PHENYLKETONURIA

Though phenylketonuria is an uncommon disease, with an incidence of about 1/15,000 live-births, its detection in the newborn period may make all the difference between life-long mental retardation and treatment in an institution and a reasonably worthwhile existence. The Guthrie test is the one most frequently used as a screening test for phenylketonuria and has replaced tests of the urine, which are unreliable. A sample of the

infant's blood, obtained by heel prick, is collected on to a piece of absorbent filter paper, usually about the tenth day of life and not earlier than the fifth day and is despatched to an appropriate laboratory. The detection of phenylketonuria is based on bacteriological inhibition assay and the test may also be adapted to reveal other metabolic disorders such as maple syrup urine disease, histidinaemia, homocystinuria, and galactosaemia.

Computers in Medicine

Computer Service for Obstetric Records

JOANNA SOUTH, PHILIP RHODES

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The Royal College of Obstetricians and Gynaecologists several years ago laid down a standard book of tables¹ into which could be entered relevant details about patients in any given obstetric unit. When completed it is meant to be a check on the performance of the unit so that it can be judged against national performance and compared with other units. Too often the total results of a unit for a year have appeared too late to have any relevance. Even if they showed a state of affairs which ought to be remedied it has been easy to cast doubt on the statistics, so that action has been shelved. The system is not good enough for present-day needs.

To be able to use their available resources most effectively doctors must know as much about their "output" as factory managers know about theirs. The need for removing the tedium of collecting statistics, for increasing their accuracy, and for getting them out quickly made us think of how a computer might be used. Two computer systems have been developed at St. Thomas's Hospital.

Original System

In the first system, data after each episode of childbearing were abstracted from the case notes into an eight-page coding booklet. The numerical codes reduced the information to manageable proportions for subsequent data processing (Fig. 1). The object was to identify 73 possible factors in pregnancy, 4 about hospital admissions, 20 on blood pressure, 39 on labour, 20 on the puerperium, and 43 on the neonate. House officers and registrars were asked to do the coding. Data in the coding booklet were transferred to punch cards and processed by the department of epidemiology and social medicine.

The project finally failed because it was too costly, too time-consuming, and those working it could not see its relevance. But it was not without value for it had shown: (1) that any workable scheme should not rely on ever-changing, relatively unwilling, or unconvinced workers; (2) that the project must

come so far as possible under the direction of the department requiring the results—reliance on another department for the computer processing leads to delay and frustration; (3) that summarizing the events of childbirth after the patient is discharged is a laborious task, and that some details of the sum-

ST. THOMAS'S HOSPITAL Department of Obstetrics

PREGNANCY SHEET

Surname..... Forenames.....

HOSPITAL NUMBER 1 - 7

YEARS MARRIED AT LMP { 00=less than 1 year 09=before marriage 99=unknown } 8 - 9

AGE AT CONCEPTION (years) 10 - 11

AGE OF HUSBAND (years) { 99 not married 98 unknown } 12 - 13

DURATION OF PREGNANCY (weeks) { 99=uncertain 98=Abortion (including missed expelled after 28 weeks) } 14 - 15

NUMBER OF ANTE-NATAL VISITS 16 - 17

HEIGHT (Inches) 18 - 19

GRAVIDITY (28 weeks) 20 - 21

NO. OF ABORTIONS { 8=8 or 8+ 9=habitual } 22

PAST MEDICAL HISTORY

(a) DIABETES 23

(b) POSITIVE W.R. Yaws = 2, Ch. Syphilis = 3, Acute Syphilis = 4 24

(c) HYPERTENSION 25

(d) RENAL DISEASE 26

(e) URINARY INFECTION 27

(f) CARDIAC DISEASE, Grade 1=5, 2=2, 3=3, 4=4 28

(g) RHEUMATIC FEVER / CHOREA 29

(h) OTHER 30

GYNAECOLOGICAL HISTORY

(a) MENSTRUAL CYCLE { 1=Regular 28±4 days 2=Irregular } 31

(b) INFERTILITY, (3 years +) 32

(c) FIBROIDS+2, Red Degeneration = 3 33

(d) MYOMECTOMY 34

(e) ENDOMETRIOSIS 35

(f) OVARIAN CYST = 2 IN PRESENT PREGNANCY = 3 36

(g) LAPAROTOMY IN PRESENT PREGNANCY Cyst = 3, App. = 4, Others = 5 37

(h) OTHER 38

PAST OBSTETRIC HISTORY

(a) DELIVERY { 1=Normal 2=Instrumental 3=Caesarean Section } 39

(b) P.E.T. { 1=None 2=P.E.T. 3=Edema 4=Hypertension } 40

(c) A.P.H. { 1=None 2=Abruption 3=Abruption with clotting defect 4=Placenta previa 5=Unknown origin } 41

