least in children. However, results of a "negative" type are of value, but results of a "positive" type must be interpreted with caution.

We thank Dr. Nancy Hayward for constant help and advice, especially to one of us (R. F. L.); the medical staff of the Royal Children's Hospital, who have referred the patients to us; and the nursing staff, who have given co-operation. We are indebted to the bacteriology department of the University of Melbourne for space made available to one of us (R. F. L.).

REFERENCES

Brown, A., Courtney, A. M., Davis, G. A., and MacLachlan, I. F. (1925). *Amer. J. Dis. Child.*, 30, 603.
Cregan, J., and Hayward, N. J. (1953). *Brit. med. J.*, 1, 1356.
Frazer, A. C. (1949a). Ibid., 2, 731.
—— (1949b). Ibid., 2, 769.
—— (1952). *Trans. roy. Soc. trop. Med. Hyg.*, 46, 576.
—— French, J. M., Sammons, H. G., Thomas, G., and Thompson, M. D. (1949). *Brit. J. Nutr.*, 3, 363.
Herter, C. A. (1908). *On Infantilism from Chronic Intestinal Infection.* Macmillan, New York.
Kendall, A. I. (1909). *J. biol. Chem.*, 5, 419.
Martini, G. A., Phear, E. A., Ruebner, B., and Sherlock, S. (1957). *Clin. Sci.*, 16, 35.
Schiff, E., and Kochmann, R. (1922). *Jb. Kinderheilk.*, 99, 181.

A MURMUR FROM THE DUCTUS ARTERIOSUS IN THE NEWBORN BABY

BY

E. D. BURNARD, M.B., M.R.C.P., M.R.A.C.P.
Paediatric Unit, St. Mary's Hospital Medical School, London

In the newborn lamb Dawes and his collaborators have shown that the ductus arteriosus closes by muscular contraction (Dawes *et al.*, 1955b ; Born *et al.*, 1956b). After a rapid reduction in diameter by about half within a few minutes of birth, it remains as a channel through which a considerable amount of blood passes from aorta to pulmonary artery for 24 hours or longer. During this time a loud continuous murmur is heard through the chest wall, a phenomenon found also in the newborn of other mammalian species, such as the calf and foal (Amoroso *et al.*, 1958).

In the newborn baby there are wide differences in the incidence of murmurs estimated by different observers, from 1.9% (Lyon *et al.*, 1940) to 25% (Siemsen, 1938). Their disappearance after weeks or months has been noted (Richards *et al.*, 1955), together with their faintness and blowing or humming quality. The emphasis in descriptive accounts has been on their benign nature rather than their origin.

Recent workers investigating the state of the human neonatal circulation have not found a murmur, though they concluded that the ductus was open (Eldridge and Hultgren, 1955 ; Rowe and James, 1957 ; Adams and Lind, 1957). The animal studies that have been cited suggested none the less that a renewed scrutiny of babies in the first hours of life might reveal comparable findings.

In one-third of 100 healthy infants examined at birth or soon after a rough murmur which was heard in late systole seemed in some to run through the second sound and in others to stop there. In phonocardiographic tracings the murmur displayed a crescendo to the second sound and then in some instances a diminuendo. A high-pitched murmur accentuated in late systole and audible after the second sound is a sign of the patent ductus that was described by Gibson (1898, 1900). He deduced that it signifies blood flow from aorta to pulmonary artery. Bonham Carter and Lovel (1953) have established that in early childhood the murmur may be confined to systole. In babies a systolic murmur might therefore mean that the ductus is open if it could be distinguished from other systolic murmurs that are heard at this age.

In the present paper a crescendo systolic murmur, whether or not there is a following diminuendo, is referred to as the ductus murmur. Its characteristics are described and two factors that seem to affect its detection discussed.

There is general agreement, summed up in the work of Richards *et al.* (1955), that murmurs in the neonatal period have very little connexion with congenital heart disease. The ductus murmur is usually faint, transient, and not easy to distinguish by ear from other murmurs in the early hours of life. Absence of clinical reports of the murmur is therefore not remarkable.

