
THE REPORT OF THE SECOND HYDERABAD CHLOROFORM COMMISSION.

In presenting to our readers this week a selection of tracings from those obtained by the Second Hyderabad Commission, we think it may be well to bring shortly again to their notice the facts about this Commission. Its object was an essentially practical one, and could not be better defined than in the words of his Highness the Nizam himself, "to save people's lives." This object Surgeon-General Major Lawrie hoped to attain by showing experimentally what he, in common with his teacher Syme and many others, had found clinically, that attention to the respiration was the safeguard against death during chloroform anesthesia. At his suggestion, the First Hyderabad Commission was appointed by the Nizam's Government, but the results were so different from those obtained by many other experimenters that we hesitated to accept them when they were forwarded to us. At Dr. Lawrie's instance a Second Commission was appointed, and the Nizam generously forwarded to us £1000, with the request that The Lancet would nominate an expert to assist in the investigation, and Dr. Landor Brunton kindly acceded to our request to act as our representative. To take up the whole general action of anaesthetics, although interesting, would have occupied more time than the Commission was able to devote to its disposal, and consequently it restricted its experiments to those having a direct practical bearing.

In a subject of such vital interest as the mode of action of chloroform, it is important that no conclusion should be accepted without the most thorough criticism, and it is with the view of enabling our readers to draw their own conclusions from the experiments of the Second Hyderabad Commission that we present their tracings in this number of THE Lancet. Nearly 600 experiments in all were performed by this Commission, about 150 of them being blood-pressure, and each blood-pressure, as a rule, involving three or four tracings or more. Out of the total number of tracings, amounting to 400 or 500, we now select 32 in order to illustrate some of the most important points.

The facts on which the Commission lay most stress are that when chloroform is given to animals by inhalation, in the same way as it is given to patients during operations, the respiration invariably stops before the heart, and if the administration of the anaesthetic be stopped and artificial respiration be begun as soon as natural breathing ceases, life can invariably be set again to the heart, as a matter of course, and will fill up and return as soon as possible, and that they will also aid us in our work by obtaining answers from as many trustworthy persons as they can.

By combining the experimental and clinical data we have acquired, we shall be in a position to state finally the vexed question of how death occurs during anaesthesia, and thus "to save people's lives," as the object of the Commission was expressed by the enlightened ruler to whose generosity, ourselves, and the Committee of the British Medical Association, and which has been regarded as due to the action of chloroform, the Hyderabad Commission regards as unproved and as entirely failed to obtain this tracing by giving chloroform with free admixture of air, but were able to obtain it at will by simple obstruction of the animal's respiration. Moreover, instead of looking at this slowing of the heart's action as a cause of danger, the Commission regard it rather as a means of safety, preventing the anaesthetic from being carried too rapidly from the lungs to the nerve centres. From the observations made by the Commission there seems to be little doubt that while chloroform given with a free supply of air by inhalation does not paralyse the heart directly, yet that asphyxia with chloroform is very dangerous, and generally causes the heart to stop much more quickly than asphyxia alone would do, although to this rule there may be exceptions.

The Influence of Shock was very fully tested by the Commissioners in their experiments, and found to be very much less than what much have been expected. These experiments are no doubt open to the objection that the operations intended to produce shock were not performed at the time when sudden death from shock was least likely to be mistaken for chloroform poisoning; but the resuscitation taken by the Ludwig's or mercurial kymograph, termed shortly "Ludwig" in the tracings, and the pulse beats were taken by a Fick's kymograph on the quickly revolving cylinder. These tracings were taken by the word "Fick" in the tracings. In the tracings taken by Ludwig's manometer a straight line will be found here and there in place of the usual curve. These lines indicate the points where the Fick's kymograph was connected with the Ludwig's. Each observation is placed in its proper position in the tracings, and by reference to the corresponding tracings by Fick's kymograph the character and rate of the pulse at any of these periods can be readily ascertained.
November 12th. — Experiment 79.