(d) BABY { 1=Alive 2=Dead S.B. = 4 3=N.N.D. Alive and N.N.D.=5 } 42

(e) MALPRESENTATION 43

(f) CONGENITAL ABNORMALITY 44

(g) PREVIOUS PROLONGED LABOUR (> 36 hrs.) 45

(h) RETAINED PLACENTA 46

(i) P.P.H. 47

Form 306

FIG. 1—Page from coding booklet used in original system.

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mary can be completed as the medical record is being written up; (4) that special staff should be employed to control the data collection, at least until such time as department staff can be relied on to produce good enough input data when required; (5) that though most coded items were easy to record a few factors were ambiguous and difficult to interpret; and (6) the coding form should be compatible with the medical record format—three different maternity records were used in the St. Thomas's group and none had the same sequence or format as the coding form.

By 1967 it was decided to approach the Ministry of Health for support, which it generously provided, and the working of the project was taken over by one of us (J.S.). The first phase was to check all the computer records and to correct the errors indicated by a validation computer programme. When the computer records were compared with the midwives' records at least 10% of all records were found to be missing, because the summary chart had never been filled in or had been mislaid, and when they were ultimately traced they were found to include a high proportion of abnormalities of either the mother or the child. This search showed conclusively the shortcomings of the system and that another would have to be devised.

Existing System

The potential use of a computerized obstetric record was examined and it was decided to concentrate on supplying infor-

mation for the annual report of the obstetrics department (previously derived from the R.C.O.G. book) for a computerized obstetric summary on each patient which could be sent to general practitioners, for hospital and departmental planning, for Government statistics such as the hospital in-patients inquiry, and for the local health authority.

An obstetric booklet was designed to incorporate the computer coding with a medical record system adopted by all three obstetric units (Fig. 2). A set amount of basic information is collected on every patient. Numerical data are recorded directly into boxes and simple coding instructions are printed beside the boxes for punching alongside the clinical findings. Complications are coded at the end of the record together with additional diagnoses, operations, drugs, x-ray examinations, and investigations. Well-established codes are used whenever possible. An extra digit has been added to the International Classification of Diseases and the General Registry Office's operations code to give clearer definition inside the obstetric section, and the same code enables details in other disease groups to be recorded which would have been impossible in a code designed only for the obstetric project.

The basic 130 items of information are stored on six 80-column cards. A maximum of 27 complications can be recorded on a variable length field which may use another three 80-column cards.

DATA COLLECTION

There are about 4,500 deliveries every year at the three maternity units in St. Thomas's group. The obstetric booklet is started at the booking clinic and most of the boxes for computer use are completed during the patient's confinement and pregnancy by the obstetric unit doctors, midwives, students, and clerks. After the mother's discharge the booklet is sent to a central office, where coding is completed and each record checked by a trained clerk and by the project midwife before it is sent for punching. The complications are coded by the midwife or the doctor on the project. A careful track has to be kept of the medical records in case they are required at short notice—for instance, when a patient is readmitted to hospital. The booklets are punched daily, so that they can be returned and filed in the appropriate hospital as quickly as possible.

The success of the system depends on the co-operation of the staff, from consultants to pupil midwives. Initially there was opposition to it, probably owing to fear of change and loyalty to previous methods. The extra information required has increased the time taken to fill in the booklet by about 10%, but the staff agree that the standard of note keeping is better and that this second method of data collection is much more popular than the first.

DATA PROCESSING

A suite of computer programmes has been written in Fortran IV to handle the data. The validation programme checks that each item of information lies within defined limits. Cross checks have been built into the design so that combinations of variables can be checked by the computer. For example, the presentation at delivery is examined against the mode of delivery and inconsistencies are printed out by the computer. New variables are created from the raw data and checked in a similar way. Thus the actual time recorded is validated as well as the time interval and the sequence of events.

