been admitted elsewhere if the ward did not exist. In normal hospital practice these patients are admitted to consultant beds, thus depriving patients who may require more specialized care.

There is another, smaller, group of patients (211) who would not have been admitted to hospital but for the existence of the unit. The general practitioner deals with a large number of patients who, because of social reasons or inadequate facilities, cannot be managed satisfactorily at home, but do not normally justify admission to hospital. Inpatient treatment of these people leads to more rapid relief of disability, shortening of illness, and earlier return to work. For example, a large number of varicose ulcers (which have taken many hours of doctors' and patients' time in domiciliary practice) have been healed or generally relieved in the unit.

Another not so tangible and yet very real advantage is that of being able to admit a patient for assessment. A chronic patient who does not seem to be doing very well, but involves one in a great deal of thought and time when visiting, can be admitted and thoroughly investigated, often with very gratifying results. The future management is greatly facilitated. The discipline involved in treating a patient in a hospital environment helps to sharpen one's clinical acumen. A number of Surrey doctors,⁴ fearing closure of cottage hospitals, state: "We believe that direct hospital access to enable us to care for certain of our patients is of great importance to our standards."

I would suggest that such a scheme is a direct stimulant to general practice and if extended should attract doctors who are keen to make the most of their clinical abilities. General practitioners who leave to practise abroad are often attracted by the possibility of access to hospital beds. The use of hospital beds by the general practitioner in this country should be one answer to the emigration problem.

It is very important at this time to increase the attractiveness of general practice, especially for the younger doctor. It is

interesting to note that in the Royal College of General Practitioners' report,² quoted above, the large majority of doctors either had or wanted access to hospital beds. There was a minority of 12 (approximately 18%) who did not want access, and all except one of these were over the age of 40. The younger doctor will become the general practitioner of tomorrow; therefore it is important that general practice should be moulded in the right way. The provision of direct access to hospital beds appears to be a step in the right direction.

The doctors using the unit feel that it is now very well established and is proving to be even more valuable than was envisaged when first opened. From our experience there appears to be very little doubt that there is a real place for this type of unit within the National Health Service.

Summary

A hospital bed unit is described in which the general practitioner is solely responsible for the care of his own patient. This results in gain to the patient in continuous care, to the hospital by releasing beds which would otherwise have been occupied elsewhere, and to the general practitioner by allowing him to make fuller use of his medical skills and training. It is suggested that a unit of this type would increase the attractiveness of general practice in this country.

REFERENCES

- ¹ Gillie Report, para. 146. H.M.S.O., London.
- ² General Practice in South-west England. Report of Royal College of General Practitioners, January 1968.
- ³ Wilkinson, B. R., *J. Coll. gen. Practit.*, 1966, 11, 348.
- ⁴ Attenborough, J., *et al.*, *Brit. med. J.*, 1968, 1, 247.

HOSPITAL TOPICS

Experience with an Ultrasonic Foetal Pulse Detector

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The detection of foetal life in early pregnancy has hitherto been a problem not readily resolved. Even in late pregnancy the foetal heart may occasionally be difficult to hear, and electrocardiographic and phonocardiographic methods, while sometimes helpful, are costly and require special skill.

Reports by Callagan *et al.* (1964), Johnson *et al.* (1965), and Bishop (1966) have suggested that an ultrasonic detector, utilizing the Doppler shift phenomenon (the apparent change of frequency of a moving source of sound), may be of practical value when detection of intrauterine life is important.

Method

A transistorized "crystal" held in a probe transmits ultrasound of low intensity into the body tissues. The sound waves are reflected by interfaces of different acoustic impedance perpendicular to the beam and picked up by a receiver crystal in the probe. Any movement—for example, of foetal heart or a

column of blood—towards or away from the transmitted signal will cause it to be reflected with a shift of frequency, and this difference, suitably filtered and amplified, is converted into an audible signal heard through a loudspeaker or earphones.

The apparatus¹ (Fig. 1), which is powered by rechargeable batteries, is compact, light in weight (4 kg.), readily portable, and easily operated. Provision is made for connexion to a tape recorder when a permanent record is required, and it is possible to display the record on an oscilloscope or suitable pen recorder.

Several different sounds may be identified by means of the ultrasound detector. (1) *Maternal vessels*: the uterine vessels produce a single blowing sound synchronous with the maternal pulse. (2) *Foetal heart sounds* are identified as distinctive double sounds of "gallop" rhythm at foetal heart rate. (3) *Foetal vessels* produce a single sound synchronous with the foetal heart. The *umbilical cord* gives a similar sound of higher pitch; its location may vary, as the cord tends to drift out of

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¹ The apparatus used in this study was manufactured by the Smith Kline Instrument Company and is known as the Doptone Foetal Pulse Detector.

the sonic beam. (4) *Placental sounds* are complex, and are composed of an umbilical cord sound superimposed on a low-pitch, modulating, blowing sound of varying intensity—a "wind-like" noise. (5) Occasionally a single sound caused by a *foetal movement* may be heard.