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Ludwig I

Expt. 79

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Ludwig II

Expt. 79
NOVEMBER 18TH. — EXPERIMENT 92.
November 19th. — Experiment 97.

- Heart still, jussk. Artery cut.
- Heart needle not moving. Open thorax.
- N 38

- Artificial Respiration.
  - Needle not moving euphonically.
  - Needle turns about
- N 36

- Stop off.
  - Self-Infused a Phosphorus.
  - Stop Infusion.
  - Sustaining Infusion Respiration
- N 56

- Push Chloroform.

- Not reported much. The lower part of the abdomen
  is marked by the butts of phlebostats.
- N 43

- N 31

- N 29

- Application completed.
- N 23

- Petrol Stole — Handbag, one minute after
  Application
- N 26

- N 25

Ludwig I. Exp. No. 97.

November 28th. — Experiment 137.

- More Chloroform
- Shaved. Slight Cut
- Stiffened Muscles
- Temp. 103°
- N 40

- Stop Infusion
- N 39

- Stop Chloroform

- 12.38 Chloroform Prone
  Temp. 102º

- 12.37

- 12.35 Stop Chloroform
  Drawn back
- N 24

- 12.23

- 12.21

- 12.20

- 12.13

- 12.10

- 12.08

- 12.03

- 12.00

- 11.42

- 11.39

- 11.38

- 11.37

- 11.34

- 11.30

- 11.29

- 11.27

- 11.24

- 11.20

- 11.16

- 11.10

- 11.05

- 11.00

Ludwig I. Exp. No. 137.
November 30th — Experiment 146.

Nov. 30th — Experiment 147.
EXPERIMENT 148 (continued).
EXPERIMENT 148 (continued).

The respiratory trace taken with a needle in the diaphragm.

During barbiturate sleep

After barbiturate administration

During oxygen

During chloroform

During ether

Blood pressure trace.

Respiratory trace by mercury manometer attached to needle in diaphragm.
Experiment 161 (continued).
EXPERIMENT 185 (continued).

Open thorax, heart still
3.45 Heart stopped
   Flicker only
3.44
   Needle into heart moving
3.43
Pulse imperceptible
3.40 P perceivable in femoral
3.39
3.38 Tail trembling
3.37 Breathing stopped.
3.36
3.35 Chloroform continuously
3.33 Squint Oper and Asphyxia
     Commence Squint Oper
3.31
3.30 Chloroform
   Respiration feeble
   Needle in heart going gaily
   Respiration stopped
3.21
Chloroform
EXPERIMENT 185 (continued).
DESCRIPTION AND REMARKS.

NOVEMBER 12TH.—EXPERIMENT 79.

Good-sized pariah, weight 33 lb., that has had two doses of phosphorus—one yesterday, the other to-day, each 1-16th of a dose. Into chloroform box at 2h. 9m. 34s. Fallen down at 2h. 23m. 39s. Placed on the table at 2h. 24m. 28s. Respiration stopped at 2h. 24m. 45s. Artificial respiration until 2h. 27m. 39s. Artery ligatured and cannula inserted at 2h. 30m. 17s. Temperature in the rectum 100 ° F. Connection made with the manometer at 2h. 39m. 30s. Two Ludwig and one Fick tracings during—(a) Change to the vertical position of the body; (b) chloroform administration while in the vertical position; (c) ammonia inhalation while in the vertical position; (d) squirting chloroform into the nose while in the vertical position; (e) evulsion of the nails while in the vertical position; (f) extraction of the teeth while in the vertical position; (g) violent slap with the open hand on abdomen while in the vertical position; (h) restoration to the recumbent position on the table; (i) inversion of the body so that the dog was completely head downwards, and again lowering the body to the vertical position; (j) chloroform administration in the ordinary position; (k) attempts to pass grooved staff and Thompson's dilators into the bladder; (l) slitting prepuce; (m) pushing chloroform carelessly until after respiration had ceased; temperature after death 99 ° F.; the corpse was kept in the room 23-° cent. Large-sized pariah. Temperature of the room 23 ° cent. Into chloroform box at 01h. 50m. 37s. Fell down at 01h. 53m. 42s. Respiration ceased at 01h. 54m. 14s. Cannula inserted at 01h. 54m. 28s. Temperature of the rectum 101 ° F. Two Ludwig and one Fick tracings during administration of ether per rectum and poisoning. The heart continued to beat feebly for seven minutes after the commencement of artificial respiration.