Material and Methods

The babies were all healthy. Five were premature, 5–5½ lb. (2,270–2,500 g.) in weight. Deliveries took place in a labour room at 75–80° F. The cord was clamped at birth. Oxygen was sometimes given for a brief period at the midwife's discretion. If there was delay in breathing, likely to be due to administration of pethidine to the mother, 1 mg. of N-allyl-morphine was given intramuscularly. After the mother had held the baby for a few minutes it was taken to the nursery (70–75° F. (21–24° C.)), where in the course of the next hour it was bathed. Examinations were carried out in a quiet room next door. An adult-sized bell chest-piece was used for auscultation. Although some faint murmurs were better heard with a diaphragm it was unsuitable for routine use because of friction sounds from the skin if a baby was restless.

The phonocardiograph was a portable direct-writing instrument, manufactured by Elema, of Stockholm. In this apparatus the five frequency ranges are 12 to 50, 25 to 100, 50 to 200, 100 to 400, and 200 to 800 cycles per second. These are denoted by the frequency recorded to the highest amplitude within each range, giving five "standard frequency" bands (Mannheimer, 1955) of 25, 50, 100, 200, and 400 c./s. The 400 c./s. "standard frequency" band is nearest to the auscultatory findings and displayed fairly satisfactorily what was heard through the stethoscope. The microphone, 4 cm. in diameter, was held with light pressure on the infant's chest. Tracings were taken at the point of greatest intensity of a murmur when it had been detected with the stethoscope. The speed was 100 mm. per second. The E.C.G. was omitted if attaching the electrodes disturbed the baby. Interference from breath sounds and bodily movements was always a problem.

A uniform plan of examination had not been settled at the start of the study, and the first 20 babies in the series on which the report is based, in whom examination was later judged to have been sufficiently frequent, were selected from a larger number. The remaining 80 were taken consecutively, provided their hour of birth allowed time for convenient observation, and were examined at intervals of one to two hours. 44 babies were seen within 15 minutes of birth.

Rectal temperature was measured at intervals of two to four hours to give a rough indication of metabolic activity over the period of study.

Ductus Murmur

The murmur was best heard in the region of the third and fourth left costal cartilages. It was usually faint but sometimes fairly loud, intensity varying between grades 1 and 3 (Levine and Harvey, 1949). The louder murmurs were audible at the second left interspace, at the lower left costal cartilages and xiphisternum, and slightly across the midline to the vicinity of the second and third right chondrosternal junctions. The murmur was not conducted to the lung bases behind, nor to the axilla. As already stated, it occupied a characteristic place in the cardiac cycle. The crescendo leading up to a loud second sound could be made out with the stethoscope. A diminuendo in early diastole might then be heard (Figs. 1, 2, 3A) which was brief and of reduced intensity compared with the crescendo part.

Fig. 3A is an instance where the full murmur was well displayed; three hours later (Fig. 3B) only the crescendo was heard, though a brief diminuendo appeared on the trace. The diminuendo was always hard to identify by ear though it might be apparent in the phonocardiogram.

In the tracings a brief interval usually occurred between the first sound and the start of the murmur (Figs. 1, 2, 3A and B), but sometimes the murmur began straight after the first sound (Figs. 4 and 5).

The murmur's accoustic properties showed some variation, partly depending on intensity. Some of the louder murmurs sounded harsh, while others had musical overtones as well. In some fainter examples the rough quality alone was detectable. At its faintest the murmur was musical, almost like a whistle or a cheep. It was best shown graphically in the high-frequency range, 400 c./s. "standard frequency" (Figs. 1, 2, and 5), and this is evidence of the relatively high pitch.

KEY TO LETTERING ON ILLUSTRATIONS

Upper line denotes features of phonocardiogram as follows: 1 and 2, first and second sounds; S, early systolic murmur; C, crescendo systolic murmur; D, diminuendo in early diastole; P, presystolic vibrations; H, venous hum; E, ejection click; Br., breath.

Below the phonocardiogram the first line gives the site at which the microphone was centred, left costal cartilage (L.C.C.) or interspace (L.I.S.); the second is the "standard frequency" band in cycles per second (C.S.); and the third is the gain as an arbitrary fraction (1/20, 1/10, or 1/5) of a maximum 0.1 represents 0.1 second. The E.C.G. is lead II or III; the QRS complex is marked only when there is much interference with the baseline.

