II. Jones considers the administration of hypnotics as dangerous, but this does not seem to apply to our cases of low anaesthesia. Jones fears that the paralysis of the intercostal nerves would add in a dangerous manner to the diminished excitability of the respiration caused by the narcotic. This theory is no doubt correct in cases of high spinal anaesthesia, when injecting 12 to 14 c.c. and more so between L1 and L3 or higher. However, in our 250 cases in which we injected 10 c.c. the "twilight sleep" of our patients never affected the respiration adversely. It is remarkable that the "twilight sleep" increases generally in depth during the course of spinal anaesthesia, a condition which I associate with the fall of the blood-pressure. There is no doubt that the narcophine-scopolamine "twilight sleep" represents a remarkable humane procedure, whilst without "twilight sleep" the psyche of the women is in many cases adversely affected through their being conscious during the operation. "Twilight sleep" constitutes, in addition, a very important factor of safety in low spinal anaesthesia. The safety of spinal anaesthesia is closely connected with the stabilisation of the conditions within the spinal canal, and specially with the constant height of the column of cerebrospinal fluid. The research work of Hartwich has proved unquestionably that anxiety, excitement, cough, straining and crying are liable to drive the liquid quickly to the suboccipital region irrespective of its having a lighter or heavier specific gravity. The following table (III) shows the results of Hartwich's experiments:
Spinal Anaesthesia with Percaine

### Table III (Hartwich)

**Spinal injection of 1 c.c. phenolsulphophthalein in decubitus: appearance suboccipitally:**

- after 20 minutes, no morphine ... Patients strained as a result of fear and excitement.
- after 20 minutes, no morphine ...
- after 15 minutes, no morphine ...
- after 60 minutes, with morphine ... Quiet. Nothing.
- after 2 hours, with morphine ... Quiet. Nothing.
- after 2½ hours ... ... ... ... Moribund, practically pulseless. Nothing.
- after 4½ minutes ... ... ... ... Asked to cough and strain.

**Spinal injection of stained meningococcus serum (of higher specific gravity) in decubitus: appearance suboccipitally:**

- after 20 minutes Child cried at intervals.
- after 15 minutes Child cried.
- after 11 minutes Child cried the whole time.
- after 5 minutes Child cried lustily.
- after 5½ minutes ... ... ... Child strained and coughed.

Consequently the quietness resulting from “twilight sleep” stabilises the column of cerebro-spinal fluid and prevents the anaesthetic solution injected into the spinal canal being driven in the direction of the medulla oblongata as a result of the behaviour of the patient.

### III. We ask ourselves, In what concentration is percaine still effective on the medulla oblongata? It is obvious that a solution injected into the lumbar region must become more diluted by the time it reaches the medulla, no matter what the circumstances are which bring this about. The possibility of the solution reaching the medulla in a more dangerous concentration is greater with a highly concentrated injection than with the introduction of a very diluted solution, even when the quantity of the latter is larger.

Several authors have confirmed, both clinically and experimentally, that by direct application of the anaesthetic agent to the medulla it is possible to anæsthetise the head without fear and without endangering respiration (Koster and Kasman, Meleiro de Souza, Shimotsuma, Imagaron and Hang Kong Su). Some of those authors assume a different reactivity of the sensitive and the motor nerves...
towards the anaesthetic. As a consequence of a series of similar experiments we have formed our own point of view on this subject. Already Harrison and Frank, as well as Cotui and Standard, disagree with the above-mentioned opinion.

In order to investigate the question of concentration regarding the danger to, and general action on the respiratory centre exerted by different percanine concentrations, we used Standard's method and noted the costal and abdominal respiration and also the blood-pressure in 20/25 Kg. dogs narcotised with pernocton. The cervical vertebrae were exposed by incision, and the suboccipital puncture made to bring the solution into direct contact with the medulla oblongata.

Sixteen experiments were made, details of which are set out in Table IV. This table shows:

1. The injection of 3-5 c.c. of a percanine solution 1:1500 in 0.5 per cent physiological salt solution causes immediate respiratory paralysis and a fall in blood-pressure to zero in three to four minutes; even artificial respiration cannot delay death (Curve I).

2. With a dilution of 1:1 of this solution, injected in doses of 2-5 c.c., immediate respiratory paralysis and death appeared only in three of five animals, whereas in two animals only transitory respiratory depression with lowered blood-pressure was observed.

