Archives of Disease in Childhood, 1973, **48**, 296.

Prophylactic antibiotics in umbilical artery catheterization in the newborn*

P. K. J. VAN VLIET and J. M. GUPTA

From the School of Paediatrics, University of New South Wales, Randwick, Australia

van Vliet, P. K. J., and Gupta, J. M. (1973). *Archives of Disease in Childhood*, **48**, 296. **Prophylactic antibiotics in umbilical artery catheterization in the newborn.** Over a period of 30 months, umbilical artery catheters were inserted in 229 infants. The main complications were haemorrhage, infection, and obstruction of a blood vessel. The incidence of infection was not affected by the use of prophylactic antibiotics. Vascular obstruction was more common in small infants, and in those in whom a catheter was reintroduced in the same blood vessel.

Over the past 15 years it has become increasingly clear that monitoring of blood gas tensions and acid-base balance is extremely important in the management of newborn infants with respiratory problems; a recent recommendation (Committee on Fetus and Newborn, 1971) by the American Academy of Pediatrics supports routine blood gas measurements in such cases. The most satisfactory route of sampling is the radial or the temporal arteries, but this is cumbersome, especially when repeated sampling is required, and therefore the umbilical artery has been favoured by most observers (Gupta, Roberton, and Wigglesworth, 1968; Cochran, Davis, and Smith, 1968; James, 1969). A number of centres have reported their experience, and the major complication rate has varied between 1·5% and 7%. The main complications are haemorrhage, infection, and obstruction (temporary or permanent) of a major blood vessel. In this paper we describe our experience over a period of 30 months with umbilical artery catheterization, and discuss the value of antibiotics in the prevention of infection, and also the relation between the length of time the catheter remained *in situ* and the incidence of infection and of obstruction of a major blood vessel.

Materials and methods

The umbilical artery catheterizations were carried out at the Royal Hospital for Women, Paddington, and the Prince of Wales Hospital, Randwick, Australia. The technique used for inserting umbilical artery catheters was similar to that described by Gupta *et al.* (1968) with certain modifications. Before starting the procedure, a loosely tied purse-string suture was inserted through the skin at the base of the umbilicus and this was left in place; in the event of accidental dislodgement of the catheter the suture could be tied immediately by the doctor or nurse on the spot. If possible, the catheter tip was placed at the level of the diaphragm. Catheters were removed when further monitoring of blood samples was deemed not necessary, or on the occurrence of obvious complications such as arterial obstruction of a blood vessel or infection. On removal the catheter was withdrawn slowly to prevent the occurrence of brisk haemorrhage. The umbilical stump was cleaned with methylated spirit and hexachlorophene at 3-hourly intervals while the catheter was *in situ*, and for at least 48 hours after its withdrawal. It was planned to take cultures from the umbilical stump and umbilical artery catheter tip, and blood from a peripheral vein at the time of removal of the catheter, though this proved impossible in every case. In the infants who died, arterial catheter tip cultures were not taken, but blood cultures were obtained (where possible) on the deterioration of the baby's condition.

The decision whether or not to administer routine prophylactic antibiotics (kanamycin (15 to 20 mg/kg per day) plus *either* penicillin (100,000 units/kg per day) *or* ampicillin (200 mg/kg per day) for a period of 5 to 10 days) at birth was made by the medical officer in charge of the case and was not influenced by the history or condition of the infant concerned. As the practice of administering prophylactic antibiotics depended upon the beliefs of individual medical officers (irrespective of other factors), whether or not a baby was put on antibiotics was more or less a random decision.

Results

The reasons for umbilical artery catheterization are shown in Table I. In 30 months attempts

Received 7 August 1972.

*Work supported by a N.H. and M.R.C. Grant.

TABLE I

Reasons for umbilical artery catheterization

Condition	No antibiotics	Antibiotics	Total
Respiratory distress syndrome	105	30	135
Apnoeic spells	30	11	41
Birth asphyxia	5	2	7
Haematological conditions	6	2	8
Others (including aspiration)	28	10	38
Total	174	55	229

were made to catheterize the umbilical artery in 250 infants with 21 failures. The failure rate of about 8% remained constant throughout the period. Most cases of failure were in small infants in whom the umbilical clamp had been placed very close to the skin of the umbilicus at birth. In a few cases where it was difficult to insert the catheter into one artery, the catheter was subsequently inserted into the other vessel. In 3 cases the catheter was replaced (in the same vessel) when it was found to be blocked. 97 infants died and necropsy was carried out in all but 4.