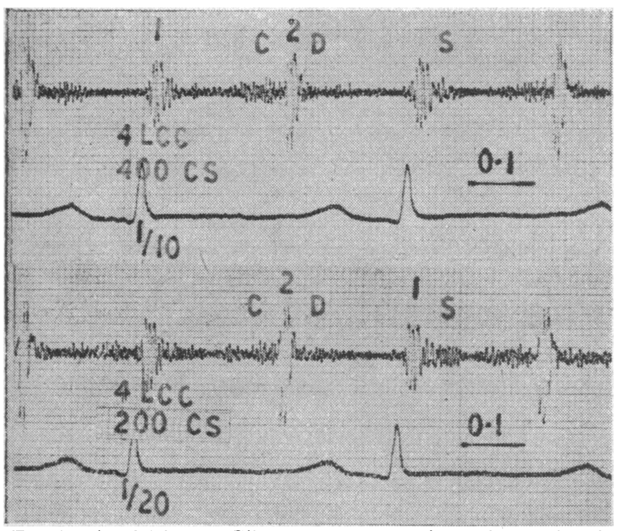

FIG. 1.—Aged 1 hour. Gibson-type murmur in tracing, and early systolic murmur which is shown rather better in the lower frequency (200 c./s.). On auscultation there was a harsh faint late systolic murmur running through the second sound and a blowing early systolic.

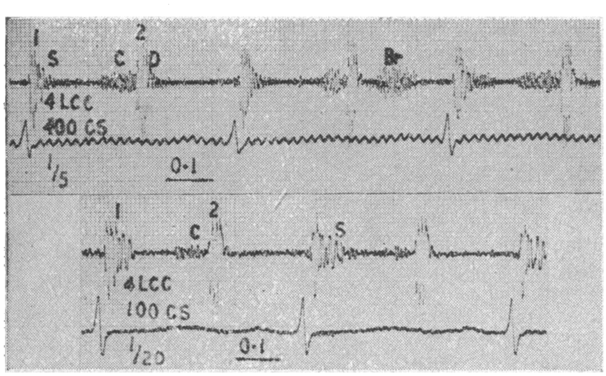

FIG. 2.—Aged 20 minutes. Gibson-type murmur in tracing, best shown in the high frequency (400 c./s.), and brief early systolic. The late systolic murmur was high-pitched, musical, and ran through the second sound; the early systolic was not detected by auscultation.

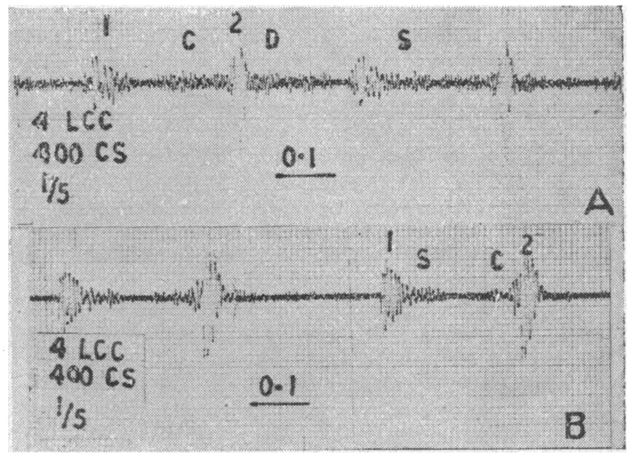

FIG. 3.—A: Aged 1½ hours. Tracing shows Gibson-type murmur, and also an early systolic murmur. Only one systolic murmur was heard, and it ran through the second sound. B: Same baby, aged 4½ hours. Both elements of Gibson-type murmur still present in tracing but much shorter. On auscultation there was a faint high-pitched murmur in late systole.

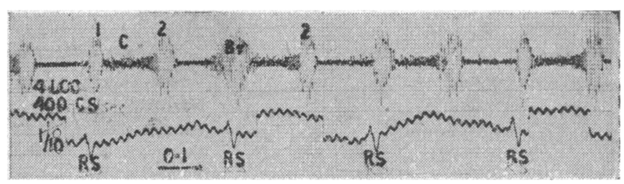

FIG. 4.—Aged 2 hours. Crescendo systolic murmur beginning straight after first sound; second sound broad. The murmur was fairly loud, about grade 3, and musical.