3. With the injection of 3-6 c.c. of a dilution of 1:2 of the original solution it was observed that 6 c.c. could still cause respiratory paralysis which, however, could be overcome by artificial respiration. In one case there was only a slight depression and in another no effect at all was registered. In the last case the blood-pressure fell as usual, but in the two other cases an unexpected and considerable rise took place, which lasted for 30 and 12 minutes respectively (Curve II).

4. In four cases, 2-4 c.c. of a 1:3 dilution of this Standard solution had no effect on the respiration, but in one case a slight inhibition of the thoracic respiration was noted. In three cases the blood-pressure was not affected, but in two
it rose for a period of 45 and 8 minutes respectively. (Experiment discontinued).

5. There is no connection between the quantity of liquid injected and the rise in blood-pressure, because 3 c.c. of physiological salt solution caused only a slight rise of 20 mm. Hg. which lasted five minutes, whereas from the details given in the Table it will be seen that a similar quantity of percaine solution causes an increase in blood-pressure of from 40 to 60 mm. Hg., which lasts from 12 to 45 minutes.

6. The behaviour of the blood-pressure and respiration has also no connection with the toxic amount of percaine injected. A dog weighing 25 lb. (11.4 Kg.) received intravenously 3, 5, 7, 10, 15 and 20 c.c. of a standard solution 1:1500 at intervals of 15 minutes, and another dog, weighing 20 Kg., received 10 c.c. of 1:1000 percaine solution three times intravenously at intervals of 15 minutes, and in each case blood-pressure and respiration were not affected.

7. Five c.c. of coramine injected suboccipitally within one minute after the blood-pressure had fallen to 80 mm. Hg. and the respiration showing a depression of medium strength (as a result of the previous suboccipital injection of a 1:1 dilution of a 1:1500 percaine solution), appreciably stimulated the respiration for a period of four minutes and also caused an increase in blood-pressure, which was maintained for 10 minutes before it fell to the level prior to the coramine injection (see Curve III). Therefore it appears that the suboccipital injection of respiratory stimulants suggested by Janossy and Kulenkampf, can be considered as a suitable therapy in threatening paralysis of the medulla oblongata (see Curve IV).

8. The respiratory failure is not a sequel of the primary circulatory insufficiency but appears immediately after the percaine solution has come into contact with the medulla oblongata; only, afterwards, the increasing paralysis of the circulatory centre causes blood-pressure to fall.

Jones's assertion that the danger to the respiratory centre decreases rapidly by further dilution of the 1:1500 solution
<table>
<thead>
<tr>
<th>Percaïne Dilution</th>
<th>Quantity in c.c. injected suboc-</th>
<th>Blood-pressure prior to injection</th>
<th>Effect on blood-pressure</th>
<th>Effect on respiration</th>
</tr>
</thead>
</table>
| 1:1500 in 0.5% NaCl = Standard solution | 0:0 5 | 180 | Fell to 0 in 4 min. | Immediate stoppage.  
Death after 4 minutes.  
No artificial respiration. |
| 1:1 | 4 145 | Fell to 0 in 4 min. | Stoppage after 1 minute.  
Death after 4 minutes,  
in spite of artificial respiration. |
| | 3 150 | Fell to 0 in 3 min. | Immediate stoppage.  
Death after 3 minutes.  
No artificial respiration. |
| Standard solution 1:1 | 5 | — | | |
| 1:1 | 4 220 | Fell to 185 in 5 min. | Pronounced depression after 5 minutes.  
Circulation and respiration spontaneously.  
Recovered in 15 minutes. |
| | 3 140 | Fell to 80 in 5 min. | Medium depression.  
Circulation and respiration spontaneously.  
Recovered in 30 minutes. |
| | 3 | — | Stoppage after 6 minutes.  
Death after 20 minutes,  
in spite of artificial respiration. |
| | 2 160 | Fell to 0 in 4 min. | Stoppage after 4 minutes.  
Death after 4 minutes.  
No artificial respiration. |
### TABLE IV (Continued).