A certain amount of background interference is usual but is seldom distracting.

Clinical Studies

We have used the ultrasonic detector in a variety of circumstances in an attempt to assess its clinical usefulness. The examination is readily made, with no discomfort or inconvenience to the patient, who welcomes reassurance about her pregnancy. Indeed, we have been impressed how often the patient is clearly overjoyed to hear her baby's "heart sounds."

Foetal Life in Early Pregnancy

Examinations were made of 150 patients in early pregnancy drawn from the antenatal clinics or admitted to the gynaecological wards with symptoms suggestive of abortion. The period of gestation varied from 8 to 26 weeks. In each case the foetal heart could not be heard with the ordinary Pinard monaural stethoscope. The results are summarized in Table I. Of the 150 patients five aborted within 48 hours of the examination, two were cases of missed abortion, and two were later delivered of a hydatidiform mole. In none of these was a

FIG. 1.—Foetal pulse detector in use.

foetal impulse demonstrated with the ultrasonic detector. The corrected overall result was that a foetal impulse was detected in 96% of patients with a live pregnancy.

There were 15 patients who were less than 12 weeks pregnant. Four aborted within 48 hours after examination. Of the remaining 11 a foetal impulse was detected in 6 (55%). The earliest time at which foetal life was detected was nine weeks' gestation.

Of the 135 patients who were 12 or more weeks pregnant a foetal pulse was detected in 130. Of the five with a negative response one aborted within 48 hours, two were later confirmed as missed abortions, and in two a diagnosis of hydatidiform

mole was subsequently established. In this series, therefore, a foetal impulse was detected in all cases of live pregnancy of 12 weeks' gestation or more. Moreover, the foetal impulse when present was always distinct.

Placental Localization

This was attempted in patients scheduled for caesarean section. The examination was undertaken the day before operation, the site of the placental attachment being carefully observed at operation. All the patients examined were of at least 37 weeks' gestation. Results in a small series are shown in Table II.

TABLE II.—*Placental Localization by Ultrasonic Detector*

Placental Site	Correct Localization	Incorrect Localization	Total
Anterior	4	0	4
Posterior	8	3	11

In several cases of antepartum haemorrhage no evidence of placenta praevia was found with the ultrasonic detector, and placenta praevia was excluded by examination under anaesthesia. They are not included in the series because the precise placental site was not confirmed at caesarean section.

Some degree of skill and practice are required in the examination for placental localization. Even then, in our view, the results are as yet unsatisfactory. The particular reason for this is that the posteriorly implanted placenta cannot be identified direct and its position can only be inferred by exclusion. Exclusion of the anteriorly implanted placenta can, however, be a helpful preliminary to amniocentesis.

There was only one proved placenta praevia in the series. In this case there was no antepartum bleeding, but caesarean section was contemplated because of an unstable lie. A placental sound indicated an anterior placenta praevia, and this was confirmed at operation.

Other Uses in Obstetrics and Gynaecology

The ultrasonic detector was many times found useful in detecting foetal impulses under adverse conditions—for example, in very obese patients, in cases of hydramnios, or in abruptio placentae. In one instance its use was particularly rewarding. The patient had severe accidental haemorrhage at 34 weeks with classical signs. The foetal heart could not be heard, but a foetal impulse was found with the ultrasonic detector. Because of this demonstration of foetal life an emergency caesarean section (of a Couvelaire uterus) was performed and a live child, which otherwise might well have been lost, was delivered. The detection of a foetal impulse in early pregnancy was often of considerable value, particularly in the differential diagnosis of abortion or missed abortion, molar pregnancy, and pelvic tumours. The ultrasonic method is quick and easily performed, and (at least after the 12th week) reliable. Moreover, being a test of foetal rather than chorionic life, it has in some cases obvious advantages over other pregnancy tests.

TABLE I.—*Foetal Impulse Detection in Early Pregnancy in 150 Patients*

		Gestation in Weeks																		
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Foetal impulse	+	0	2	0	4	8	18	18	8	16	8	12	4	4	10	6	4	6	6	2
	-	2	3	2*	2*	1*	1†	2‡	0	0	0	0	0	1§	0	0	0	0	0	0
Total No.		2	5	2	6	9	19	20	8	16	8	12	4	5	10	6	4	6	6	2

*Aborted within 48 hours. †Missed abortion. ‡One missed abortion and one hydatidiform mole. §Hydatidiform mole.

The following examples illustrate the range of usefulness of the test:

Mrs. A. A brown discharge and a uterus which was small for the duration of amenorrhoea suggested a missed abortion. The ultrasonic examination demonstrated a live pregnancy, which continued to term.