During this period, 64 infants developed complications of haemorrhage (8 cases), infection (43 cases which included 14 where *Staphylococcus albus* was isolated), clinical or postmortem signs of obstruction to a blood vessel (11), and 2 other miscellaneous conditions. In the 8 cases of haemorrhage the bleeding occurred at the time of removal of the catheter: these were in the earlier cases when the resident medical staff were not familiar with the procedure. 2 babies who had clinical evidence of vascular obstruction were subsequently found to have thrombosis of the vessel at necropsy.

The incidence of infection, *defined as isolation of an organism from the umbilicus, umbilical artery catheter tip, or blood*, was correlated with the administration or withholding of antibiotics (Table II). Of the 299 infants in whom catheterization was successful, 174 received no antibiotics and the remaining 55 were given prophylactic antibiotics. Cultures were taken from various sites in 66 babies who did not receive antibiotics. Of these cultures, 21 were taken from the umbilical cord, 46 from the umbilical artery catheter tip, and 26 from blood by peripheral venepuncture. 41 organisms were cultured from 30 babies including one baby where two organisms were grown from the umbilical cord. Of the positive results, 16 cultures from 14 infants grew *Staph. albus* only; one baby also yielded a growth of *Staph. aureus* from another site.

TABLE II

Complications of umbilical artery catheterization

	No antibiotics (no. = 174)	Antibiotics (no. = 55)	Total (no. = 229)
Infection	30	13	43*
Clinical signs of vascular obstruction	4	1	5
Thrombosis at necropsy	5	3	8†
Others	2	—	2

*Includes 14 infants who had positive culture for *Staph. albus* only from various sites.

†Includes 2 infants who also had clinical signs of obstruction.

Thus, altogether pathogenic organisms (i.e. excluding *Staph. albus*) were cultured in 17 babies, in 9 of whom the organism was *Staph. aureus*.

Of those infants who received antibiotics, cultures were taken from 20 babies. The number of cultures taken from the umbilical cord, umbilical artery catheter tip, and blood, respectively, were 15, 9, and 6. Of these cultures, 17 were positive in 13 babies. One infant grew *Staph. albus* only, so that pathogenic organisms other than *Staph. albus* were cultured from 12 babies. On comparing the antibiotic group with the group that did not receive antibiotics, the results were not different when *Staph. albus* was regarded as a pathogen, but were highly significant in favour of the group *without antibiotics* when it was regarded as a non-pathogen (Tables III, IVA, B). Table V shows the number of babies in whom organisms were isolated from blood in both groups. The results indicate that antibiotics do not appear to reduce the incidence of positive blood cultures.

We also looked at our results to see whether birthweight or duration of catheter *in situ* were related to complications. For the purpose of this analysis, all the complications were taken as one group rather than splitting them up into the antibiotic and no-antibiotic groups. It was found that neither the birthweight nor the duration of catheter *in situ* had any relation to the incidence of infection, whether *Staph. albus* is regarded as a pathogen or not. On the other hand, obstruction was far more common in infants under 1000 g (Table VI). When the results are looked at in relation to duration of catheter *in situ*, it is obvious that complications of obstruction did not correlate with the duration of catheter *in situ* (Table VII).

Discussion

There is much controversy regarding the value of prophylactic antibiotics in babies with umbilical

TABLE III

Organisms cultured from different sites

Organism/site	Umbilical cord		Umbilical arterial catheter		Blood	
	No antibiotics	Antibiotics	No antibiotics	Antibiotics	No antibiotics	Antibiotics
Staph. albus	4	—	11	1	1	—
Staph. aureus	4	—	4	1	6	—
Esch. coli	4	3	1	3	—	1
Klebsiella sp.	2	1	1	1	—	2
Pseudomonas	—	1	—	2	—	1
Others	1	—	2	—	—	—
Total	15	5	19	8	7	4

Note: This table includes results of cultures that were positive from more than one site in the same infant and also cases where more than one organism was cultured from the same site. Hence it does not indicate the number of babies (43) infected.

TABLE IV

Organisms isolated from any site

Antibiotics	Infected	Not infected	Total
A. Number of babies with organisms (including Staph. albus*) isolated from any site related to antibiotic cover**			
No antibiotic cover	30	36	66
Antibiotic cover	13	7	20
Total	43	43	86
B. Number of babies with pathogenic organisms (other than Staph. albus*) isolated from any site related to antibiotic cover†*			
No antibiotic cover	17	49	66
Antibiotic cover	12	8	20
Total	29	57	86

* $\chi^2 = 2{\cdot}3455$, $0{\cdot}2 > P > 0{\cdot}1$ for 1 degree of freedom.
† $\chi^2 = 9{\cdot}084$, $0{\cdot}005 > P > 0{\cdot}0025$ for 1 degree of freedom.