NOVEMBER 18TH.—EXPERIMENT 92.

Temperature of the room 23 ° cent. Large-sized pariah. Weight 33 lb., rather thin. Into chloroform box at 7h. 24m. 43s. Fallen down at 7h. 25m. 33s. On the table at 7h. 29m. 37s. Artery ligatured at 7h. 41m. 8s., and cannula inserted. Temperature in the rectum at 7h. 42m. 30s., 100-6 ° F. Jugular vein tied at 7h. 51m. 47s. Connexion made with the manometers at 7h. 58m. 20s. One Ludwig and one Fick tracing during injection of solution of hydrochloric acid (0-8 per cent.) in normal saline solution into the femoral vein. Death ensued. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time after the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration.

NOVEMBER 28TH.—EXPERIMENT 137.

Goat, young male. Weight 15-2 lb. Into chloroform box at 11h. 48m. 43s. Fell down at 12h. 2m. 30s., and taken out of box, but still quite sensitive. More chloroform from time to time to keep the pulse fully 81 per minute. The pulse was 79 two minutes after the case of 146. It is, however, more sickly. Into chloroform box at 10h. 27m. 50s. Fallen down at 10h. 32m. 25s. On to the table at 10h. 33m. 15s., and given chloroform from time to time. Left carotid ligatured and cannula inserted into it. Connexion with manometers at 10h. 35m. 30s. Two Ludwig and one Fick tracings during administration of ether per rectum and poisoning. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for some time before the fact was observed, and the animal died in spite of artificial respiration.
(b) giving ether in the same way, (c) giving ammonia in the same way, and (d) giving chloroform in the same way, causing efforts to be made to keep the animal quiet, the needle being introduced at the jugular vein. On the attempt to make the animal inhale concentrated chloroform vapour through the tube tied into the nose, (a) chloroform (vide Ludwig II., 3.36) causes a corresponding irregularity in the blood-pressure; (b) chloroform causes no perceptible effect on the blood-pressure; and (c) chloroform is given with insufficient air so as to cause the animal to hold its breath and struggle from asphyxia, irregularity of the blood-pressure was produced, which recovered when the animal was recovering. This corresponds exactly with the irregularity in the Glasgow trances A, B, &c. on the one hand, and on the other in the irregularity caused by artificial stimulation of the vagus. With reference to this point, compare trances 157, Ludwig I., between 12.25 and 12.29, with trance 148 Ludwig I., between 31 and 3.3. It was in experiment 148 that the Commission first became fully aware of the vital importance of natural respiration in chloroform administration. The tracings show that even with struggling (vide Ludwig II., 3.36) and, so far as can be judged from the traces, without interference with respiration (vide Ludwig III., 4.2 to 4.5) a corresponding irregularity in the blood-pressure. But whenever the chloroform was given so that the respiration was irregular, the blood-pressure was regular, as is seen in Ludwig I. at 3.17 and Fick III., reading 42. The tracings of Experiment 148 also show the effects of simple asphyxia and of electrical irritation of the vagus for 20 seconds (vide Fick IV., reading 23).

