Prophylactic antibiotics in umbilical artery catheterization in the newborn*

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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, Robertson, and Wigglesworth, 1968; Cochran, Davis, and Smith, 1968; James, 1969). A number of centres have reported their experience, and the main 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
Respiratory distress
Haematological
Apnoeic spells
Total infants
250
made to
were
8
about cases of
cases where it
was
inserted
was
necropsy
found
catheter was
isolated),
tion
conditions.
procedure.
2
the bleeding
thrombosis
vascular
medical staff
umbilical
catheter: these
an
catheter
was
the
vessel,
was
artery,
infants
were
positive results,
Staph.
were
cultured
from
the
cultures were
were
pathogenic organisms
when it
that
pathogen
Staph.
infants
were
grown from the
Staph.
were
cultured from
babies
in
babies.
who
to
by
in
administration
or
cord. Of the
were
cultured
from
the
albus
also
from
the
albus
albus
were
cultured from
babies. One
babies
antibiotics,
results
were
taking
the
was
regarded as a
were
highly
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 anti-
biotic 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 I

Reasons for umbilical artery catheterization

<table>
<thead>
<tr>
<th>Condition</th>
<th>No antibiotics</th>
<th>Antibiotics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory distress syndrome</td>
<td>105</td>
<td>30</td>
<td>135</td>
</tr>
<tr>
<td>Apnoeic spells</td>
<td>30</td>
<td>11</td>
<td>41</td>
</tr>
<tr>
<td>Birth asphyxia</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Haematological conditions</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Others (including aspiration)</td>
<td>28</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>174</td>
<td>55</td>
<td>229</td>
</tr>
</tbody>
</table>

TABLE II

Complications of umbilical artery catheterization

<table>
<thead>
<tr>
<th>Condition</th>
<th>No antibiotics (n = 174)</th>
<th>Antibiotics (n = 55)</th>
<th>Total (n = 229)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>30</td>
<td>13</td>
<td>43*</td>
</tr>
</tbody>
</table>
| Clinical signs of vascular
  obstruction                      |                          |                      |                 |
| 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.

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 complica-
tions 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.

Thus, altogether pathogenic organisms (i.e. exclud-
ing 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.

http://adc.bmj.com/ Arch Dis Child: first published as 10.1136/adc.48.4.296 on 1 April 1973. Copyright by
permanently blocked infants in blood positive catheterizations). Tatter, complications occurred in particular the antibiotics of different and at catheters. Hitherto 29 evaluate to antibiotics of babies. No antibiotic Antibiotic cover 12 8 20
Number of babies with antibiotics isolated from blood related to antibiotic cover

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>Blood culture positive</th>
<th>Blood culture negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>7</td>
<td>59</td>
<td>66</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>75</td>
<td>86</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 1.42, \; 0.3 > P > 0.2 \text{ for } 1 \text{ degree of freedom.} \]

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 \textit{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 \textit{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

<table>
<thead>
<tr>
<th>Birthweight (g)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1000</td>
<td></td>
</tr>
<tr>
<td>1001–1500</td>
<td></td>
</tr>
<tr>
<td>1501–2000</td>
<td></td>
</tr>
<tr>
<td>&gt;2000</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
</tr>
<tr>
<td>Infection (all organisms)*</td>
<td>22</td>
</tr>
<tr>
<td>Infection (excluding Staph. albus)†</td>
<td>0</td>
</tr>
<tr>
<td>Obstruction‡</td>
<td>4</td>
</tr>
</tbody>
</table>

*Infection (all organisms) vs birthweight: \( x^2 = 3.394, \ 0.05 > P > 0.3 \) for 3 degrees of freedom.
†Infection (excluding Staph. albus) vs birthweight: \( x^2 = 3.812, \ 0.05 > P > 0.15 \) for 3 degrees of freedom.
‡Vascular obstruction vs birthweight: \( x^2 = 9.470, \ 0.025 > P > 0.0125 \) for 3 degrees of freedom.

TABLE VII
Relation of duration of catheter in situ to complications

<table>
<thead>
<tr>
<th>Duration (hr)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 or less</td>
<td></td>
</tr>
<tr>
<td>48 to 96</td>
<td></td>
</tr>
<tr>
<td>96 to 144</td>
<td></td>
</tr>
<tr>
<td>&gt;144</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
</tr>
<tr>
<td>Infection (all organisms)*</td>
<td>93</td>
</tr>
<tr>
<td>Infection (excluding Staph. albus)†</td>
<td>12</td>
</tr>
<tr>
<td>Obstruction‡</td>
<td>6</td>
</tr>
</tbody>
</table>

*Infection (all organisms) vs duration of catheter in situ: \( x^2 = 4.163, \ 0.05 > P > 0.2 \) for 3 degrees of freedom.
†Infection (excluding Staph. albus) vs duration of catheter in situ: \( x^2 = 5.438, \ 0.2 > P > 0.1 \) for 3 degrees of freedom.
‡Vascular obstruction vs duration of catheter in situ: \( x^2 = 1.523, \ 0.6 > P > 0.3 \) for 3 degrees of freedom.

TABLE VIII
Data on blood infections and blood vessel obstruction

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

*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 re-introduction 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

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