
!  to analyze the FHR tracing and describe characteristics of it !
in response to displayed questions.
!  The value of "condition" can be "ok", "monitor", "danger" or
!  "emergency" Rules 48 - 59 ask the user to describe the tracing.
!  The rules then give the appropriate instructions.
        FIND Condition

!  These commands allow the user to open the worksheet, where the !
chart can be viewd and printed, or a graph can be created.  The !
consultation will then either continue or quit.  Rules 60-62 are !
assessed.

        CLS
        FIND GPH
        FIND ZERO
        FIND CONTINUE
        END;
```

```
! Rules Block

 RULE 1
      IF START = NEW
      THEN DECISION=NO;

    RULE 2
      IF START=EXISTING
      THEN DECISION=YES
      DISPLAY "You will now be transferred to the worksheet files where
      your consultation data is saved in the file named 'LABORREC'.
      Determine which record number you wish to continue with, and make
      and save any changes to the file. It is VERY important to save the
      file before returning to the consultation, even if no changes are
      made.~"
      CCALL 123, ""
      DISPLAY "Reading data from file..."
      WKS NAME,C1,LABOREC
      WKS AGE,C2,LABOREC
      WKS DATE,F1,LABOREC
      WKS BEGTIME,F2,LABOREC
      WKS GRAVIDA,B3,LABOREC
      GRAV = (GRAVIDA - 1)
      WKS PARITY,B4,LABOREC
      WKS TIME,COLUMN=TIME,LABOREC
      WKS
      DILATION,COLUMN=DILITATION,LABORE
      C WKS
      STATION,COLUMN=STATION,LABOREC
      WKS
      CONTRACT,COLUMN=CONTRACTION,LABOR
      EC WKS
      CONTDUR,COLUMN=DURATION,LABOREC
      REGDEL = UNK
      CSECT = UNK;

    RULE 3
      IF GRAV=0
      THEN PARITY=0;

    RULE 4
      IF GRAV=0  OR
      PARITY=0
      THEN WOMAN=YES;

    RULE 5
      IF GRAV>=1 AND
      PARITY >=1
      THEN WOMAN = NO;

    RULE 6
      IF PARITY=0 OR
      REGDEL=NO
      THEN WOMAN = YES;


    RULE 7
      IF PARITY=1 AND
```

```
        REGDEL=YES
        THEN CSECT=NO;

    RULE 8
        IF PARITY >=1 AND
        CSECT=YES
        THEN WARNING = YES
        COLOR=12
        DISPLAY"        Attempt to determine why a C-section was
        performed on this patient in the past.  Keep this information
        as a consideration, should this delivery develop difficulties.
        (Type any key to continue)~"
        COLOR=15;

! In assessing rules 9 - 11, the consult allows the user to
! examine all the variables of labor, or just the fetal monitor
! tracing.

    RULE 9
        IF CHANGE= MONITOR
        AND N=0
        THEN NEWREC = NO
        STATUS = ACTIVE
        FHRM = YES
        FHR = YES
        ELTIME =0
        DIL = 0
        RATE=1
        DILRATE=1
        STAVALUE=1
        SRATE=1
        DESRATE=1
        CONTRD=1;

RULE 10
        IF CHANGE = MONITOR
        AND N>0
        THEN NEWREC = NO
        N=(N-1)
        ELTIME = (TIME[N])
        DIL = (DILATION[N])
        RATE = 1
        DILRATE=1
        STAVALUE=1
        SRATE=1
        DESRATE=1
        CONTRD=1;

    RULE 11
        IF CHANGE=CHANGE
        THEN NEWREC=YES
        FIND NEW
        N=(NEW);

! Rules 12-13 determine the status of labor:
    RULE 12
        IF DIL>0 AND
        DIL<3 AND
        TERM= YES
```

```
THEN STATUS = LATENT
DISPLAY "
  The labor is in the latent phase, because dilatation is <3 cm.