December 3rd.—Experiment 156. Weight 27 lb. A large white parish that had two grains of phosphorus this morning died. Into chloroform box at 3h. 26m. 30s. Fallen down at 3h. 39m. 35s., and placed on the board at 3h. 40m. 10s. Artery ligatured at 3h. 45m. 50s., and cannula inserted at 3h. 48m. Loop under both vagi. Communication with manometer at 3h. 51m. Ludwig I., Fick I., and two Fick tracings during (a) administration of chloroform with a cap closely applied to the muzzle (Fick 2 shows the extreme depression of the heart’s action); (b) gradual administration of chloroform with plenty of air; (c) simple smothering without chloroform by holding the mouth and nose (compare Fick reading 5 with 2); (d) division of both vagi; (e) simple smothering again (compare Fick 5 with 2); (f) administration of absolute alcohol through the nose; (g) simple smothering again (compare No. 151); the pressure fell rapidly, and after the chloroform was given the animal gave two or three convulsive fits in rapid succession, which had no effect on the pressure; (g) artificial respiration failed to restore the animal, and the heart stopped beating about six minutes after the last gasp. Temperature 101.4°F. Thorax opened at 4h. 25m. Heart quite soft, but irritable.

December 4th.—Experiment 159. Dog, 37 lb. Given chloroform at 11h. 12m. 30s. Fallen down at 11h. 15m. 55s., Placed on the table at 11h. 16m. 10s. More chloroform injected at 11h. 17m. 47s. Stopped at 11h. 18m. 25s. More chloroform at 11h. 19m. 5s. Artery ligatured at 11h. 19m. 55s. Cannula inserted at 11h. 21m. 35s. More chloroform and artificial respiration were introduced at 11h. 23m. 10s. Artificial respiration at 11h. 25m. 15s. Cannula inserted at 11h. 25m. 25s. More chloroform and artificial respiration were introduced at 11h. 27m. 10s. Cannula inserted at 11h. 27m. 35s. More chloroform at 11h. 30m. 25s. Cannula inserted at 11h. 31m. 25s. More chloroform at 11h. 33m. 50s., as the animal was sensitive and groaning. Temperature 103.5°F. Artificial respiration maintained until death.

December 5th.—Experiment 160. Pariah dog, weight 24 lb.; has had two grains of phosphorus, as in 159. Into chloroform box at 3h. 35m. 24s. Fallen down at 3h. 49m. 20s. Placed on the table at once. Cannula inserted into the lower jaw at 3h. 55m. 45s. Artificial respiration with manometer at 3h. 59m. 30s. One Ludwig I., Fick I., and three Fick tracings during (a) administration of chloroform; (b) gradually administration of chloroform; (c) simple smothering without chloroform by holding the mouth and nose (compare Fick reading 5 with 2); (d) division of both vagi; (e) simple smothering again (compare Fick 5 with 2); (f) administration of absolute alcohol through the nose; (g) simple smothering again (compare No. 151), the pressure fell rapidly, and after the chloroform was given the animal gave two or three convulsive fits in rapid succession, which had no effect on the pressure; (g) artificial respiration failed to restore the animal, and the heart stopped beating about six minutes after the last gasp. Temperature 101.4°F. Thorax opened at 4h. 25m. Heart quite soft, but irritable.

December 6th.—Experiment 161. Temperature of the room 20° cent. Large parish, weight 26 lb., that has had three grains of phosphorus in one grain daily doses, but is not particularly sick, though out of a batch of seven, of which he is one, that were dosed with phosphorus in the same way three died in the course of the day. Into chloroform box at 10h. 11m. 20s. More chloroform into the box at 10h. 17m. 40s. Fallen down at 10h. 23m. 40s. Placed on the table at 10h. 29m. Slight convulsions at 10h. 25m., after which the breath was held for about half a minute, and artificial respiration was employed for a few seconds. More chloroform at 10h. 25m. 40s. Tonsils got into a division of the vagus; (a) clamping his head; (b) planing the anus; (c) pulling out the tongue forcibly, which had the effect of making him hold his breath; (f) chloroform administration during struggling; (g) pushing chloroform until respiration stopped; (h) holding an ordinary cap with ammonia on it before the nose; (i) chloroform administration during struggling and holding of the breath; (j) snipping the anus; (k) pulling out the tongue forcibly, which had the effect of making him hold his breath.
GENERAL VIEW OF THE APPARATUS EMPLOYED.