A summary of the patient's pregnancy and confinement is printed in the form of a letter to the patient's general practitioner. Any error messages are printed after each letter; this enables the summary to be corrected manually and dispatched with minimal delay.

SUMMARY OF LABOUR

		HOSPITAL		1	
		BUREAU NUMBER		2-7	
		MOTHER'S DATE OF BIRTH		8-13	
		DAY	HOUR (0-23)	MIN (0-60)	
FIRST STAGE	LABOUR BEGAN AT			14-17	
	MEMBRANES RUPTURED AT			18-23	
	SYNTOCINON COMMENCED AT			24-29	
DURATION OF FIRST STAGE					
SECOND STAGE	BEGAN AT			30-33	
	DELIVERY TIME			34-39	
DURATION OF SECOND STAGE					
THIRD STAGE	COMPLETED AT			40-43	
DURATION OF THIRD STAGE					
METHOD OF MEMBRANE RUPTURE					
Spontaneous (1) Artificial a) F.W.R. (2) b) H.W.R. (3) c) F.W.R. + H.W.R. (4)					
REASON FOR INDUCTION OF LABOUR					
Spontaneous Onset (1) Postmaturity (2) Toxaemia (3) Small for dates (4) Social (5)					
A.P.H. (6) Rhesus Incompatibility (7) Other (8) Not known (9)					
Other: Specify					
METHOD OF DELIVERY					
NORMAL (1) ABNORMAL (2)					
CEPHALIC (1)	BREECH (2)	FORCEPS (3)	VACUUM (4)	C/S (5)	
MULTIPLE PRESENTATION (9)		+ VACUUM (6)		+ VACUUM (7)	
				+ FORCEPS (8)	
				+ VACUUM + FORCEPS (9)	
SPONTANEOUS (1)	SPONTANEOUS (1)	NO ROTATION (4)	BEFORE F.D. (3)	L.S.C.S. (7)	
	ASSISTED (2)	KIELLANDS ROT. (5)	AFTER F.D. (2)	CLASSICAL (8)	
	EXTRACTION (3)	MANUAL ROT. (6)	NOT KNOWN (1)	OTHER (9)	
	INT. VERSION + EXTRACTION (4)				
TYPE OF ANAESTHESIA					
Nil (1) Pudendal Block (2) Local Infiltration (6) General Anaesthetic (4) Epidural Block (3) Both (7)					
PERINEUM					
Intact (1) Episiotomy (2) Tear - 1° (3) 2° (4) 3° (5)					
Sutured By					
DELIVERED BY					
Midwife (1) Pupil Midwife (2) Medical Student (3) Houseman (4)					
Registrar (5) Consultant (6) Other (7) Not Known (9)					
SENIOR PERSON PRESENT AT DELIVERY (Classification above)					
PLACE OF DELIVERY					
Hospital (1) Home (2) In Transit (3) Casualty (4) Other (8) Not known (9)					
Infant Identified by					

FIG. 2—Page from booklet currently in use incorporating computer coding with medical record system.

A simple analysis of results is produced by the table programme, which can be run at, say, monthly or three-monthly intervals. Another programme converts the variable length record format into a fixed length record by creating new variables from the complications code. This conversion is needed so that the data can then be analysed by the "X tab" series of statistical analysis programmes.² A programme is being written to convert the data from St. Thomas's Hospital format into the format required by the General Registry Office for its hospital inpatients inquiry. Computer-held dictionaries have been developed to translate the diagnosis, operations, and drug codes used. A list of general practitioners and their code numbers is continually growing and is reviewed every year against the list from the executive council.

This series of programmes is currently running on the I.B.M. 7094 at the Imperial College of Science and Technology and the C.D.C. 6600 at the University of London.

COSTS

The St. Thomas's project currently uses the London University computer, where time is not charged. Staff costs (£6,000) include a doctor to design the programmes and a programmer to write them. In a service situation these costs would not normally be incurred, and a midwife and clerk would probably be sufficient.

