METHOXYFLURANE ANALGESIA FOR BURNS DRESSINGS AND OTHER PAINFUL WARD PROCEDURES IN CHILDREN

SHIRLEY FIRN

SUMMARY

Methoxyflurane, administered from a Cardiff Penthrane inhaler was used as an analgesic agent for burns dressings and other painful ward procedures in a series of 36 children, aged 4 months to 13 years, on 94 occasions. No other intraoperative analgesics were required and preoperative sedation was used only six times in four patients. Preoperative starvation was unnecessary and no side effects were observed. Of the 94 administrations, analgesia was assessed as "very good" or "good" on 67 (71%) occasions.

Anyone who has worked with burned patients is keenly aware of the problems associated with providing adequate analgesia for the day-to-day treatment of burns, such as dressings, skin grafting and minor desloughing procedures, without interfering with the nutritional demands and physiotherapy time, in patients, who are often ill and toxic, show electrolyte disturbances, and are possibly emotionally disturbed as a result of their injuries.

Various analgesics, and forms of general anaesthesia, have been used, but so far the most useful analgesic agent appears to be methoxyflurane.

Methoxyflurane contained in a simple disposable plastic vaporizer (Analgizer) was used by Packer and Titel (1969) for burns dressings. Four of their 11 patients were children, the youngest being 16 months old. The advantages noted were absence of undue sedation, lack of necessity for preoperative starvation and avoidance of venepuncture. The disadvantage of the Analgizer is that it does not deliver a fixed concentration of methoxyflurane, the maximum concentration being about 0.8% in air. The delivered concentration is variable and partly depends upon the frequency and depth of the patient’s inspirations and also on the amount of air added via the diluter opening, which can be varied in size.

Laird and Gray (1971) reported on the use of methoxyflurane 0.35% v/v from a Cardiff Penthrane inhaler for burns dressings, and compared its effects with trichloroethylene 0.5% v/v in 13 patients. They also studied the analgesic effects of methoxyflurane 0.3% v/v and methoxyflurane 0.5% v/v and found little difference between the effectiveness of the two concentrations. None of their patients was under 8 years of age. They found methoxyflurane to be the more effective agent, but considered it to be an unsatisfactory analgesic in young children.

The present study was undertaken in an attempt to assess the value of methoxyflurane administered from a Cardiff Penthrane inhaler as an analgesic agent in children undergoing painful ward procedures such as burns dressings. The study was begun in February 1970, and lasted one year, at Nottingham City Hospital.

METHODS

Patients.

It was originally intended to confine the use of methoxyflurane analgesia to burned children. Early success in these children led to the extension of its use for painful procedures such as removal of sutures, femoral venepuncture, and setting up of intravenous infusions. The method was also used for procedures such as catheterization and bladder washouts which, although not in themselves painful, can be very frightening to a small nervous child.

Any child who it was thought would benefit physically and mentally from the use of the technique was included in the trial. On two occasions this included outpatients who had been brought to the ward by their parents for removal of sutures and who were judged to be unduly apprehensive.

Apparatus.

The Cardiff Penthrane inhaler was developed during the trials of methoxyflurane in midwifery by Rosen and associates (1969), and delivers a concentration of 0.35% ± 0.07% of the agent in air, irrespective of changes in flow rate and ambient temperature unless the temperature change is sudden (Jones, Molloy and Rosen, 1971). It has been

accepted by the Central Midwives Board for the self-
administration of methoxyflurane as an analgesic
for patients in labour, under the supervision of a
midwife. The vaporizer complies with all the require-
ments of the Board, i.e. it delivers its fixed concen-
tration of methoxyflurane in any working position
and after inversion or shaking. In addition, a “key”
safe filling device is provided with each apparatus
to ensure that only methoxyflurane from the Abbott
tube can be used to charge the inhaler, which cannot
be overfilled. Rebreathing is prevented by a
large non-return valve in the outlet, and the face
mask connection contains a lightweight expiratory
valve.