The apparatus stands on a solid teak table. In front is seen a strong upright for supporting a Bernard's dog-holder. Close behind the upright is a wooden burette-holder, bent almost to a horizontal position. This was used to support the elongated glass bulb connected with the arterial cannula, and to prevent any drag being exerted upon it. Y is almost hidden by the upright, and is supported by a long needle above the Y-tube, which it indicates. From the Y-tube go two white tubes to the two manometers; 2 indicates Fick's manometer; 3 is fastened above the mercurial manometer, against the tracing on Ludwig's kymograph, above the clockwork of which 9 is fastened; 6 indicates the magnetic time-marker, and is raised on a large block of wood to a proper height; on a small block of wood at the bottom of the instrument is seen the watch of the observer; 7 is the Du Bois-Reymond key, by which the time-marker is worked; 8 is a Du Bois-Reymond's coil for irritating nerves; 8, the key by which contact is made and broken; X is a Leclanché battery for the time-marker, and Z a bichromate cell for the coil; 5 indicates the tracing on Fick's kymograph, and W the clockwork of the instrument; A and B are two of Marey's tambours connected together. The lever of A was connected occasionally by a thread with a needle fixed in the heart or diaphragm of the animal, and the movement being transmitted to A was recorded by it on the cylinder of Fick's kymograph. V indicates the valve used with the bellows for artificial respiration. It is fixed to the nozzle of the bellows by a kind of splint made of wood and cork. Across the top of the photograph and down its centre extends the indiarubber tube conveying soda solution to the apparatus from the vessel fixed against the wall.
The chloroform tracings of the Glasgow experiments should be compared with the Fick tracings of the Commission's Experiments 148, 156, and 185, in which there are irregularities due to asphyxia, or to some interference with or irregularity of the respiration. The Commission has shown that regularity of the respiration ensures regularity of the fall of the blood-pressure in chloroform inhalation, and the fact that the blood-pressure was irregular in the Glasgow Committee's tracings is proof positive that there was irregularity of the respiration in their experiments.
EXPERIMENTS WITH CHLOROFORM MADE BY SURGEON-MAJOR LAWRIE, SURGEON ARTHUR CHAMARETTE, MR. WILLIAM MAYBERRY, AND MR. KNIGHTLEY OWEN BURNE.

Temperature of room 28°C. Chloroform given in box 1 h. 58 m. 30 s. Dog fallen down 2 h. 4 m. Dog on table 2 h. 5 m. Artery ligatured 2 h. 10 m. 30 s. Cannula inserted 2 h. 12 m. 30 s. Connection with manometer made 2 h. 16 m. 30 s.

Ludwig III. shows the effects of—
(a) Recovery from chloroform.
(b) Ordinary chloroform inhalation at 2 h. 5 m. 30 s.
(c) Spontaneous recovery without artificial respiration.
(d) Ordinary chloroform inhalation.

Ludwig IV. shows the effects of—
(a) Ordinary chloroform inhalation at 3 h. 13 m. 40 s.
(b) Ordinary chloroform inhalation at 2 h. 54 m. 30 s.
(c) Ordinary chloroform inhalation at 2 h. 56 m. 30 s.

EXPERIMENT PERFORMED ON MARCH 6TH, 1890.

I. Experiment performed on March 6th, 1890.

J. Experiment performed on March 6th, 1890.
THE HYDERABAD CHLOROFORM COMMISSION.

BY SURGEON-MAJOR LAWRIE.