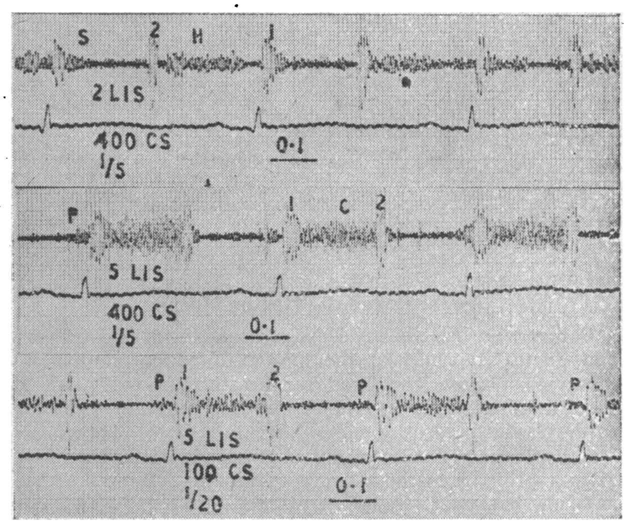

FIG. 5.—Aged 1½ hours. Mid-diastolic murmur "venous hum" at second space. Crescendo systolic murmur at fifth space, best shown in the higher frequency (400 c./s.). Elements of this murmur are also seen in the upper tracing. The diastolic murmur was blowing, the systolic harsh and of grade 3 intensity. The presystolic vibrations P were not audible.

In some instances a clear relationship to breathing could be ascertained, the murmur being confined to inspiration or else becoming louder then. The relationship could not, however, be recorded on the instrument used. During the few hours when it could be detected the murmur was characteristically faint and rough at first, becoming louder with or without musical overtones. In some a musical note developed as they faded, while others that were already musical lost this quality. When the murmur was heard at birth it was harsh from the start. From the findings on auscultation the form of the tracing could not be predicted with certainty; the combination of murmurs illustrated in some of the figures may be sufficient reason for this.

A systolic crescendo in the phonocardiogram has been the criterion adopted for assigning a murmur to flow through the ductus. The murmur was audible beyond the second sound in only a minority of babies; in the illustrations it is then called a "Gibson-type" murmur. There were uncertainties in distinguishing the diminuendo part, and a statement of its incidence is not attempted.

There was no clinical evidence of a right-to-left shunt such as the cyanosis of the lower trunk mentioned by Eldridge and Hultgren (1955); on the contrary, many babies who were a little dusky after birth became pinker while the murmur was present.

Fig. 6 provides a general picture of the incidence of the murmur. The length of its existence is somewhat underestimated in this illustration, since the time between examinations was increased once the murmur had been identified. Only rarely was it heard after eight hours. Of the two present at 24 hours, one had gone by 36 hours and the other by 48 hours.

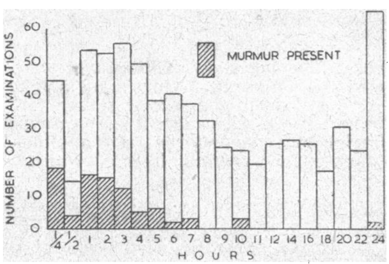

Fig. 6.—Proportion of positive examinations in 100 babies according to age in hours.

Babies have been divided into those first examined during the first 15 minutes of life, most of them very soon after birth, and those seen for the first time after 15 minutes. Of the 44 in the former group the murmur was present in 18 at the time of the initial examination or developed within 15 minutes of birth (Table I). In seven of them the murmur appeared for the first time half to five hours after birth.

Table I.—*Subdivision of Cases According to Age When First Examined*

First Examined	No. of Babies	Murmur First Heard in 15 Mins.	Total where Murmurs Heard
0–15 minutes ..	44	18	25
1–11 hours ..	56		12
	100		37

Asphyxia and the Ductus Murmur

Babies who had shown signs of asphyxia during delivery had ductus murmurs at the first examination more commonly than those who cried and breathed normally within three minutes. Fig. 7 (Twin A and Twin B) shows phonocardiographic records of such murmurs at birth. These were from twins born three weeks prematurely by forceps delivery after a prolonged second stage of labour. Both breathed at birth, but, apart from intermittent gasping, Twin A was then apnoeic for five minutes and Twin B for eight minutes.

Table II sets out the findings in relation to asphyxia in the 44 cases examined within 15 minutes of birth. "Asphyxia" here means apnoea following birth for three minutes or more, and is also applied to babies who breathed within that interval but had shown signs of foetal distress or suffered prolonged labour. In none did the condition give cause for serious concern, only a minority approaching a state of "white asphyxia." 71% of the asphyxiated babies developed the murmur, as compared with 13% when there was no asphyxia. The difference is highly significant (P<0.001).