To reduce the risk of cross-infection, a selection
of face masks in various sizes were used with extra
breathing tubes and face mask connections. After
use, masks and tubing were cleaned and autoclaved.

Procedure.

On entering the treatment room the child was
greeted by the anaesthetist or ward sister, who was
to administer the methoxyflurane. If the patient was
old enough, an attempt was made to explain the effect
of the use of the inhaler in simple terms and the
child was shown how to breathe in and out of the
face mask. With gentle persuasion most children
accepted the face mask and the “funny smell”, and
were soon breathing away quite happily. The patients
were not starved prior to the procedure and pre-
médication was only given in the circumstances
described later.

The child was allowed to use the inhaler for 10
min before any procedure was attempted. This was
sufficient time for onset of analgesia in most cases
and often marked the end of the inhalation for short procedures such as removal of sutures and catheterizations.

For the longer procedures, such as burns dressings,
the mask was removed, if the start of the procedure
did not distress the child. If the child showed signs
of inadequate analgesia, a further 5-min period of
inhalation was allowed before proceeding. The mask
was reapplied for 3–5 min, if the child ceased to be
relaxed or comfortable. If, at any time, during this
intermittent inhalation the child was thought to be
becoming excessively drowsy the mask was immedi-
ately removed and inhalation was withheld until the
patient was just starting to respond to the procedure.

The administration was carried out by the author
whenever possible. On other occasions the adminis-
tration was carried out by one of the ward sisters
or a staff nurse supervised by a sister. Routine ward
resuscitation equipment was always present in the
treatment room.

The effect of the technique was judged by two
experienced ward sisters. Their assessment was based
on the patient’s acceptance of the inhaler, objective
observation of the child’s physical and mental
reaction to the procedure, and the degree of co-
operation obtained. With older children the patient’s
own assessment was also taken into account. The
grading of effect corresponds to that used by Packer
and Titel (1969) who assessed the analgesic effect by
the same criteria and is as follows:

Very good: total analgesia with full mental and
physical relaxation.

Good: slight discomfort, insufficient to cause
anxiety.

Fair: discomfort causing some anxiety but not
severe enough to require supplementary drugs.

Poor: discomfort or anxiety sufficient to require
supplementary analgesics or sedation.

At the end of the procedure, each child was
returned to bed after a rest of about 5 min. No
further postoperative supervision was found to be
necessary.

RESULTS

During the trial period of 12 months, the inhaler
was used on 94 occasions in 36 children, whose ages
ranged from 4 months to 13 years. Only 3 of these
children were older than 8 years (fig. 1). Nineteen
of the children who used the inhaler were suffering
from burns, 12 were undergoing various types of
plastic surgery, and the remaining 5 were under the
care of general surgeons. The patients in the latter
two groups were undergoing the additional pro-
cedures referred to earlier.

![Figure 1](https://academic.oup.com/bja/article-abstract/44/5/517/318149/fig1)

**Fig. 1.** Histogram showing the age distribution of 36 children using the Cardiff Penthrane inhaler for analgesia.
The inhaler was used for any one child from 1 to 13 times. In 26 of 36 children (72%) it was used once or twice (fig. 2). The shortest duration of use was 10 min, and the longest was $2\frac{1}{2}$ hours intermittently (fig. 3).

Tables I and II show details of the use of the inhaler in the 36 patients. In a total series of 94 administrations, its effect was assessed as being "very good" in 37 (39%), "good" in 30 (32%), "fair" in 21 (22%) and "poor" in 6 (7%).