Obstetric units vary in overall cost, depending on length of stay, number of outpatient visits, etc. If the overall cost is £450,000 a year for 4,500 cases, the proportion spent on computer data processing would be between 0.9 and 1.6%. For comparison, there seems to be a general tendency for commercial organizations to spend between 1 and 2.5% on data processing.

Results

The annual report of the obstetric department produced from the computer system shows the number of patients with defined characteristics and the frequencies of abnormalities. The tables show the difference in perinatal mortality and admission rates in the three hospitals and also a difference in the social, racial (country of origin), and obstetric characteristics of the women delivered at each hospital. Results are being compared with groups of mothers with standard characteristics in order to detect differences in obstetric care between the units.

The obstetric behaviour of different racial (country of origin) and social groups is being examined: 1,946 West Indian, 772 African, 434 Mediterranean, and 972 Irish patients will be compared against 6,585 British patients. The obstetric care of 1,305 single women can be compared with the care of married women in the study and analysed against the mortality and morbidity of mother and child. Methods of delivery and time in labour should be compared in 851 cases of fetal distress and 110 cases of stillbirth in order to isolate areas where care in labour might be improved.

The obstetric summary printed by the computer on each discharged patient is now being sent to general practitioners. A summary is also placed in the bureau notes for filing. At present the summaries cannot be produced until two weeks after discharge. Though the error rate is less than 0.5% per data item, 48% of records have to have corrections and at least 30% have to be re-examined. This is time-consuming. About 3% of records never arrive in the coding office. They are often difficult to trace and delay the completion of the data set.

The annual report statistics provide continuous information on the work load of the different departments in the group. Special ad hoc analyses have also been provided to determine the use of delivery and first-stage labour rooms when an

extension to the maternity wing was being planned. The same type of information has been used in some hospitals^{3,4} in simulating the likely effects of change in policy within a department.

The computerized obstetric records can easily be searched for cases that fulfil the necessary criteria for the "at risk" infants register,⁵ and a list can be provided for the appropriate health authority. Computer selection would lead to fewer omissions, but using current criteria would lead to the selection of about 60% of all infants born in our hospitals. The criteria would therefore probably have to be refined.

Discussion

Though using a computer has cost more the quality of information is improved, a complete set of data can be achieved, and it can be analysed to produce extra information.

Though the quality of information depends to a large extent on the original observer he can be helped by a well-designed medical record. Inconsistencies can be checked by the computer validation programme, which can be very searching. Errors which have passed the inspection of two trained staff have been detected, and though correcting them is laborious the quality of the final record is uniformly high.

A complete data set can be achieved if data are collected on a unit record basis and checked to ensure that all the deliveries have been entered. It is important to obtain a complete data set before analysis is undertaken, since the missing records have been shown to contain a high proportion of abnormalities.⁶

The book of obstetric tables was useful as a reference against predefined criteria, but a set of computerized records is much more flexible and allows a detailed retrospective inquiry to be made of groups not previously selected. This facility is used to answer questions thrown up by the standard analysis tables and to provide statistics or a list of relevant patients for a specific research project or planning exercise. The effects of social class, age, parity, and maternal height have been well demonstrated.⁷ In order to compare the results of different hospitals these and other variations in the maternal population should be taken into account as well as the allocation of maternity beds. This type of detailed analysis is extremely easy for a computer.

The discharge summary is being produced for all patients, and a similar computer programme could be used to produce letters to the midwife and health visitor. The existing system, however, is unable to produce the discharge summary in time for it to replace the houseman's letter. A computer installed in the unit would avoid many delays. Rapid validation of input data would also minimize the laborious process of correcting errors.

A data-processing facility giving a fast service would enable the record to be processed in several stages throughout pregnancy (and not just at the end), so that lists of patients admitted and discharged and those still in hospital could be produced daily. This is happening at Queen Elizabeth's Hospital, Birmingham,⁸ where lists of births are also sent to the registrar's office. The work load on the antenatal clinic and the maternity wards can be predicted if information is processed in the antenatal period.

Computerized medical records have considerable potential for assessing work load and determining areas where care should be improved. Nevertheless, a data-processing scheme should not be undertaken lightly. Much work is required to achieve satisfactory results, and these can be achieved only with the co-operation of the whole department.

