

THE DETERMINATION OF BLOOD PRESSURE IN INFANTS BY THE FLUSH METHOD

BY

JOHN REINHOLD and MICHAEL PYM

From the Paediatric Unit, St. Mary's Hospital Medical School, London

(RECEIVED FOR PUBLICATION OCTOBER 20, 1954)

Accurate determination of the blood pressure in the arms of small infants by auscultation, and even by palpation, is a difficult and time-consuming procedure. For this reason it is either not attempted, or, if it is, the results are liable to be inaccurate. It is usually impossible to obtain blood pressure readings in the legs by these methods at this age. The need for a simple and accurate method is evident and we believe that the flush method described below provides it. Goldring and Wohltmann (1952) have shown that this method gives readings about 10 mm. Hg lower than the auscultatory method, and this has been our experience also in older children where the comparison can be made. The purpose of this paper is to make this technique more widely known; in it we describe the findings obtained in normal infants, show the variation of the method, and establish the gradient of systolic blood pressure between the arms and legs in normal infants. Readings from two cases of coarctation of the aorta are included to demonstrate the value of the method in the early diagnosis of this condition in infancy.

The Method

The method is based on that originally described by Gaertner (1899) for determining digital blood pressures.

He used an inflatable cuff placed round the base of the finger and connected to a manometer.

A blood pressure cuff of the appropriate size is placed round the forearm or lower leg of the infant. The limb distal to the cuff, which must be warm, is then exsanguinated by wrapping a thin sheet rubber or crepe bandage around it from the periphery up to the level of the cuff. The cuff is inflated to well above the expected systolic pressure and the bandage is removed. The pressure in the cuff is then slowly released by an assistant, while the observer watches closely, in a good light, for the first signs of a flush as blood re-enters the exsanguinated limb (Fig. 1). Provided the limb is warm and has been blanched completely, and if the pressure is released not faster than 5 mm. per second, this end-point is abrupt and quite distinct. It must be emphasized that it is the first sign of flushing that is taken as the point of systolic pressure.

It is essential that the baby should be quiet, neither crying nor moving the limbs excessively.

Woodbury, Robinow and Hamilton (1938) have shown, using intra-arterial pressure recordings from the umbilical artery in 10 normal infants, that the average rise in systolic pressure on crying was 27 mm. Hg. We have found a bottle feed or a teat filled with glucose solution an effective method of sedation.

The correct width of cuff is of importance. We have found that the 2.5 cm. cuff as recommended by some (Goldring and Wohltmann, 1952) gives very variable

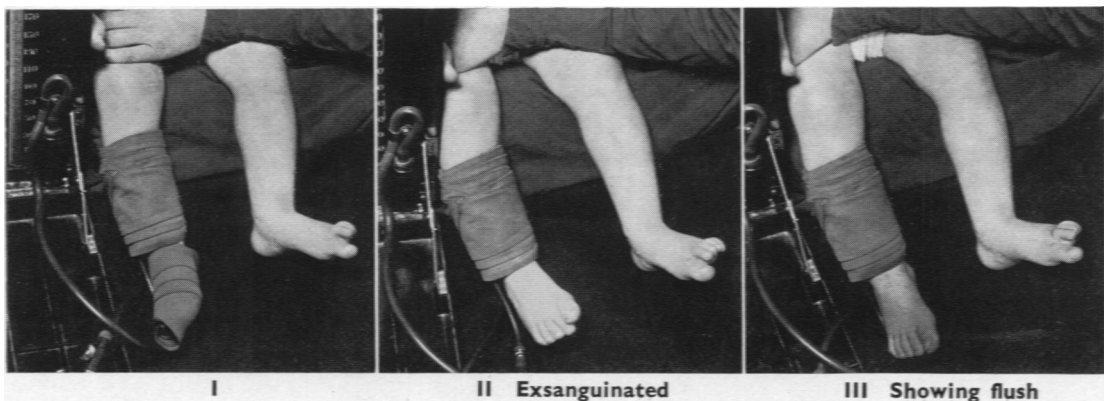


FIG. 1.

results by this method, and we have discarded it in favour of the 6 cm. cuff for small infants. It has been suggested (Woodbury *et al.*, 1938) that this size of cuff gives too low readings, but it will be seen that our results in newborn infants by this method compare quite well with the mean figure of 64 mm. Hg obtained by direct recordings from the umbilical artery by Abt and Feingold (1930). Where possible two recordings should be taken from each limb.

Variation of the Method

Sixteen readings of systolic blood pressure from the right leg were made in each of five normal newborn infants (Table 1). In each subject, all the readings were

TABLE 1
SYSTOLIC BLOOD PRESSURES FROM RIGHT LEG
IN FIVE NORMAL INFANTS

Readings (mm. Hg)	Infant 1 (2 Days Old)	Infant 2 (1 Day Old)	Infant 3 (2 Days Old)	Infant 4 (1 Day Old)	Infant 5 (3 Days Old)
1	56	56	48	48	50
2	58	62	48	48	48
3	58	56	48	46	50
4	60	60	46	46	54
5	50	52	52	38	58
6	46	50	58	40	56
7	50	50	50	42	64
8	48	54	56	40	58
9	46	56	48	40	40
10	46	60	54	42	44
11	50	56	50	40	44
12	50	60	52	40	48
13	54	54	46	40	50
14	56	60	52	42	48
15	56	60	48	40	52
16	48	62	48	44	58
Mean ..	52	57	50	42	51
Standard error of the mean	1.2	0.97	0.85	0.78	1.5

It will be seen that the standard error of the mean in these five subjects varies between 0.78 and 1.5.

obtained within a period of 12 hours. It was not possible to complete each investigation at one time as the infant tended to become restless if more than four readings were made consecutively.