Where the method was judged to have had a poor effect, it was found that the child was often rather frightened of the mask itself and failed to breathe deeply enough to draw air through the inhaler. Since a baby of 4 months (Case 7) was able to use the inhaler with very good effect, it suggested that the equipment itself had a low resistance to air flow. This prompted the author and a colleague to measure the resistance and it was found that at a continuous flow rate of 20 l./min the resistance of the inhaler with tubing and valves was 7.4 mm H$_2$O, it was...
TABLE II. Details of the uses of methoxyflurane analgesia for painful ward procedures.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr. mth)</th>
<th>Sex</th>
<th>Procedure</th>
<th>No. of administrations</th>
<th>Average duration of procedure (min)</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>M</td>
<td>A, B</td>
<td>2</td>
<td>20</td>
<td>Very good</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>M</td>
<td>A</td>
<td>1</td>
<td>25</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>M</td>
<td>B, H</td>
<td>4</td>
<td>36</td>
<td>Fair</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>M</td>
<td>A</td>
<td>1</td>
<td>15</td>
<td>Poor</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>M</td>
<td>A, C, F</td>
<td>13</td>
<td>22</td>
<td>Poor</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>M</td>
<td>A</td>
<td>1</td>
<td>25</td>
<td>Poor</td>
</tr>
<tr>
<td>13</td>
<td>26</td>
<td>F</td>
<td>F, G, D</td>
<td>6</td>
<td>19</td>
<td>Poor</td>
</tr>
<tr>
<td>19</td>
<td>4</td>
<td>F</td>
<td>A, H</td>
<td>2</td>
<td>20</td>
<td>Poor</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>F</td>
<td>C</td>
<td>1</td>
<td>10</td>
<td>Poor</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>M</td>
<td>B</td>
<td>2</td>
<td>25</td>
<td>Poor</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>M</td>
<td>A</td>
<td>1</td>
<td>20</td>
<td>Poor</td>
</tr>
<tr>
<td>26</td>
<td>3</td>
<td>F</td>
<td>C</td>
<td>1</td>
<td>15</td>
<td>Poor</td>
</tr>
<tr>
<td>29</td>
<td>5</td>
<td>M</td>
<td>D</td>
<td>2</td>
<td>18</td>
<td>Poor</td>
</tr>
<tr>
<td>31</td>
<td>6</td>
<td>M</td>
<td>A</td>
<td>1</td>
<td>45</td>
<td>Poor</td>
</tr>
<tr>
<td>34</td>
<td>2</td>
<td>F</td>
<td>E</td>
<td>1</td>
<td>15</td>
<td>Poor</td>
</tr>
<tr>
<td>35</td>
<td>1</td>
<td>F</td>
<td>A</td>
<td>1</td>
<td>20</td>
<td>Poor</td>
</tr>
<tr>
<td>22</td>
<td>7</td>
<td>F</td>
<td>A, B</td>
<td>2</td>
<td>30</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Key to procedure:
A = Removal of Sutures
B = Skin graft dressing
C = Wound i.d.
D = Enema toilet
E = Starting i.v. infusion
F = Catheterization
G = Bladder washout
H = Venepuncture

No other intraoperative analgesia was found to be necessary. Preoperative sedation was required 6 times in 4 patients, only one of these requiring extra sedation on more than one occasion. The sedative used was the oral preparation of methadone, given in a dose of 2.5 mg/kg 1½ hours before the start of the ward procedure. As can be seen from table III, premedication was employed when a very nervous child was using the inhaler for the first time or if previous experience had been unsatisfactory. Patient 14 was very apprehensive and difficult. On the days of dressings 4 and 6, she was in a calm, happy mood and did not require extra sedation. An effect judged to be “poor” was in each case improved when the child was sedated with trimeprazine.

TABLE III. Details of drug supplementation using trimeprazine tartrate 25 mg/kg.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Dressing No.</th>
<th>Dose (mg)</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>2</td>
<td>36</td>
<td>Very apprehensive and difficult child</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>36</td>
<td>Very apprehensive and difficult child</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>42</td>
<td>Apprehensive; mentally subnormal</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>75</td>
<td>Frightened; very restless</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>40</td>
<td>Very frightened</td>
</tr>
</tbody>
</table>

4.6 mm H₂O for the inhaler alone, 2.8 mm H₂O for the tubing and valve and 2.6 mm H₂O for the expiratory valve. The measurements were made using an air compressor to provide the flow, and an Elema transducer EMT32. The results were recorded on a trace (Mingograph) which had been calibrated to give a 0.5 cm deflection for 1 mm of water pressure. These results appear to correspond with those produced by Jones, Molloy and Rosen (1971).