Whatever may be the result of the labours of the Second Hyderabad Chloroform Commission, the gratitude of our profession is due to his Highness the Nizam of Hyderabad for the opportunity of scientific progress which his unbounded liberality has afforded. At the time the Commission was appointed, the Pioneer, the leading journal of India, wrote: "Nothing could show better the beneficent nature of the old and friendly tie which binds together the British and the Nizam's Governments than the remarkable and cosmopolitan interest which his Highness the Nizam and his officials, one and all, have taken in bringing the question of the safety of chloroform to the proof. It redounds to the honour of the Government of India no less than to that of the administration of Sir Asman Jah, that the leading Indian State should take a principal share in the settlement of a question which concerns the welfare and happiness of the whole of mankind." Since we are in a position to show that the researches of the Commission have finally proved the safety of chloroform, it is right to think that the Nizam and his Minister, Sir Asman Jah, together with the Minister's responsible adviser, the Nawab Mushtak Hussain, should receive public recognition as benefactors not only of the human race, but of the animal kingdom, which, less than mankind, will derive benefit from the advantages chloroform confers in the abolition of pain and in the relief of suffering.

In considering the work of the Second Hyderabad Chloroform Commission, a very brief recapitulation is necessary. Four hundred and thirty animals were killed with chloroform by the Commission's subcommittee, or were subjected to the effects of artificial respiration, with the object of confirming, elaborating, or disproving the work of the First Commission. In addition to this, 168 animals were killed by the Commission with chloroform and ether, and the efforts were recorded by Drs. Lauder Brunton and Bomford with Ludwig's and Fick's manometers. The subcommittee's experiments confirmed the results obtained by the First Commission presented over by Dr. Hehir; and in their turn the results of the subcommittee were confirmed by the experiments taken in with a recording apparatus. In every case of death from chloroform the respiration stopped before the heart. The three series of experiments showed that simple chloroform poison-inducing absence of the respiratory centre and then gradual death, the heart being the last organ in the body to die. The exceptions to the rule that the heart retains its vitality longer than any other part of the body were found in those which more or less are paralytic or the diaphragm occurred after the cessation of the heart's action. In one case the contractions took place after the thorax had been laid open, and when the lungs were collapsed. The Commission called these movements gasps, and solely for convenience and the want of a better term. They were no more respiratory movements than the wagging of the tail and the snapping of the jaws, which went on for ten minutes after death in two other cases, were movements of grip of muscles, not identically a co-ordinating centre, but there is no reason why any of the muscles should not contract spasmodically from stimuli applied to their proper centres after the respiratory centre is paralysed. The diaphragmatic contractions in vomiting and hicoucou are not generally considered respiratory movements.

With reference to the manometric experiments of the Commission, it is borne in mind that the use of chloroform necessarily causes a fall of the blood-pressure. When this was first imperfectly demonstrated by the English Commission in 1864 it was erroneously thought to be a source of danger; and the idea was confirmed by the Glasgow Committee in 1879, which went further and attempted to prove, by means of more accurate apparatus, that not only does chloroform cause a fall of the blood-pressure, but the fall is not insensible, that this constitutes the grave danger in chloroform administration.

The Commission have shown that the capricious effects which the Glasgow Committee attributed to chloroform were produced by accidental asphyxia, and the fact that the fall of the blood-pressure, as indicated in the Glasgow Committee's tracings, was irregular is now known to prove that there must have been irregularity of, or interference with, the respiration in their experiments.

The fall of the blood-pressure was found to be greater than might be left for physiologists to determine, but it must be clearly understood that it is in no sense a danger, in any case which is fit for an operation, unless it is excessive—that is to say, unless an over-dosage of chloroform.

The facts brought out by the manometric experiments of the Commission, which can be proved from the tracings, are:

1. "Chloroform, when given continuously by any means which ensures its free dilution with air, causes a gradual fall in the mean blood-pressure, but it is evident that respiration is not impeded in any way, and it continues to breathe quietly without struggling or involuntary holding of the breath. As this fall continues, the animal first becomes insensible, then the respiration gradually ceases, and lastly the heart stops beating (vide Experiment 169: Ludwig and Fick tracings). If the chloroform is less diluted the fall is more rapid, but it is always gradual so long as the other conditions are maintained; and, however concentrated the chloroform may be, it never causes sudden death from stoppage of the heart."

2. Chloroform has no power of increasing the tendency to either shock or syncope during operations. Every operation that ingenuity could suggest, or that has ever been known to prove that there must have been irregularity of, or interference with, the respiration in their experiments.