Systolic Blood Pressure in Arms and Legs in Normal Newborn Infants

Sixteen infants in the neonatal period are included in this investigation and two readings have been taken from each limb. The results are shown in Table 2.

In this group the systolic blood pressure in the legs was lower than that in the arms in all but two instances. In the majority this difference ranged between 1 and 5 mm. Hg and in none was the leg systolic pressure more than 13 mm. lower than that in the arms.

It has been stated (Woodbury *et al.*, 1938) that, in the first 10 days of life, the systolic blood pressure

TABLE 2
SYSTOLIC BLOOD PRESSURE IN ARMS AND LEGS
IN NEONATAL PERIOD

Age	Case	Arms (mm. Hg)		Legs (mm. Hg)	
		Right	Left	Right	Left
1st day	(1) C.K.	46	48	57	58
		50	50	60	58
	(2) B.B.	54	52	60	55
		58	50	58	56
4th day	(3) B.T.	61	56	54	51
		60	60	56	55
	(4) A.C.	50	54	51	50
		55	54	50	50
7th day	(5) W.C.	66	68	64	60
		66	66	64	64
	(6) R.A.	68	66	56	54
		65	64	57	54
11th day	(7) B.H.	68	62	58	66
		69	66	60	66
	(8) B.L.	66	66	67	65
		66	70	64	66
15th day	(9) R.S.	58	61	58	55
		62	64	56	57
	(10) Y.M.	76	78	71	74
		75	78	69	74
16th day	(11) S.K.	64	64	68	66
		71	68	72	58
	(12) C.S.	70	66	58	54
		65	66	60	60
17th day	(13) K.N.	75	74	71	70
		79	74	76	70
	(14) R.D.	77	73	69	67
		80	79	61	70
18th day	(15) R.Y.	67	69	64	66
		71	69	64	68
	(16) D.D.	76	74	65	67
		76	70	68	67

of the infant gradually rises. Our figures (Table 2) confirm this observation.

Systolic Blood Pressure in Arms and Legs of Older Infants

Eleven infants were investigated in this group and the findings are shown in Table 3.

TABLE 3
SYSTOLIC BLOOD PRESSURE IN ARMS AND LEGS
IN NORMAL INFANTS

Age	Case	Arms (mm. Hg)		Legs (mm. Hg)	
		Right	Left	Right	Left
2 months	(1) B.H.	100	104	98	103
		103	108	98	95
3 months	(2) E.K.	85	85	96	83
		100	102	105	110
4 months	(4) R.H.	98	98	98	110
		110	112	104	105
4½ months	(5) T.S.	80	80	74	72
		83	82	78	74
6 months	(6) B.S.	75	78	78	78
		80	80	79	82
7 months	(7) C.K.	86	88	75	85
		100	88	92	98
8 months	(8) R.W.	102	94	96	102
		102	94	96	102
13 months	(9) M.T.	98	90	110	100
		98	94	116	102
15 months	(10) B.R.	92	101	96	110
		102	98	108	100
2½ years	(11) W.R.	106	96	110	103
		106	96	110	103

In this group the systolic blood pressure in the legs was higher than that in the arms in five subjects, and three of these are the three oldest children included in this investigation. In no instance was the systolic pressure in the legs more than 14 mm. Hg lower than that in the arms.

Flush Blood Pressure Readings in Coarctation of the Aorta

The blood pressures in two cases of coarctation of the aorta (adult type) in infants are shown in Table 4 to illustrate the value of this technique in establishing the diagnosis at an early age. In some instances surgical intervention may have to be undertaken early, and so early diagnosis becomes imperative.

TABLE 4
BLOOD PRESSURE READINGS IN COARCTATION OF AORTA

Case	Age	Sex	Arm		Leg		Diagnosis Confirmed
1	9 months (pre-op.)	Female	120	130	70	75	By angiocardiography and operation
	13 months (post-op.)		90	90	90	90	
2	3 weeks	Male	62	65	22	25	At necropsy

In these two cases it can be seen that the systolic pressures in the legs are markedly lower than in the arms and that this difference is well outside the range shown for normal infants.

Summary and Conclusions

The flush method is a simple and accurate means for determining the systolic blood pressure in infants. The method is described and is shown to give reproducible results. The gradient of systolic blood pressure between the arms and legs in 27 normal newborn and older infants is recorded. In many the pressure in the legs was lower than that in the arms, but in none was this difference greater than 14 mm. of mercury, and in the majority it was considerably smaller. This contrasts with the findings in adults (Hamilton, Woodbury and Harper, 1936) where the systolic pressure in the femoral artery has been shown to be 20 mm. Hg higher than that in the brachial.

In two infants with coarctation of the aorta of the adult type the systolic pressure in the legs measured by the flush method was 52 mm. and 40 mm. of mercury less than that in the arms.

We are indebted to Dr. Reginald Lightwood and to Dr. Ursula James for the opportunity to study their patients. We would also like to thank Dr. Alexander Nadas of Boston for drawing our attention to the method, and Mr. K. P. Goldman of St. Mary's Hospital Medical School for his assistance.

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