No side effects were observed, either during or following the use of the inhaler. One child (Case 10), an outpatient aged 2½ years with 1% burns who received two administrations of 23 min average duration, remained drowsy but easily rousable for about 5 min after methoxyflurane inhalation had been discontinued. The other children remained fully alert, despite the length of the operation. Several chatted away quite happily under the mask during normally painful procedures and a few after their first experience with the inhaler, held the mask themselves during subsequent administrations. It was found that patient acceptance of the inhaler was either approximately the same or improved on subsequent use. The youngest child to hold the mask herself (Case 2) was 1 year 9 months old. She had sustained 9% burns on the back of her neck and shoulders and had to be seated during the dressings and skin grafting.

Supplementary analgesia or sedation.

No other intraoperative analgesia was found to be necessary. Preoperative sedation was required 6 times in 4 patients, only one of these requiring extra sedation on more than one occasion. The sedative used was the oral preparation of trimeprazine tartrate (Valbergan) given in a dose of 2.5 mg/kg 1½ hours before the start of the ward procedure. As can be seen from table III, premedication was employed when a very nervous child was using the inhaler for the first time or if previous experience had been unsatisfactory. Patient 14 was very apprehensive and difficult. On the days of dressings 4 and 6, she was in a calm, happy mood and did not require extra sedation. An effect judged to be “poor” was in each case improved when the child was sedated with trimeprazine.
METHOXYFLURANE ANALGESIA FOR BURNS DRESSINGS

tartrate. When the inhaler was used more than once, and was judged at the first administration to have been used to poor effect, there was always improvement on further usage. This improvement was very striking in some cases. Often these particular patients had been admitted to other hospitals, where the inhaler was not in use and had had their first dressings carried out before transfer to this unit.

A typical example was a 6-year-old child (Case 25) who had sustained severe burns of face, hands, lower trunk and thighs. He was an emotionally labile child and extremely apprehensive. The first time the inhaler was used he was ill and, because of extreme apprehension, was sedated with trimeprazine tartrate. The second administration lasted 1½ hours. No preoperative sedation was given, and this time the effect was judged to be “fair”. At the end of the procedure the patient volunteered the information that “the smell stops it hurting”. Subsequently, further dressings and skin grafting using the inhaler were carried out on a happy, talkative and co-operative child.

The inhaler was also used with success on a 5-year-old mentally subnormal girl (Case 16) with full thickness burns of chest, arms and thighs. She also required trimeprazine sedation on the first occasion. Subsequently the analgesic technique was judged as having a very good effect.

DISCUSSION

We have been favourably impressed with the value of methoxyflurane inhalation from the Cardiff Penthrane inhaler in children undergoing painful procedure. Apart from the analgesic properties of this agent, its “mood-modifying” effects were noteworthy. This beneficial effect has been described by other authors (Dragon and Goldstein, 1967; Rosen et al., 1969; Packer and Titel, 1969; Laird and Gray, 1971). This proved to be a particularly useful property as far as our patients were concerned, many of whom were too young to be able to understand all that was being done to them, and why. The children quickly developed trust in the people concerned in their day-to-day treatment. The importance of such a relationship was discussed by Bernstein (1963) who described the use of hypnosis in the treatment of three severely burned children. He states that hypnosis relieved their anxiety and “they became more co-operative and developed an increased tolerance to the hardships of hospitalization. This change in attitude of the children encourages the staff and restores communication with the patients”.