3. Chloroform, when given continuously by any means which ensures its free dilution with air, causes a gradual fall in the mean blood-pressure, but it is evident that respiration is not impeded in any way, and it continues to breathe quietly without struggling or involuntary holding of the breath. As this fall continues, the animal first becomes insensible, then the respiration gradually ceases, and lastly the heart stops beating (vide Experiment 169: Ludwig and Fick tracings). If the chloroform is less diluted the fall is more rapid, but it is always gradual so long as the other conditions are maintained; and, however concentrated the chloroform may be, it never causes sudden death from stoppage of the heart."

4. Following up the discovery regarding the vagus, the Commission found that an effect precisely similar to that caused by electrical stimulation of the vagus is produced through the same nerve: (a) in the holding of the breath, in the earlier stages of chloroform poisoning, as follows: Experiment 148: Fick I. and II., readings 2, 3, 4, 6, 8, 9, and 11; (b) in asphyxia (vide Experiment 161: Fick I., readings 9); and (c) sometimes after the respiratory centre is paralysed in the later stages of chloroform poisoning (vide Experiment 148: Ludwig III., from 4 to 4.7; and Experiment 178, all tracings). The same effect is produced in this way in any case of chloroform poisoning. The report of the President of the LANCET of March 2nd, 1889, wrote of as "primary and secondary sycope." It is evidenced by pallor of the face and other symptoms, to which Mr. Butter and Mr. Hewett referred in their letters to The Lancet of Feb. 22nd and March 1st, 1890.

5. The Commission discovered gradually (vide Experiment 148) that it is possible to give chloroform in such a way that full anaesthesia is produced, with a gradual fall of blood-pressure, unaccompanied by any irregularity of the heart or circulation. The Commission found that the way to do this was to ensure natural and regular respiration, which the arterial blood, which was correct, and interfered with the breathing. It became evident in the course of the experiments that it was difficult, if not impossible, to make any animal inhale unduly strong chloroform; for without it it is impossible, it is in any case which is fit for an operation, unless it is excessive—that is to say, unless an over-dosage of chloroform is given. When an inhaler saturated with chloroform is held too close to the mouth and nose an animal holds his breath; and in many animals,
especially the rabbit or the goat, holding the breath stimulates the vagus and at once slows the heart and retards the circulation.

6. The experiments of the Commission proved that death from chloroform is invariably due to an over-dose; and the question whether or not it was the next arose was, Are there any circumstances which make chloroform inhalation dangerous, and, if so, were the causes open to view, or may they be avoided? The heart’s beat is slowest when the circulation from eighty-six to forty-two a minute and saved the dog’s life. Tracing 4 shows how, after the stoppage of the respiration, when artificial respiration was not employed and the vagus was not definitely affected, the circulation fell to forty-two a minute. The second tracing shows how useless it would have been to have taken the action of the pulse as a guide. When the pulse failed, as it did at the end of Tracing 4, it was a sign of impending death. The two tracings demonstrate that by the time the respiration ceased the poisoning had been averted, as it always can be in the human subject under chloroform, if the breathing is carefully kept free. It is remarkable that in these two experiments the chloroform was given undesignedly for precisely the same length of time—viz., 4/24 minutes. Considered by the light of the work of the Commission, these tracings prove incontestably that the slowing of the heart and circulation through the stimulation of the vagus is a safeguard in chloroform poisoning. The symptoms—pallor and loss of pulse—produced in a similar manner in man are none the less signs of the greatest danger, as they signify that the patient has been over-dosed or improperly breathing, or that the respiratory centre has been paralysed. They do not indicate, as has hitherto been supposed, that chloroform has any direct effect upon the heart; but whenever the failure of circulation is due to the inhalation of chloroform, they show unmistakably that it has been given in such a way as to interfere with the breathing.