  1. Observe 12 hours, or until dilatation of cervix reaches 3 cm.

  2. If labor does not become active, rule out pregnancy abnormalities
  then consider IV pitocin.

                NOTE: If you use pitocin, observe the protocol of your
  institution~";

        RULE 13
                IF DIL>0 AND
                DIL<3 AND
                TERM = NO
                THEN STATUS = FALSE
                DISPLAY" This is Braxton_Hicks false labor."
                ELSE STATUS = ACTIVE
                DISPLAY "The patient is in active labor, since dilatation
  is >3 cm.~";

        !       Rules 14 -17 ask the user to view the tracing and determine if
        it
        !       falls within roughly normal limits.  The monitor is readjusted
        !       at first if the tracing is not acceptable.

        RULE 14
                IF  FHRM = YES AND
                FHR = NO
                THEN    MonitorPos= BAD
                Display "Check accuracy of FHR data, resposition monitor
                if necessary~" ;

        RULE 15
                IF FHRM=NO
                THEN READJUST=BAD
                DISPLAY "Do a manual fetal heart auscultation.~";

        RULE 16
                IF FHRM = YES AND
        MONITORPOS = BAD AND
        FHR2=NO
        THEN READJUST=BAD
        DISPLAY "Do a manual fetal heart
auscultation~";

   RULE 17
      IF READJUST = BAD AND
      FHR3 = NO
      THEN MANUAL = BAD
      COLOR=12
        DISPLAY "Turn patient to left lateral recumbent position,
      start IV fliuds, administer oxygen.  Recheck in fifteen minutes.~"
      COLOR=15;

! If after readjusting the monitor and applying certain measures to the
! patient the tracing still appears abnormal, rule 18 raises an alarm.
```

```
RULE 18
    IF Manual = BAD AND
    FHR4 = NO
    THEN Fetal = BAD
    COLOR=28
    DISPLAY"THE FETAL HEART RATE REMAINS ABNORMAL!!!
        DELIVER VIA CESAREAN IMMEDIATELY~"
    COLOR=15
    STAVALUE = NO
    SRATE = NO
    oCONTRD = NO
    CONDITION = NO
    GPH = NO;
```

! The rate of dilatation is
calculated:

```
RULE 19
    IF N>1 AND
    DILATION[Z]>= 3.0 AND
    DIL>=3.0 AND
    DIL<10.0
    THEN RATE = YES
    DILATION[N]=(DIL)
    A=(N-1)
    D=(DILATION[N] - DILATION[A])
    T= (TIME[N] - TIME[A])
    RATEDIL[N] = (D/T)
    WFORMAT FIXED, 2
    PWKS DILATION,COLUMN=DILATATION,LABOREC
    ELSE RATE=NO
    RATEDIL[N]=0;
```

! Rates of dilation are compared to norms in rules 20-
23:

```
RULE 20
    IF DIL>=3 AND
    RATE = YES AND
    WOMAN = YES AND
    RATEDIL[N]>=1
    THEN DILRATE = ACCEPTABLE
    DISPLAY"
     The dilatation rate is {ratedil[n]}, which is acceptable,
    because dilatation rate is >=1.0 cm/hr for the first
delivery.~";
```

```
RULE 21
    IF DIL>=3.0 AND
    RATE = YES AND
    WOMAN = NO AND
    RATEDIL[N]>=1.5
    THEN DILRATE= ACCEPTABLE
    DISPLAY"
    The dilatation rate is {ratedil[n]}, which is acceptable,
    because dilatation rate is >=1.5 cm/hr for the multi
    delivery~";
```

```
        RULE 22
```

```
         IF DIL>=3.0 AND
         RATE = YES AND
         WOMAN = YES AND
         RATEDIL[N] <1.0
         THEN DILRATE = PROTRACTED
      COLOR=12
      DISPLAY"
The progress of dilatation is not acceptable,
      because dilatation rate is {ratedil[n]}, which is less than
   1 cm/hr for the first delivery. Evaluate contraction strength
    and duration.  If contractions are not adequate, rule out
   pregnancy abnormalities, then consider pitocin.
   If there is no response to increased
   levels of pitocin, a surgical delivery must be considered.

   If contractions are acceptable, but the dilatation is
   decreasing, fetopelvic disproportion or malpresentation likely
   exist.
   A C-section may be required.~"
   COLOR=15;


   RULE 23
      IF DIL>=3.0 AND
      RATE = YES AND
      WOMAN = NO AND
      RATEDIL[N]<1.5
      THEN DILRATE = PROTRACTED
      COLOR=12
      DISPLAY"
      The progress of dilatation is not acceptable,
      because the dilatation rate is {ratedil[n]}, which is less than
      1.5 cm/hr for the multi delivery.  Evaluate contraction
      strength and duration.  If contractions are not adequate, rule
      out pregnancy abnormalities, then consider pitocin.
       If there is no response to increased levels of pitocin,
      a surgical delivery must be considered.