The mood modification produced by methoxyflurane bears some similarity to the effects of hypnosis described by Bernstein (1963). It is hoped that the children who have used the inhaler will have a reduced incidence of the type of emotional disturbance described by Woodward (1959).

Preoperative starvation was found to be unnecessary and, because of the absence of nausea or vomiting all the children were able to eat and drink normally within minutes of the end of the procedure.

A concentration of methoxyflurane 0.35% in air appears to give good analgesia without producing undue drowsiness. From the author’s personal experience the methoxyflurane vaporizer (Pentec; Cyprane) is capable of delivering a variable concentration of 0.1% to 1% in air, although concentrations in excess of 0.5% do not produce any notable increase in analgesia, but result in a greater degree of drowsiness with its subsequent reduction of patient co-operation.

None of the patients in this trial complained of headache after methoxyflurane inhalation.

Perhaps the most valuable comment has come from the two experienced ward sisters involved in this trial. They have stated that the inhaler has halved the time required for painful procedures, and that often more can be achieved in one session. In addition the patients were not nearly as shocked or exhausted, at this time. They were mainly quiet, relaxed, and co-operative instead of being a frightened, screaming mass of moving arms and legs. Skin grafts could be placed accurately and aseptically, instead of being thrown hopefully at a moving target. The analgesic technique can be safely carried out by the nursing staff. After a preliminary trial of two months these two sisters begged to be allowed to keep the inhaler, stating, “We can hardly believe the difference it has made, and already we do not know how we have managed without it.”

The analgesic technique described in this paper has now been adopted as a routine method of analgesia for painful ward procedures carried out on children in this particular hospital.

ACKNOWLEDGEMENTS

I would like to thank Sister Moore, Sister Hart and the nursing staff of Ward B2, Nottingham City Hospital, without whose help and co-operation this study would not have been possible; Dr F. E. Bennetts and Mr Thomas of Abbott Laboratories, whose interest and suggestions have been most helpful in the preparation of this paper. Dr A. M. Wilson suggested the method of measuring the resistances across the Cardiff inhaler, and helped to carry out the measurements. Finally I would like to thank the surgeons who allowed their patients to be included in this study.

REFERENCES


**MISE EN OEUVRE D'UNE ANALGESIE AU METHOXYFLURANE CHEZ DES ENFANTS EN VUE DE PROCÉDER À DES PANSEMENTS POUR BRULURES AINSI QU'A D'AUTRES INTERVENTIONS DOULOUREUSES**

**SOMMAIRE**

En utilisant un inhalateur de type Penthrane-Cardiff, on a eu recours à méthoxyflurane en tant qu'agent analgésique en vue de procéder à des pansements pour brûlures, ainsi qu'à d'autres interventions dououreuses. On a utilisé 94 reprises dans une série de 36 enfants âgés de 4 mois à 3 ans. Il n'a été nécessaire de recourir à aucun autre analgésique en cours d'intervention et une prémédication n'a été mise en œuvre, à 6 reprises, que chez 4 malades. Il n'a pas été utile de respecter un jeûne pré-opératoire et aucun effet secondaire n'a été noté. Sur ces 94 cas d'administration du médicament, l'analgésie obtenue a été jugée "très bonne" ou "bonne" à 67 reprises (71 p.cent des cas).

**THE 3rd EUROPEAN CONGRESS ON PAEDIATRIC NEUROSURGERY**

The congress previously planned to take place in Göttingen on September 21-23, 1972, will be held on September 3-7, 1972.

**Subjects:**

1. Problems of anaesthesia and postoperative control of neurosurgical baby and infant patients.
2. Long-term follow-up after neurosurgical interventions in babies and infants.
4. Recent diagnostic and operative techniques in paediatric neurosurgery.
5. Demonstrations of rare cases.
6. Free papers.

For information please write to:

Prof. Dr. med. K.-A. Bushe
Direktor der Neurochirurgischen Klinik der Universität Göttingen
3400 Göttingen, Gosslerstraße 10