Mrs. B. A symptomless pelvic tumour to the umbilicus had the characteristics of an ovarian rather than a uterine swelling. A uterine souffle could not be heard with the stethoscope but the ultrasonic counterpart was clear. Laparotomy confirmed the diagnosis of uterine fibroids.

Mrs. C. A 41-year-old nullipara complained of two months' amenorrhoea. She had an obvious melon-sized mass of fibroids, said to have increased in size recently. With the ultrasonic detector a uterine souffle was heard, but there was no foetal impulse. Findings at operation were confirmatory.

Mrs. D. A 30-year-old multipara presented with vaginal bleeding and vomiting after 10 weeks' amenorrhoea. A Pregnosticon test was positive at 1:100 dilution and negative at 1:200. The uterine size corresponded to 20 weeks' gestation. Ultrasonic examination excluded foetal life. Later a hydatidiform mole was confirmed.

Discussion

Yoshida *et al.* (1961) introduced the Doppler phenomenon into medical ultrasonics some years ago with an approach to measurements of the adult heart. Later the method was used in a transcutaneous blood flowmeter (Rushmer *et al.*, 1966). It has now been applied in a foetal impulse detector, and it is our view that this novel technique provides a quick, easily operated, reliable means of detecting foetal life and monitoring the foetal heart, with considerable value in clinical practice.

After the twelfth week of gestation we detected a foetal impulse in all cases of live pregnancy, the earliest detection of foetal life being at the ninth week. In the few cases when the foetal sound was not heard the pregnancy soon aborted or was later shown to be a missed abortion or hydatidiform mole.

FIG. 2.—Monitoring the foetal heart. A graphic recording of the foetal pulse in labour.

These findings support the view of Bernstein and Callagan (1966) that in the earlier months of pregnancy the reliability of the ultrasonic detector of foetal life surpasses that of foetal electrocardiography. The method provides an accurate test of foetal life and is a valuable diagnostic tool in early pregnancy, with advantages over the usual pregnancy tests.

The ultrasonic foetal pulse detector offers a means of monitoring the foetal heart in labour. With suitable (albeit expen-

sive) electronic equipment the record can be displayed graphically on an oscilloscope or pen recorder or feed a rate-meter. Fig. 2 is an example of such a record. This is a promising field about which more is likely to be heard in future—always provided the safety of the method can be assured.

There is in fact no evidence to suggest that the low-intensity ultrasound used (30 mw./sq. cm.) has any harmful effect on mother or foetus. Possible genetic effects cannot be predicted, but animal experiments have failed to show any deleterious effect on adult or embryonic tissues from pulsed ultrasound much above diagnostic levels (Donald *et al.*, 1958; Smyth, 1964), while Kohorn *et al.* (1967) were unable to show any electroencephalographic changes in neonates subjected to ultrasound.

The use of the ultrasound detector in placental localization has been disappointing in our hands. Our own experience is very limited, but even if the correct prediction in 85% of cases quoted by Bishop (1966) could be emulated the position would not be satisfactory. The chief limitation of the method is that the posteriorly implanted placenta can as yet be diagnosed only by inference and cannot be directly identified. The method is certainly useful in detecting the anterior placenta. We suggest that the diagnosis of placenta praevia would be facilitated by the use of a vaginal probe.

Summary

Application of the Doppler principle has led to the development of an ultrasonic foetal pulse detector which is simple to operate, portable, and effective.

By its use foetal life can be detected as early as the ninth week of pregnancy and in all cases after the twelfth week.

Its reliability as a test of live pregnancy makes it a most valuable diagnostic tool in the differentiation of abortion and missed abortion, molar pregnancy and pelvic tumours, and as a monitor of the foetal heart under adverse conditions.

As a means of placental localization it is useful, but its reliability falls short of acceptable standards.

REFERENCES

- Bernstine, R. L., and Callagan, D. A. (1966). *Amer. J. Obstet. Gynec.*, 95, 1001.
- Bishop, E. H. (1966). *Ibid.*, 96, 863.
- Callagan, D. A., Rowland, T. C., jun., and Goldman, D. E. (1964). *Obstet. and Gynec.*, 23, 637.
- Donald, I., MacVicar, J., and Brown, T. G. (1958). *Lancet*, 1, 1188.
- Johnson, W. L., Stegall, H. F., Lein, J. N., and Rushmer, R. F. (1965). *Obstet. and Gynec.*, 26, 305.
- Kohorn, E. I., Pritchard, J. W., and Hobbins, J. C. (1967). *Ibid.*, 29, 272.
- Rushmer, R. F., Baker, D. W., and Stegall, M. F. (1966). *J. appl. Physiol.*, 21, 554.
- Smyth, M. G. (1964). *Proceedings of Annual Meeting of American Institute of Ultrasonics in Medicine*.
- Yoshida, T., *et al.* (1961). *Amer. Heart J.*, 61, 61.