    If the contractions are acceptable, but the dilatation rate
    decreases, fetopelvic disproportion or malpresentation likely
    exist.  A C-section may be required.~"
    COLOR=15;

! The value of the station is compared to norms in rules 24-28

   RULE 24
      IF DIL>=3.0 AND
      WOMAN=YES AND
      STA>=0
      THEN STAVALUE = ACCEPTABLE
    DISPLAY" Fetus is engaged, station is acceptable, because
      station>=0 for the first delivery.~";

   RULE 25
      IF DIL>=3.0 AND
      DIL<7.0  AND
      WOMAN = YES AND
      STA<0
      THEN STAVALUE= NOT_ACCEPTABLE
      COLOR=12
```

```
    DISPLAY"
    Presenting part is not engaged, because station is
    negative. Rule out fetopelvic disproportion, do not use
    pitocin.
    If fetopelvic disproportion is present, deliver
    via cesarean section."
    COLOR=15;

RULE 26
    IF DIL>=3.0 AND
    WOMAN = NO AND
    STA>=0
    THEN STAVALUE = ACCEPTABLE
    DISPLAY" Station is acceptable, because it is >=0
for
    the multi delivery.";

RULE 27
    IF DIL>=3.0 AND
    DIL<7.0 AND
    WOMAN= NO AND
    STA<0
    THEN STAVALUE = NOT_ACCEPTABLE
    COLOR=12
    DISPLAY"
    Station is not acceptable, because it is less than
    0. Perform Hillis maneuver.  If fetus descends,
    continue.
If fetus does not descend, check for fetopelvic disproportion.
Consider the causes of possible previous cesarean deliveries. Do
not use pitocin.  If fetopelvic disproportion exists, deliver via
cesarean section."
    COLOR=15;

RULE 28
    IF DIL>=7.0 AND
    DIL<10.0 AND
    WOMAN= NO AND
    STA<0
    THEN STAVALUE = NOT_ACCEPTABLE
    COLOR=12
    DISPLAY
    "Station remains negative, repeat Hillis maneuver.  If fetus
    descends, continue.  If fetus does not descend, consider
    reasons.  If membranes are still intact, consider artificial
    rupture of the membranes."
    COLOR=15;

RULE 29
    IF DIL>=7.0 AND
    DIL<10.0 AND
    WOMAN = YES AND
    STA<0
    THEN STAVALUE = NOT_ACCEPTABLE
    COLOR=12
    DISPLAY"
    Failure to descend; evaluate for disproportion.  If
    fetopelvic disproportion exists, deliver via cesarean
    section.  If not, monitor closely and chech efficiency of
```

contractions.~" COLOR=15;

!   The rate of descent is calculated and written to the worksheet in
!   rule 30:

        RULE 30
                IF N>1 AND
DIL>=7.0
THEN SRATE = YES
B=(N-1)
S= (STATION[N]-STATION[B])
T= (TIME[N]-TIME[B])
RATEDESC[N]=(S/T)
WFORMAT FIXED, 2
PWKS RATEDESC,COLUMN=DESC_RATE,LABOREC
ELSE SRATE=NO
RATEDESC[N]=0
PWKS RATEDESC, COLUMN=DESC_RATE,LABOREC;

! The rate of descent is compared to norms in rules 31-
38:

  RULE 31
      IF DIL >=7.0 AND
      DIL<10.0 AND
      WOMAN=YES AND
      SRATE=YES AND
      RATEDESC[N]>=1.0
      THEN DESRATE=ACCEPTABLE
      DISPLAY" Progress is acceptable, because station is >=0
      and descent rate is {ratedesc[n]}cm/hr. It should be
      >=1.0cm/hr for the first delivery.~";

      RULE 32
                IF DIL>=7.0 AND
                DIL<10.0 AND
                WOMAN =YES AND
      SRATE = YES AND
      STA>0 AND
      RATEDESC[N]<1.0
      THEN DESRATE=NOT_ACCEPTABLE
      COLOR=12
      DISPLAY"
      The rate of descent, {ratedesc[n]}cm/hr, is too slow,
    because the rate of descent is {ratedesc[n]} cm/hr, which is less
     than 1 cm/hr. Evaluate conraction strength and duration.
     If contractions are not adequate, check for pregnancy abnormalities
     and consider pitocin. If there is no response to increased levels
     of pitocin, a surgical delivery must be considered.

      If contractions are acceptable, but the rate of descent decreases,
                fetopelvic disproportion or malpresentation likely
      exist.
                A C-section may be required.~"
                COLOR=15;

        RULE 33