We thank the maternity departments in the St. Thomas's group for their help and co-operation; Mrs. Chable, Mrs. Wilkins, Miss Jefferies, Mrs. Bird, Mrs. Gosling, Miss Edwards, and Miss Naldret, who have worked together as a team to maintain and develop the project; Mr. Nicholas and Miss Pearce for punching

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Clinical Problems

Rapid Detection of Certain Basic Drugs in Urine

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Summary

Equipment costing only a few pounds can be used to detect a wide range of drugs in urine by anyone with a minimum of scientific knowledge. A run of tests takes about half an hour to perform and cost about 10p.

Introduction

Though the recent trend in toxicological analysis has been towards increasing automation and instrumentation, the growing problems arising from drug addiction have led during the past few years to the publication of a number of so-called simple methods for the detection of drugs in urine.¹⁻¹⁰ Most of these are based on thin-layer chromatography; all of them take several hours to perform and call for full laboratory facilities and considerable expertise. There are occasions, however, when these are not available, and specificity and sensitivity must be sacrificed to speed and simplicity. The method described below can be carried out anywhere by anyone with a minimum of scientific knowledge. The total cost of the equipment needed is less than £5. Each test costs about 10p and takes less than half an hour to perform.

Materials

Apparatus.—Wide-mouthed 8-oz (227-ml) bottles, Bakelite-capped. McCartney bottles (wide-mouthed, with plastic caps). White tile or pieces of white opal glass. Filter paper (Whatman No. 1; strips 6 by $\frac{1}{2}$ in; 15 by 1.3 cm). Small glass rods. Small dropping-bottles with glass stoppers and rubber teats. Forceps. Scissors. A small glass funnel and a spatula are useful but not essential.

Reagents.—(All chemicals of General Purpose Reagent grade.) Sodium sulphate, anhydrous. Chloroform. Sodium tetraborate.

Modified Marquis reagent—dissolve 200 mg of paraformaldehyde in 10 ml of concentrated sulphuric acid. Sodium sulphite solution 10%, freshly prepared. Sulphuric acid, concentrated. Sulphuric acid 2N. Potassium iodoplatinate solution—dissolve 25 mg of platonic chloride and 0.5 g of potassium iodide in 10 ml of water. Cobalt thiocyanate solution 5%. FPN reagent—mix together 0.5 ml of a 5% w/v solution of ferric chloride in water with 4.5 ml of 20% w/w perchloric acid and 5 ml of 50% w/w nitric acid. Ammonium vanadate—make a saturated solution of ammonium vanadate in boiling water, cool, and add an equal volume of 0.880 ammonium hydroxide solution. Paradimethylaminobenzaldehyde—dissolve 0.1 g of paradimethylaminobenzaldehyde in 10 ml of a mixture of ethanol and concentrated hydrochloric acid (10:1). Acetone:water, 20:1 (for chromatography).

Extraction

Place 75 g of anhydrous sodium sulphate and 1 g of sodium tetraborate in an 8-oz (227-ml) bottle (these bottles may be prepared in advance; provided the cap is screwed on tightly they keep indefinitely). Add about 30 ml (a full McCartney bottle) of chloroform. Shake briefly till the sulphate is wet. Add about 25 ml (a McCartney bottle, full to the shoulder) of urine. Shake immediately and continue shaking for two to three minutes. Allow to stand till the chloroform separates then decant into a McCartney bottle containing 1 g of sodium sulphate. If less than half the original volume can be obtained add a little more chloroform to the extraction bottle, shake again, and decant. Shake the McCartney bottle thoroughly. It is essential that the chloroform be absolutely dry; this is indicated by its being completely transparent. If there is any doubt add a little more sulphate and shake again. Decant the chloroform into another McCartney bottle.

By this procedure almost all basic drugs are extracted into the chloroform phase. They are now purified and concentrated by the acid-spot technique introduced by Morgan.⁸

Take a strip of filter paper 6 by $\frac{1}{2}$ in (15 by 1.3 cm) and mark it with a pencil 1 in (2.5 cm) from one end, then at every $\frac{1}{4}$ -in (1.9-cm) interval. At each pencil mark place a small spot, less than 1/10 in (2.5 mm) in diameter, of dilute sulphuric acid. This is most conveniently done by having the pipette of