TABLE V

Number of babies with organisms isolated from blood related to antibiotic cover

Antibiotics	Blood culture positive	Blood culture negative	Total
No	7	59	66
Yes	4	16	20
Total	11	75	86

$\chi^2 = 1{\cdot}42$, $0{\cdot}3 > P > 0{\cdot}2$ for 1 degree of freedom.

artery catheters. Hitherto it has been impossible to evaluate the results from various centres because of different practices. We were fortunate in that the decision whether to give antibiotics was left to the particular medical officer in charge of the case, and hence we had two populations chosen more or less at random. Our results leave little doubt that antibiotics are of little use in prevention of infection in infants with umbilical artery catheters. Hodgman Tatter, and Bhatt (1971) have reported similar results in infants with umbilical vessel catheters.

The major complications were septicaemia and permanent blockage of a blood vessel, and these complications occurred in 20 cases (9% of successful catheterizations). Of the 11 infants with positive blood cultures (Table VIIIA), 4 infants completely recovered. 4 infants died, but in 2 of these (all receiving antibiotics) death was due to intracranial haemorrhage. Serious sequelae as a result of infection occurred in 4 infants: 3 of these infants had received no antibiotics (3 out of 174, 2%) and the infecting organism was *Staph. aureus*; the fourth infant who belonged to the antibiotic group (1 out of 55, 2%) developed klebsiella meningitis. It is important to note that the organisms cultured were different in the two groups and that *Staph. aureus* infection was the serious problem in the group that did not receive antibiotics.

Obstruction to a major blood vessel was encountered in 11 cases. This was recognized in 5 infants during life, 2 of whom died subsequently and were found to have obstruction of a major blood vessel at necropsy (Table VIIIB). Of the other 3 infants, 2 improved rapidly on withdrawal of the catheter and the third developed an area of gangrene in his left groin which was due to an embolus in the common iliac artery. After embolectomy the infant recovered, and on follow-up was found to have shortening of the leg.

Evidence of obstruction to a blood vessel was found in 8 cases at necropsy, but in only 2 of these was it suspected during life. In 7 cases there was obstruction to a major blood vessel, and in one

TABLE VI

Relation of birthweight to complications

	Birthweight (g)				Total
	<1000	1001–1500	1501–2000	>2000	
Totals	22	40	49	118	229
Infection (all organisms)*	1	6	11	25	43
Infection (excluding *Staph. albus*)†	0	4	8	17	29
Obstruction‡	4	2	1	4	11

*Infection (all organisms) vs birthweight: $\chi^2 = 3{\cdot}394$, $0{\cdot}5 > P > 0{\cdot}3$ for 3 degrees of freedom.
†Infection (excluding *Staph. albus*) vs birthweight: $\chi^2 = 3{\cdot}812$, $0{\cdot}3 > P > 0{\cdot}15$ for 3 degrees of freedom.
‡Vascular obstruction vs birthweight: $\chi^2 = 9{\cdot}470$, $0{\cdot}025 > P > 0{\cdot}0125$ for 3 degrees of freedom.

TABLE VII

Relation of duration of catheter in situ *to complications*

	Duration (hr)				Total
	48 or less	48 to 96	96 to 144	>144	
Total	93	86	29	21	229
Infection (all organisms)*	12	15	8	8	43
Infection (excluding *Staph. albus*)†	8	11	4	6	29
Obstruction‡	6	4	0	1	11

*Infection (all organisms) vs duration of catheter *in situ*: $\chi^2 = 4{\cdot}163$, $0{\cdot}3 > P > 0{\cdot}2$ for 3 degrees of freedom.
†Infection (excluding *Staph. albus*) vs duration of catheter *in situ*: $\chi^2 = 5{\cdot}438$, $0{\cdot}2 > P > 0{\cdot}1$ for 3 degrees of freedom.
‡Vascular obstruction vs duration of catheter *in situ*: $\chi^2 = 1{\cdot}523$, $0{\cdot}6 > P > 0{\cdot}3$ for 3 degrees of freedom.