```
          IF DIL>=7.0 AND
          DIL<10.0 AND
          SRATE=YES AND
          WOMAN=NO AND
          STA>=0 AND
          RATEDESC[N]>=1.5
          THEN DESRATE=ACCEPTABLE
          DISPLAY"
     Progress is acceptable, because station is >=0 and descent rate is
     {ratedesc[n]}cm/hr.  It should be >1.5 cm/hr for the
     multi delivery.~";

RULE 34
     IF DIL>=7.0 AND
     DIL<10.0 AND
     WOMAN=NO AND
     SRATE=YES AND
     STA>=0 AND
     RATEDESC[N] <1.5
     THEN DESRATE=NOT_ACCEPTABLE
     DISPLAY"
     The rate of descent, {ratedesc[n]} cm/hr, is too slow,
     less than 1.5 cm/hr. Evaluate contraction strength and duration.
     If contractions are not adequate, rule out pregnancy
     abnormalities, then consider pitocin.  If there is no response to
     incresed levels of pitocin, a surgical delivery must
     be considered.

     If the contractions are acceptable, but the rate of descent
     decreases, fetopelvic disproportion mor malpresentation
     likely exist.  A C-section may be required.~";


     RULE 35
     IF DIL>=10.0 AND
     SRATE=YES AND
     WOMAN=YES AND
     RATEDESC[N]>=1.0
     THEN DESRATE=ACCEPTABLE
     DISPLAY"
     The patient is fully dilated at >=10 cm.  Progress is
     acceptable because descent rate is {ratedesc[n]} cm/hr.~";


          RULE 36
               IF DIL>=10.0 AND
               SRATE=YES AND
               WOMAN=NO AND
               RATEDESC[N]>=1.5
               THEN DESRATE=ACCEPTABLE
               DISPLAY"
     The patient is fully dilated at >=10 cm.  Progress is
     acceptable because descent rate is {ratedesc[n]} cm/hr.~";


          RULE 37
               IF DIL>=10.0 AND
               SRATE=YES AND
               WOMAN=YES AND
               RATEDESC[N]<1.0
               THEN DESRATE=NOT_ACCEPTABLE
               COLOR=12
```

```
              DISPLAY"
    The patient is fully dilated, but progress is not acceptable,
    because descent rate is {ratedesc[n]}cm/hr, which is less
    than 1 cm/hr for the first delivery.  Rule out fetopelvic
    disproportion and uterine inertia.  Consider pitocin if
    no disproportion.  If disproportion is found,
    deliver via cesarean section.~"
    COLOR=15;


RULE 38
    IF DIL>=10.0 AND
    WOMAN = NO AND
    SRATE=YES AND
    RATEDESC[N]<1.5
    THEN DESRATE=NOT_ACCEPTABLE
    COLOR=12
    DISPLAY"
    The patient is fully dilated, but progress is not acceptable,
    because descent rate is {ratedesc[n]}cm/hr, which is less
    than 1.5 cm/hr for the multi delivery.  Rule out fetopelvic
    disproportion and uterine inertia.  Consider pitocin if
  no disproportion.  If disproportion is found, deliver via
    cesarean section.~"
    COLOR=15;


! The time between contractions and the contraction duration are
! compared to norms in rules 39-47:


RULE 39
    IF DIL>=3.0 AND
    DIL<7.0 AND
    CONTRA<=5 AND
    CONDUR>=45
    THEN CONTRD=ACCEPTABLE
    DISPLAY"
    Contraction and contraction duration are acceptable,
    because contractions are 5 or less minutes apart and last
    for 45 or more seconds.~";