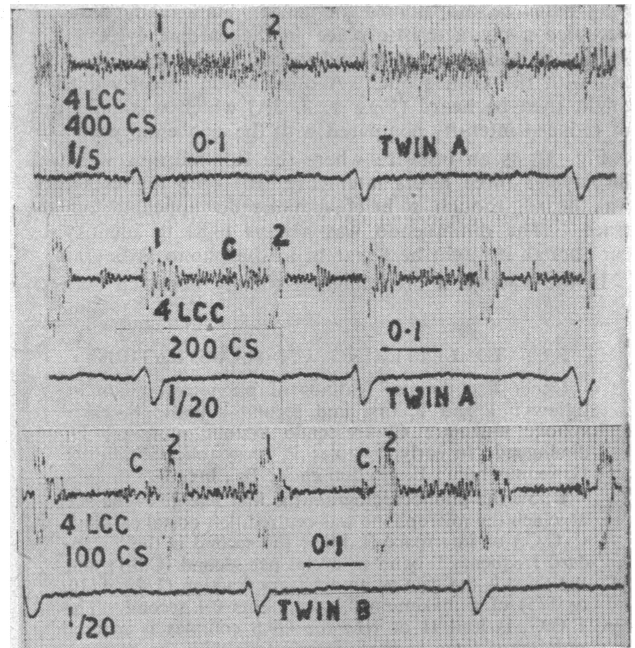

Fig. 7.—*Twin A*, aged ½ hour. Tracing shows crescendo systolic murmur; also mid-diastolic and presystolic vibrations, which were not heard. The systolic murmur was first heard within a few minutes of birth, harsh, and of grade 3 intensity. *Twin B*, aged ½ hour. Late crescendo systolic murmur, heard within a few minutes of birth (it showed better in a higher frequency) harsh and fairly loud. Brief rumbling diastolic murmur (see text).

Table II.—*Relation Between Asphyxia and the First Appearance of a Murmur in Babies First Examined* 0–15 *Minutes After Birth*

	Total No. of Babies	Murmur Present	
		No.	%
Asphyxia* ..	21	15	71
No asphyxia ..	23	3	13

* 14 apnoea for 3 minutes or more; 4 prolonged labour, breathing within 3 minutes; 3 foetal distress, breathing within 3 minutes.

Temperature and the Ductus Murmur

An association between a higher body temperature and the likelihood of hearing the murmur after normal delivery is illustrated in Fig. 8. In the group of babies who were slightly asphyxiated on delivery the correlation between a higher rectal temperature and the presence of a ductus murmur was not so clear.

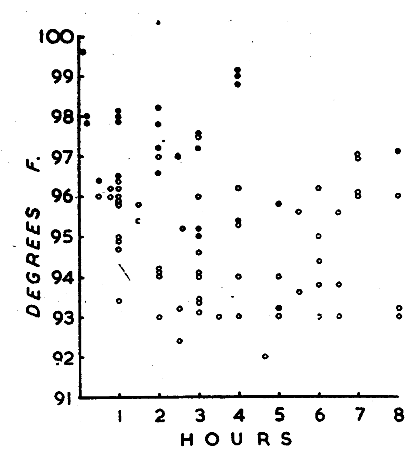

Fig. 8.—Rectal temperature after normal delivery without asphyxia. ● 10 babies with murmur. ○ 21 babies with no murmur.

Other Murmurs

These were confusing, both clinically and in the graphic records. They are mentioned here only so far as is necessary to make the ductus murmur tracings clear.

A short murmur in early systole was common, blowing in character or humming as described by Friedman *et al.* (1949). It was best heard as a rule at the fourth left space. Graphically it was best registered at a lower frequency than the ductus murmur (100 or 200 c./s. "standard frequency"), and either had a diamond shape (Fig. 9) or was more nearly diminuendo (Figs. 1, 2, 3A and B). A sharp vibration succeeding the first sound was often seen on the record of this murmur (Fig. 5), and was sometimes heard as an ejection click (Leatham, 1954).