<table>
<thead>
<tr>
<th>Percaine Dilution</th>
<th>Quantity in c.c.</th>
<th>Blood-injected suboc-</th>
<th>Effect on blood-pressure</th>
<th>Effect on respiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard solution 1:2</td>
<td>6</td>
<td>110</td>
<td>Fell to 80 in 6 min.</td>
<td>Stoppage in 2 minutes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Artificial respiration for 10 minutes. Recovery after 20 minutes.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>160</td>
<td>Rose to 210 for 30 min.</td>
<td>Slight depression for 15 minutes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>190</td>
<td>Rose to 230 for 12 min.</td>
</tr>
<tr>
<td>Standard solution 1:3</td>
<td>4</td>
<td>110</td>
<td>No effect</td>
<td>No effect.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>140</td>
<td>Rose to 190 for 45 min.</td>
<td>No effect.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150</td>
<td>No effect</td>
<td>Diminished thoracic breathing observed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>120</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>180</td>
<td>Rose to 240 for 8 min.</td>
</tr>
<tr>
<td>NaCl</td>
<td></td>
<td>3</td>
<td>160</td>
<td>Rose to 180 for 5 min.</td>
</tr>
</tbody>
</table>
seems to be strongly supported by the results of our experiments. Already with a 1:1 dilution of Standard solution there were two out of five experiments which did not terminate fatally, while with further dilutions no deaths were registered. I have also seen in patients a surprising increase in blood-pressure, following the injection of the further dilutions, as shown in Table V.

Two possibilities can be advanced to explain this phenomenon: either the percaine reaches the main innervation points of the vascular system in such a dilution that it acts not as a paralysant but as a stimulant of the blood-pressure, or it paralyses antagonistic nerves so that the group which causes a rise in blood-pressure becomes predominant.

The phenomenon, established by animal experiments and clinical observations, that in spite of effective spinal anaesthesia, in no case was there a fall in blood-pressure, but on the contrary an increase, is interesting because it presents an ideal anti-shock action which is very much desired. The establishment of this fact at least suggests the possibility that the method of spinal anaesthesia can be improved at any rate to such an extent as to avoid every fall in blood-pressure. In the cases described adrenalin was given beforehand in four instances and ephetonine in two, as a prophylactic. However, in our experiments on animals, we noticed that in those cases in which these drugs had not been administered the fall in blood-pressure was not very pronounced.

**Table V.**

<table>
<thead>
<tr>
<th>Initial value</th>
<th>After 10-15 minutes</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>80/50</td>
<td>115/65</td>
<td>60 minutes</td>
</tr>
<tr>
<td>135/80</td>
<td>165/90</td>
<td>45 minutes</td>
</tr>
<tr>
<td>110/65</td>
<td>130/70</td>
<td>2½ hours</td>
</tr>
<tr>
<td>135/90</td>
<td>155/85</td>
<td>60 minutes</td>
</tr>
<tr>
<td>130/65</td>
<td>150/90 (180/115)</td>
<td>1¼ hours</td>
</tr>
<tr>
<td>135/75</td>
<td>170/85</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>
SUMMARY.

1. Percaine spinal anaesthesia according to the method of Jones was extremely successful in 250 serious and prolonged gynaecological operations.

2. Only 3.2 per cent of the cases reported slight to medium headaches which, however, disappeared in a few days with the aid of head diathermy.

3. For gynaecological operations the injection of 10 c.c. of a 1:1500 percaine solution in 0.5 per cent physiological salt solution between L₃ and L₄ can be relied upon to produce anaesthesia lasting from one to two hours.

4. As a circulatory prophylactic against a fall in blood-pressure an intramuscular injection of ephetonine administered five to ten minutes before the spinal puncture is made, is very effective.

5. In high spinal anaesthesia "twilight sleep" is a danger to respiration, yet in low spinals for gynaecological operations it is a safety factor, as it stabilises the level of the cerebrospinal fluid and, consequently, the injected solution.

6. The effective percaine solution 1:1500 is of such a low concentration that with further dilution the dangerous effect on the respiratory centre diminishes rapidly, as observed in our experiments on animals.

7. The direct application of percaine solution on the medulla oblongata first causes immediate paralysis of the respiratory centre, then follows the circulatory collapse.

8. The suboccipital injection of cormaine stimulates the respiratory centre even when it has been previously paralysed with percaine, so that this method appears to be suitable also in clinical practice.

9. In animal experiments it was observed that in isolated cases, in spite of effective anaesthesia, a fall in blood-pressure did not occur, but on the other hand there was a considerable increase, which was maintained for a fairly long period.