RULE 40
    IF DIL>=3.0 AND
    DIL<7.0 AND
    CONTRA<=5 AND
    CONDUR<45 AND
    MEM=YES
    THEN CONTRD=NOT_ACCEPTABLE
    COLOR=12
    DISPLAY"Contraction duration is less than 45 seconds, which
    is not acceptable.  Rule out pregnancy abnormalities and
    consider pitocin.~"
    COLOR=15;


RULE 41
    IF DIL>=3.0 AND
    DIL<7.0 AND
    CONTRA<=5 AND
    CONDUR<45 AND
    MEM=NO
```

```
THEN CONTRD=NOT_ACCEPTABLE
COLOR=4
DISPLAY"Contraction duration is less than 45 seconds, which
is not acceptable.  Consider artificial rupture of
membranes.~" COLOR=15;


RULE 42
            IF DIL>=3.0 AND
            DIL<7.0 AND
            CONTRA>5 AND
            MEM=YES
            THEN CONTRD =NOT_ACCEPTABLE
            COLOR=12
            DISPLAY"The time between contractions is greater
than
5 minutes, which is not acceptable.  Rule out pregnancy
abnormalities, then consider pitocin.~"
COLOR=15;


RULE 43
    IF DIL>=3.0 AND
    DIL<7.0 AND
    CONTRA>5 AND
    MEM=NO
    THEN CONTRD=NOT_ACCEPTABLE
 DISPLAY" The time between contractions is greater than
    5 minutes, which is not acceptable.  Consider
    artificial rupture of membranes.~";


RULE 44
            IF DIL >=7.0 AND
    CONTRA>=3.0 AND
    CONTRA<=5.0 AND
    CONDUR>=45 AND
    CONDUR<=90
    THEN CONTRD=ACCEPTABLE
    DISPLAY"  Contractions and contraction duration are
    acceptable, because they are between 3-5 minutes apart and
    last from 45-90 seconds.~";


RULE 45
            IF DIL>=7.0 AND
    CONTRA<3.0 AND
    CONDUR>=90
    THEN CONTRD=NOT_ACCEPTABLE
    COLOR=12
    DISPLAY" Contractions are not acceptable, because they
    are less than 3 minutes apart and last for 90 seconds or
    more.
    Discontinue pitocin, if running, check
    for hypertonic uterus.~"
    COLOR=15;


RULE 46
    IF DIL>=7.0 AND
    CONTRA<3.0 AND
    CONDUR<90
    THEN CONTRD=ACCEPTABLE
    DISPLAY"Contractions and contraction duration are
```

acceptable, because contractions are less than 3 minutes
apart and last for less than 90 seconds.~";

RULE 47

```
IF DIL>=7.0 AND
CONTRA>5 OR
CONDUR <45
THEN CONTRD=NOT_ACCEPTABLE
color=12
```
DISPLAY"Contractions are less than adequate for this phase
of labor. Rule out uterine inertia and pregnancy
abnormalities, consider stimulation with pitocin.~"
COLOR=15;

!   Rules 48- 57 ask the user to analyze the FHR monitor
tracing.
!They must specifically determine: 1) the FH rate in bpm, 2) whether
! or not decelerations in FH occur and if they do, 3) when compared
! contractions (early, late, variable), and 4) the depth and duration
! of decelerations, and finally 5) the status of FHR variability.
! These rules then assign a value to the variable condition and
! display instructions.

```
  RULE 48
    IF Fetal<>BAD AND
    FHRM=YES AND
    BPM>160 AND
    VAR =NONE AND
    DEC = LATE OR
    DEC = VARIABLE
    THEN CONDITION = EMERGENCY
    COLOR=28
    DISPLAY "THE FHR TRACING INDICATES SEVERE DISTRESS.
    DELIVER VIA CESAREAN SECTION.
    WHILE PREPPING, PLACE PATIENT LEFT LATERAL RECUMBANT
    POSITION, ADMINISTER OXYGEN AND IV FLUIDS.~"
    COLOR=15;

  RULE 49
   IF FETAL<>BAD AND
    BPM<=160 AND
    BPM >=100 AND
   FHRM=YES AND
   VAR = NONE AND
   DEC = EARLY OR
   DEC = NONE
   THEN CONDITION = MONITOR
    COLOR=12
   DISPLAY "CONTINUE TO MONITOR CAREFULLY.  THE LACK OF
   VARIABILITY IS NOT REASSURING. IF VARIABLILITY DOES NOT RETURN
   WITHIN 15 MINUTES, EXPEDITE DELIVERY.~"
    COLOR=15;