TABLE VIII

Data on blood infections and blood vessel obstruction

Case no.	Birthweight (g)	Gestation period (wk)	Duration of catheter *in situ* (hr)	Organisms	Antibiotics	Complications
A. Blood infections after umbilical artery catheterization						
1	1510	31	32	*Staph. aureus*	No	Nil
2	2400	34	60	*Staph. aureus*	No	Nil
3	2090	33	107	*Staph. aureus*	No	Shortened right leg
4	1500	32	120	*Staph. aureus*	No	Shortened left leg
5	3640	38	144	*Staph. aureus*	No	Nil
6	1940	33	169	*Staph. aureus*	No	Died, multiple abscesses
7	1800	35	158	*Staph. albus*	No	Nil
8	1900	32	27	*Esch. coli*	Yes	Died, meningitis
9	3100	39	28	*Klebsiella* sp.	Yes	Died, intraventricular haemorrhage
10	1410	29	72	Pseudomonas	Yes	Died, posterior fossa haemorrhage
11	2900	40	91	*Klebsiella* sp.	Yes	Nil
*B. Obstruction to blood vessel after umbilical artery catheterization**						
12	2370	36	74 + 9†		No	Gangrene left groin and shortened left leg; required embolectomy
13	820	27	186 + 24†		Yes	Small bowel necrosis
14	1690	37	48 + 192†		Yes	Right renal artery thrombosis
15	750	27	15		No	Thrombosis of internal iliac artery
16	900	27	20		No	Thrombosis at tip of catheter
17	1295	32	Few minutes		No	Thrombosis of both internal iliac and right external iliac arteries
18	1500	32	94		No	Thrombosis of aorta
19	2435	36	60		No	Thrombosis of right renal artery and aorta
20	2560	35	60		Yes	Thrombosis at tip of catheter

*The two cases that improved on withdrawal of the catheter are not included in this table.
†Duration *in situ* of reinserted catheter.

case there was a gangrene (without obstruction of a blood vessel) of the small intestine. It is debatable whether the gangrene of the bowel in the last case was due to temporary occlusion of the vessel as a result of the 'diving reflex' (Kern *et al.*, 1971), or due to an unrecognized thrombosis/embolization of the small blood vessels, but it is included in the latter group.

In 3 of the 11 cases with vascular obstruction, the catheter had been reinserted into the same blood vessel because of occlusion of the catheter due to clotting. In 1 of these infants the complication was recognized during life and embolectomy was performed (see above). The other 2 infants were found to have evidence of occlusion at necropsy, one of these being the infant with infarction of the small bowel (see above). While this might be a coincidence, we feel that the reintroduction of a catheter in the same blood vessel may be hazardous and do not recommend it.

We thank Associate Professor D. D. Smith and members of staff of the Department of Bacteriology at the Prince of Wales Hospital and the Royal Hospital for Women for their bacteriological help; and Professors J. Beveridge, J. A. Davis, and Dr. E. D. Burnard for helpful criticism.

REFERENCES

Cochran, W. D., Davis, H. T., and Smith, C. A. (1968). Advantages and complications of umbilical artery catheterization in the newborn. *Pediatrics*, **42**, 769.

Committee on Fetus and Newborn (1971). Oxygen therapy in the newborn infant. *Pediatrics*, **47**, 1086.

Gupta, J. M., Roberton, N. R. C., and Wigglesworth, J. S. (1968). Umbilical artery catheterization in the newborn. *Archives of Disease in Childhood*, **43**, 382.

Hodgman, J. E., Tatter, D., and Bhatt, D. R. (1971). Evaluation of prophylactic antibiotics during umbilical catheterisation in newborns. In *Proceedings of the Thirteeth International Congress of Paediatrics*. Section on Neonatology, p. 583. Published by the Vienna Academy of Medicine.

James, L. S. (1969). Complications arising from catheterisation of the umbilical vessels. In *Problems of Neonatal Intensive Care Units*, p. 36. Report of the fifty-ninth Ross Conference of Pediatric Research. Ed. by J. F. Lucey. Ross Laboratories, Columbus.

Kern, I. B., Bowring, A. C., Cohen, D. H., Fisk, G. C., Gupta, J. M., and McCredie, R. M. (1971). Spontaneous perforation of the colon following cardiac catheterization in the newborn. *Medical Journal of Australia*, **2**, 1022.

Correspondence to Associate Professor J. M. Gupta, Prince of Wales Hospital, Avoca Street, Randwick, N.S.W. 2031, Australia.