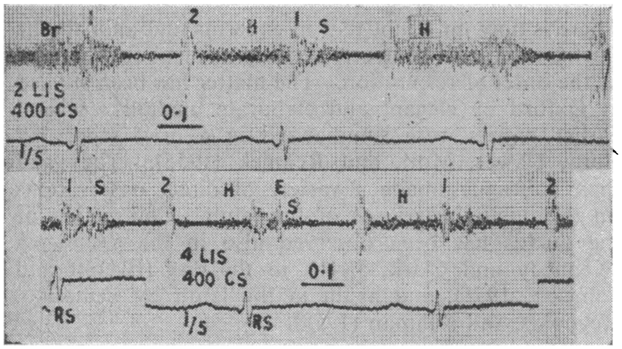

Fig. 9.—Aged 4 hours. Diastolic murmur ("venous hum"—see text), loudest at second space and conducted to fourth, with well-marked fluctuation between cycles (upper tracing); early systolic murmur. Both murmurs were blowing on auscultation. The sharp vibration E was not heard as a distinct sound.

A pansystolic murmur was found in 10 babies. It was not considered to mean flow through the ductus in the present study, though it may at times have this significance (Leatham, 1955).

A diastolic murmur that might occur by itself (Fig. 9) or with the ductus murmur (Fig. 5) has been tentatively ascribed to flow through venous channels and is referred to as a "venous hum." It was best heard below the clavicles, on the left rather than the right, and might be conducted as low as the fourth left interspace (Fig. 9). The quality was blowing, the diastolic timing not easy to ascertain by ear. It disappeared suddenly if the baby wriggled actively or cried, and then gradually returned; half a minute might pass before the murmur had resumed its previous intensity. Testing for an effect on this murmur of pressure on neck veins failed because of crying. The tracings showed that it occupied most of diastole and also that there might be considerable fluctuation in intensity from one cycle to the next (Fig. 9). It was confused with the ductus murmur because their territories overlapped, but the site of greatest intensity was different, as is well illustrated in Fig. 5. Typical examples could be fairly readily identified by ear as well as from the tracings. Different forms of diastolic murmur were found, however—for example, Fig. 7 (Twin B), where it was rumbling to the ear and rises to the first sound in the record.

Brief presystolic vibrations were occasionally recorded in the lower frequency bands (Figs. 5 and 7, Twin A), but only in one infant was a short presystolic murmur heard.

The second sound, which was always loud at birth, exhibited no constant pattern in its later development. In tracings with a ductus murmur the second sound was characteristically very narrow. A sharp, narrow second sound was often found when there was no murmur, however, and Fig. 4 shows that it could be comparatively broad in the presence of the ductus murmur.

Discussion

The evidence in favour of the ductus arteriosus as the source of a characteristic murmur may be recapitulated. Firstly, there is its position in the cardiac cycle; secondly, its harsh character; and, thirdly, its radiation downwards but not posteriorly. The site of maximum loudness is lower than in older subjects, but the pulsation of the newborn heart in the early hours is most vigorous at the same site—namely, the third to fifth left costal cartilages—and conduction might be expected there.

Dawes and his colleagues have shown conclusively that in newborn lambs the ductus remains in a partly contracted state in the first few days of life, the flow through it producing a loud murmur like that heard in patent ductus with left-to-right shunt in man. In the newborn lamb contraction of the ductus begins as saturation of the arterial blood with oxygen rises above 60%; it also occurs in those whose ventilation is grossly inefficient, probably from the release of pressor amines in response to the partial asphyxia which is a fairly common condition in the lamb after birth. In either case (Born *et al.*, 1956b) there appears a murmur whose presence can be correlated with the volume and velocity of the flow through the ductus, which are in turn dependent on the diameter of the vessel and the pressure difference across it. They believe that turbulence in the pulmonary trunk is the immediate cause of the murmur, and find that its behaviour can be quite accurately designated in terms of certain measurements (Dawes *et al.*, 1955a).

There are good reasons for believing that blood flows through the human ductus after birth in a manner and direction capable of producing a murmur. The results of cardiac catheterization suggest that closure may be incomplete for some days (Adams and Lind, 1957; Rowe and James, 1957), and, by analogy with the animal experiments quoted above, the flow through it would probably be from left to right. The intensity and, indeed, audibility of a murmur would be governed by physical conditions of pressure and flow of which little is known, and only a general statement of the variables can be made. Thus the systemic pressure rises abruptly from the foetal state when the cord is tied and peripheral resistance increases, and pressure in the pulmonary artery falls as the lung capillary bed opens with the start of respiration. Total blood flow will be related to metabolic rate in so far as it affects the cardiac output. Differences in the amount of blood transferred to the baby from the placenta (Gunther, 1957) may very well influence both systemic pressure and flow.