  RULE 50
    IF Fetal<>BAD AND
    FHRM=YES AND
    BPM<=160 AND
   VAR = NONE and
   DEC = LATE  OR
```

```
     DEC = VAR
  THEN CONDITION = DANGER
     COLOR=28
 DISPLAY " THE LACK OF VARIABILITY COMBINED WITH THE PRESENCE.
    OF DECELERATIONS IS A VERY NONREASSURING PATTERN.
  PLACE PATIENT IN LEFT LATERAL RECUMBANT POSITION, ADMINISTER
  OXYGEN AND IV FLUIDS
  AND STOP PITOCIN IF RUNNING.  MONITOR CAREFULLY
  IF DECELERATIONS CONTINUE, OR IF THE VARIABILITY DOES
NOT RETURN WITHIN 15 MINUTES, DELIVER VIA CESAREAN SECTION.~"
     COLOR=15;


RULE 51
   IF FETAL<>BAD AND
    FHRM=YES AND
    BPM >160 AND
   VAR = NORMAL AND
   DEC = EARLY OR
   DEC = VARIABLE OR
   DEC = NONE
   THEN CONDITION = MONITOR
   DISPLAY "THE FETUS IS IN TACHYCARDIA.
   POSSIBLE REASONS FOR FETAL TACHACARDIA INCLUDE:
    MATERNAL FEVER
    DRUGS SUCH AS ATROPINE AND VISTARIL
    MATERNAL HYPOTHYROIDISM
    AMNIONITIS

   THE TACHYCARDIA COULD ALSO BE A SIGN OF A MORE SERIOUS PROBLEM,
   SUCH AS FETAL HYPOXIA, ANEMIA, CARDIAC ARRHTHMIA OR HEART FAILURE.
   MONITOR CLOSELY FOR OTHER SIGNS OF FETAL DISTRESS.~";

   RULE 52
                   IF FETAL <> BAD AND
                   FHRM=YES AND
                   VAR=NORMAL AND
                   BPM<100 AND
                   DEC = NONE OR
   DEC = EARLY
   THEN CONDITION = MONITOR
   DISPLAY "THE TRACING IS SHOWING A MARKED BRADYCARDIA.
   CHECK TO SEE THAT THE MATERNAL HEART RATE IS NOT BEING
   MEASURED MISTAKENLY.
   MONITOR CAREFULLY FOR DECELERATIONS OR AN UNSTEADY
   BASELINE OR A FUTHER DECREASE IN FETAL HEART RATE.~";

        RULE 53
                   IF FETUS<>BAD AND
                   FHRM=YES AND
                   BPM <=160 AND
                   BPM>=100  AND
                   VAR = NORMAL AND
                DEC = NONE OR
                   DEC = EARLY
   THEN CONDITION = OK
DISPLAY "THE FHR TRACING IS REASSURING AT THIS TIME.~";

RULE 54
    IF FETUS<>BAD AND
```

```
                   FHRM=YES AND
                   BPM<100 AND
                   VAR = NONE AND
                   DEC=LATE OR
                   DEC=VARIABLE
                   THEN CONDITION=SERIOUS
                   DISPLAY" THE TRACING SHOWS SEVERE DISTRESS.  BE SURE THAT
                   THE BRADYCARDIA IS NOT DUE TO MEASURING MATERNAL HEART RATE.
                   PLACE PATIENT IN LEFT LATERAL POSITION, START IV FLUIDS,
                   STOP PITOCIN IF RUNNING AND ADMINISTER OXYGEN.  EXPEDITE
                   DELIVERY. ~";


                        RULE 55
                                   IF   FETUS<>BAD AND
                                        FHRM=YES AND
                                   BPM <= 160 AND
                                   BPM >= 100 AND
                                   DEC = LATE AND
                                   DUR = NO
                   THEN CONDITION= DANGER
                    COLOR=12
                   DISPLAY "LATE DECELERATIONS MAY BE AN EARLY WARNING SIGN OF FETAL
                   HYPOXIA.  PLACE PATIENT IN LEFT SIDE POSITION, ADMINISTER OXYGEN
                   IV FLUIDS AND STOP PITOCIN IF RUNNING.  MONITOR CAREFULLY.
                   IF THE DECELERATIONS WORSEN, EXPEDITE
                    DELIVERY.~" COLOR=15;


                     RULE 56
                               IF FETAL <>BAD AND
                                     FHRM=YES AND
                               BPM<=160 AND
                               BPM>=100 AND
                               DEC = VARIABLE AND
                               DUR = NO
                   THEN CONDITION = MONITOR
                   DISPLAY " THE MONITOR SHOWS SOME FHR DECELERATIONS.
                   THIS MAY BE A COMPENSATORY REACTION TO STRESS. MONITOR CLOSELY.~";


               RULE 57
                  IF  fetal<>BAD AND
                   FHRM=YES AND
                  BPM<=160 AND
                  DEC= VARIABLE OR
                   DEC = LATE AND
                  DUR = YES
                  THEN CONDITION = DANGER
                   COLOR=12
                  DISPLAY " THE FETAL HEART RATE HAS UNDERGONE A
                  PROLONGED DECELERATION. POSSIBLE CAUSES INCLUDE:
                          FETAL HYPOXIA
                          UMBILICAL CORD PROLAPSE
                        MATERNAL SUPINE HYPOTENSION
                          ADMINISTRATION OF EPIDURAL,
                          SPINAL OR PARACERVICAL
                          ANESTHESIA
CONTRACTIONS LASTING TOO LONG OR TOO CLOSE TOGETHER PLACENTAL
ABRUPTION
                          PELVIC EXAM
                          RAPID FETAL DESCENT
```

```
      PLACE PATIENT IN LEFT LATERAL POSITION,
      ADMINISTER OXYGEN AND IV FLUIDS AND STOP PITOCIN IF RUNNING.
      EXAMINE FOR POSSIBLE CAUSES. MONITOR CLOSELY.  IN THE CASE
      OF
    CORD PROLAPSE OR ABRUPTION, REPEATED PROLONGED DECELERATIONS,
    OR INADEQUATE RECOVERY TO THE BASELINE HEART RATE PLAN
    AN IMMEDIATE DELIVERY.
~"
      COLOR=15;

! If the user wishes to draw a graph, they are sent into 123,
where
! they must enter the required commands to create a graph.

   RULE 58
      IF GRAPH = YES
      THEN GPH=YES
      DISPLAY "You will now be transferred to the worksheet file,
      where you may use 1-2-3 commands to get a print-out or
      create a graph of the data obtained so far."
      CCALL 123,"";

! If the user is ready to exit the consulatation, this rule "zeroes"
! the worksheets unused record numbers. The consultation then ends.

   RULE 59
      IF CONT=EXIT
      THEN ZERO=YES
      X=(N+1)
      FOR COUNT=X TO 40
      TIME[X] = 0
      DILATION[X] = 0
      STATION[X] = 0
      CONTRACT[X] = 0
      CONTDUR[X] = 0
      RATEDIL[X] = 0
      RATEDESC[X] = 0
      X=(X+1)
      END
      PWKS TIME,COLUMN=TIME,LABOREC
      PWKS DILATION,COLUMN=DILITATION,LABOREC
      PWKS STATION,COLUMN=STATION,LABOREC
      PWKS CONTRACT,COLUMN=CONTRACTION,LABOREC
      PWKS CONTDUR,COLUMN=DURATION,LABOREC
      PWKS RATEDIL,COLUMN=DIL_RATE,LABOREC
      PWKS RATEDESC,COLUMN=DESC_RATE,LABOREC
      DISPLAY" You will now be transferred to the worksheet.
      Open the file 'LABOREC'.  Then you may save this worksheet
      and print a copy to be added to the patient file.~"
      CCALL 123,""
      DISPLAY" Press any key to exit.  Thank you!~";

   RULE 60
      IF CONT=CONTINUE

      THEN CONTINUE=YES;
```

```
! QUESTIONS BLOCK

     ASK NAME: "Please enter patient name (Last, First):";

   ASK AGE: "Please enter patient age:";

   ASK DATE: "What is the date of admission? (ex. AUG 2 93)";