The absence of a murmur is remarked both by Adams and Lind (1957) and by Rowe and James (1957). Their subjects were few in number, however, and most of them older than those in the present study. Particular attention has been given here to two circumstances that help to explain the findings. These were the occurrence of asphyxia at birth, and the body temperature in the succeeding hours; the latter was regarded as a rough measure of metabolic rate.

Thus it is possible that, in the babies who were mildly asphyxiated, contraction of the ductus occurred as in asphyxiated lambs. If at the same time the systemic blood pressure had been raised, as in asphyxiated foetal and newborn animals (Born *et al.*, 1956a), this would have increased the velocity of left-to-right flow and made a murmur more likely. In the smaller number where a murmur was observed to develop later the findings are analogous to the well-oxygenated lamb except for the shorter life of the murmur, and here contraction of the ductus may have occurred as the blood became fully arterialized. The murmur was intense enough to be audible because, with a neonatal temperature drop that happened to be less than usual, the cardiac output and hence the flow across the ductus was greater than in babies of comparable age where no murmur was heard, yet in whom, as now seems likely, the ductus was open.

The idea that asphyxia promotes contraction of the ductus and a murmur at birth may seem at variance with the relation between persisting patency and abnormal birth (Record and McKeown, 1953) or the reduced oxygen of high altitudes (Dexter, 1952). It must be remembered, however, that the present data have not been used to decide when effective flow through the ductus ceased, and also that severely asphyxiated babies were excluded from the study.

The murmur from the partly contracted ductus in animals is louder than any that were heard in babies. A possible reason for the difference is the elongated shape of the animal thorax with the great vessels lying closer to the chest wall. Relative pressures in the great vessels may also be of a different order. Further investigation may reveal more of the haemodynamic conditions responsible for the murmur. For the present its detection in a proportion of babies supports the idea that in the human as in the lamb the ductus conducts blood from aorta to pulmonary artery for a short but appreciable time after birth.

Summary

One hundred healthy babies were examined in the early hours of life. A distinctive murmur was heard in 37, and lasted for a short time. In its quality on auscultation, manner of conduction on the chest wall, and phonocardiographic properties it resembled the murmur present in persisting patency of the ductus arteriosus. The murmur was therefore attributed to flow from aorta to pulmonary artery through the ductus. The analogy with findings in the newborn lamb, where the ductus is partly contracted and a continuous murmur heard, is discussed. It is concluded that, in the babies examined, mild asphyxia at birth was responsible for the majority of the murmurs. The minority were related to a body temperature above average. Other murmurs that were detected in the first 24 hours of life are briefly described.

I wish to thank Mr. Leslie Williams, Mr. Douglas MacLeod, and Dr. Reginald Lightwood for permitting examination of the infants in their care; Sister K. A. Taylor and her staff for continuous help in carrying out the work; Dr. Geoffrey Dawes and the Nuffield Institute of Medical Research, Oxford, who lent the phonocardiograph; and Dr. Aubrey Leatham for valuable criticism of the text.

References

Adams, F. H., and Lind, J. (1957). *Pediatrics*, 19, 431.
Amoroso, E. C., Dawes, G. S., and Mott, J. C. (1958). *Brit. Heart J.*, 20, 92.
Bonham Carter, R. E., and Lovel, K. W. (1953). *Gt Ormond Str. J.*, No. 6, p. 93.
Born, G. V. R., Dawes, G. S., and Mott, J. C. (1956a). *J. Physiol. (Lond.)*, 134, 149
—— —— —— and Rennick, B. R. (1956b). Ibid., 132, 304.
Dawes, G. S., Mott, J. C., and Widdicombe, J. G. (1955a). Ibid., 128, 344.
—— —— —— (1955b). Ibid., 128, 361
Dexter, L. (1952). *New Engl. J. Med.*, 247, 851.
Eldridge, F. L., and Hultgren, H. N. (1955). *J. clin. Invest.*, 34, 987.
Friedman, S., Robie, W. A., and Harris, T. N. (1949). *Pediatrics*, 4, 782.
Gibson G. A. (1898). *Diseases of the Heart and Aorta*. Pentland, Edinburgh.
—— (1900). *Edinb. med. J.*, 8, 1.
Gunther, M. (1957). *Lancet*, 1, 1277.
Leatham, A. (1954). Ibid., 2, 607.
—— (1955). *Brit. Heart J.*, 17, 574.
Levine, S. A., and Harvey, W. P. (1949). *Clinical Auscultation of the Heart*. Saunders, Philadelphia.
Lyon, R. A., Rauh, L. W., and Stirling, J. W. (1940). *J. Pediat.*, 16, 310.
Mannheimer, E. (1955). *Advanc. Pediat.*, 7, 171.
Record, R. G., and McKeown, T. (1953). *Brit. Heart J.*, 15, 376.
Richards, M. R., Merritt, K. K., Samuels, M. H., and Langmann, A. G. (1955). *Pediatrics*, 15, 169.
Rowe, R. D., and James, L. S. (1957). *J. Pediat.*, 51, 1.
Siemsen, W. J. (1938). *Illinois med. J.*, 73, 157.