   ASK BEGTIME: "What time did labor begin? (ex: PM 1230)";
   ASK GRAV: "How many previous pregnancies has this patient
   had? (Including those that did not end in delivery.)";


     ASK REGDEL: "Have any of these previous pregnancies ended
             in regular vaginal deliveries?";
             CHOICES REGDEL:  YES, NO;

      ASK CSECT: "Have any of these previous pregnancies ended
             in delivery via cesarean section?";
             CHOICES CSECT:  NO, YES;

             ASK CHANGE: "You are now entering record #{N}.
   Do you wish to STAY with this record, skip
   straight to the Fetal Heart MONITOR ananlysis, or CHANGE
   to a different record number?";
   CHOICES CHANGE:  STAY, MONITOR, CHANGE;

   ASK NEW: "What record number do you wish to enter?";

   ASK FHRM: " Do you have a Fetal Heart Monitor?";
   CHOICES FHRM: YES, NO;

   ASK ELTIME: "What is the elapsed time since labor began?
   (In hours)";

   ASK DIL: "What is the dilatation of the cervix in cm?";

   ASK STA: "What is the station of the fetus?";

   ASK TERM: "Is the patient at term? (38 - 42 weeks)";
   CHOICES TERM:  YES, NO;

   ASK CONTRA :"How far apart are the contractions? (in minutes)";

   ASK CONDUR: "How long do the contractions last? (in seconds)";

   ASK MEM: "Are the membranes ruptured?";
   CHOICES MEM:  YES, NO;

   ASK GRAPH: "Do you wish to view the worksheet data and/or
   create a graph of the data gathered so far?";
   CHOICES GRAPH:  NO, YES;

   ASK CONT: "If the delivery is complete, choose 'EXIT' to permanently
   exit the consultation and save data.
```

Also choose 'EXIT' if the labor is latent and you do not
wish to analyze the FHR at this time.

If active labor is ongoing, choose 'CONTINUE' ";
CHOICES CONT: CONTINUE, EXIT;

ASK ANALGESIC: "WAS AN ANALGESIC RECENTLY ADMINISTERED?";
CHOICES ANALGESIC: YES,NO;

ASK BPM: "WHAT IS THE FETAL HEART RATE IN BEATS PER MINUTE?";

ASK FHR: "IS A NORMAL FHR TRACING OBTAINED BY THE MONITOR?";
CHOICES FHR: YES, NO;

ASK FHR2: "AFTER ADJUSTING THE MONITOR, IS A NORMAL FHR TRACING
SEEN?"; CHOICES FHR2: YES, NO;

ASK FHR3: "IS A NORMAL FETAL HR OBTAINED?";
CHOICES FHR3: YES, NO;

ASK FHR4: "DOES THE FHR REVERT TO NORMAL WITHIN 15 MINUTES?";
CHOICES FHR4: YES, NO;

ASK VAR: "EXAMINE THE FHR TRACING. DO YOU SEE:

1. Small, random variations (waviness) of the tracing? (NORMAL)

2. A flat tracing with no variations, or a decrease in waviness?
(NONE)"; CHOICES VAR: NORMAL, NONE;

ASK DUR: "DO THE DECELERATIONS LAST FOR A PERIOD OF 60 SECONDS
 OR LONGER?";
CHOICES DUR: NO, YES;

ASK DEC: "EXAMINE THE CURRENT SECTION OF FHR TRACING FOR DROPS IN
          HEART RATE THAT EXTEND BELOW 120 BPM.
          CHOOSE ONE OF THE RESULTS BELOW:

A) No significant decelerations are seen. (NONE)

B) Decelerations are seen that start and stop SIMULTANEOUS with the
   contractions. The tracings are mirror images (EARLY)

C) Decelerations occur that start AFTER each contraction starts and
   end AFTER the contraction ends.(LATE)

D) Decelerations are seen at seemingly random intervals throughout.
   (VARIABLE)~";
CHOICES DEC: NONE, EARLY, LATE, VARIABLE;

ASK PARITY: "How many of these previous pregnancies have ended
      in delivery?";

ASK START: "Welcome to the LaborConsult program. This consultation
            will aid you in analyzing data collected during
            labor and delivery. Do you wish to

```
          a) Start a new consultation; or
          b) Continue with an existing consultation saved on
file."; CHOICES START: NEW,  EXISTING;
```

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