Two new films, produced by Stanley Schofield Productions Ltd., were recently shown to the medical press. "An Introduction to the Study of Child Health" (16 mm., sound, 20 minutes), directed by Professor F. M. B. Allen, Nuffield professor of child health at Queen's University, Belfast, and sponsored by Cow and Gate Ltd., is intended for second-year medical students, nurses, and others. "Breast Feeding" (16 mm., sound, 25 minutes) was made at the British Hospital for Mothers and Babies at Woolwich as a tribute to the late Dr. H. K. Waller. It is intended for showing to nurses, midwives, and expectant mothers. These films may be viewed by arrangement with Stanley Schofield Productions Ltd., 6–8, Old Bond Street, London, W.1.

POST-MORTEM OBSERVATIONS ON CONTRACTION OF THE HUMAN DUCTUS ARTERIOSUS

BY

R. R. WILSON, M.D.

Morbid Anatomist, Paddington General and St. Charles's Hospitals

There is now no doubt that in experimental animals the ductus arteriosus contracts actively at or about the time of the onset of respiration. The matter has been studied at Oxford by elegant and elaborate methods; several earlier papers were summarized in a brief report by Born, Dawes, Mott, and Rennick (1955). They and their colleagues made a variety of direct observations on the ductus arteriosus of the lamb. Contraction of the ductus has been observed also in the guinea-pig (Kennedy and Clark, 1941), in the dog (Everett and Johnson, 1951), and again in the lamb by Danesino, Reynolds, and Rehman (1955).

It is natural to assume that the same thing happens in the human also. The media of the human ductus arteriosus is predominantly muscular, in contrast to the largely elastic media of the pulmonary trunk and the aorta (Kennedy and Clark, 1941; Jager and Wollenman, 1942; Danesino *et al.* 1955). Lind and Wegelius (1954) have in fact observed contraction of the human ductus by angiocardiography, but observations such as those made on animals cannot be made on human subjects. It is possible, however, to observe the condition of the ductus arteriosus at post-mortem examination of stillbirths and neonates. This has been done over a period of two years at Paddington General Hospital.

Method

The method has been to remove the tongue and the thoracic viscera in one block, after removal of the thymus; then the pericardium is opened up and the aorta and the ductus and their great branches are dissected out, with special attention to clearing up the space between the ascending aorta and the ductus.

This procedure usually enables one to say with reasonable certainty whether the ductus is contracted or uncontracted, particularly when one has learnt to recognize the uncontracted state. In this condition the ductus, seen from the front, appears little narrower than the pulmonary trunk; it tapers only slightly from its origin to its entry into the aorta; and it is rather soft and flexible. On the other hand, the contracted ductus tapers more steeply from its origin to a zone of maximum contraction, which often occupies all its distal half; and it is firmer and more rigid than either the uncontracted ductus or the other great arteries. The uncontracted ductus can be compared with that seen in slightly macerated foetuses, while the contracted ductus can be likened to that of the infant of a few weeks old (see Photograph). Partial contraction and dilatation are sometimes seen, but most cases fall into the categories of "contracted" and "uncontracted."

The condition of the ductus arteriosus has been noted in 109 post-mortem examinations, consecutive except for three or four much-macerated cases. The total of 109 is reduced to 100 by the exclusion of five that were more than 28 days old, and by four that were by oversight not weighed Among the 100 cases there were 63 neonatal deaths and 37 stillbirths. They were classified into three groups by weight: those weighing 2,500 g. ($5\frac{1}{2}$ lb.) or more and regarded as mature, those weighing less than 2,500 g. but