The most important point in all the tracings is to be found in the irregularity and fall of blood pressure when chloroform is properly administered. This is shown in many of the Commission’s experiments, especially from No. 164 to the end (vide 169), and in the tracings of March 6, 1890, respectively. In most of these experiments the fall of blood pressure is gradual and perfectly regular, and they demonstrate the only method of chloroform administration compatible with absolute safety. Though fall of pressure is inseparable from chloroform administration, there is never the least danger if it falls regularly, and if the inhalation is stopped directly the state of the cornea shows that the patient is “under.” Regularity of the blood-pressure depends entirely upon regularity of the respiration. Any irregularity, therefore, in the fall of blood pressure during chloroform inhalation indicates irregularity of or interference with the respiration; and, per contra, any irregularity of or interference with the respiration at the moment the fall of blood pressure is gradual and not interfered with, the fall of the blood-pressure will exactly correspond with it, and will cease long before a dangerous point is reached if necessary respiration is kept up. Regularity and fall of blood-pressure; or other signs show that the patient is “under.” If the respiration is kept up without struggling, holding the breath, or asphyxia, chloroform may be given slowly or quickly, freely, and with perfect confidence, without the slightest risk to the patient.

From the standpoint of medical education it is a serious misfortune that ether has been allowed to displace chloroform in any of our large hospitals. The public have a right to demand that every medical student shall be able to administer an anesthetic with safety in any part of the world; and there is no anesthetic which can be thus universally employed except chloroform. If ether is used as the sole form of anaesthesia in the hospitals attached to our medical schools, students cannot learn how to give chloroform; or if anaesthetics are only to be administered by specialists, students cannot learn anaesthesia practically; but the advantages of the chloroform method of anaesthesia are accompanied by a decrease in the employment of anesthetics by the general practitioner, and has limited their usefulness.

In conclusion, I desire to do justice to the wisdom of my old masters by comparing the principles Syme laid down for the safe administration of chloroform—principles which he always said he took from Sir James Simpson—with the principles which have now been established by the British Medical Association. It is not necessary to describe the technological processes by which the conveyance of the anesthetic to the brain is accomplished; it is sufficient to say that the effects of the anesthetic are produced in the medulla. For example, if the pulse is sixty, and sixty atoms of chloroform are conveyed to the brain in a minute, only thirty atoms a minute will reach the brain (other things being equal) if the pulse is reduced to thirty by stimulation of the vagus. Tracings 3 and 4 of the effects of ordinary chloroform inhalation are identical up to the point where the respiration ceased. Tracing 3 then shows that the breathing having entirely ceased, stimulation of the vagus slowed the circulation from eighty-six to forty-two a minute and saved the dog’s life. Tracing 4 shows how, after the stoppage of the respiration, when artificial respiration was not employed and the vagus was not definitely affected, the circulation fell to forty-two a minute. The second tracing shows how useless it would have been to have taken the action of the pulse as a guide. When the pulse failed, as it did at the end of Tracing 4, it was a sign of impending death. The two tracings demonstrate that by the time the respiration ceased the poisoning had been averted, as it always can be in the human subject under chloroform, if the breathing is carefully kept free. It is remarkable that in these two experiments the chloroform was given undesignedly for precisely the same length of time—viz., 4/24 minutes. Considered by the light of the work of the Commission, these tracings prove incontestably that the slowing of the heart and circulation through the stimulation of the vagus is a safeguard in chloroform poisoning. The symptoms—pallor and loss of pulse—produced in a similar manner in man are none the less signs of the greatest danger, as they signify that the patient has been over-dosed or improperly breathing, or that the respiratory centre has been paralysed. They do not indicate, as has hitherto been supposed, that chloroform has any direct effect upon the heart; but whenever the failure of circulation is due to the inhalation of chloroform, they show unmistakably that it has been given in such a way as to interfere with the breathing.

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The points that we consider of the greatest importance in the administration of chloroform are: first, a free admixture of air with the vapour of chloroform; secondly, we do not stint the quantity of the chloroform; and, then, this is most important, we are guided as to the effects, not by the circulation, but entirely by the respiration. We also always give chloroform in the horizontal position, taking care that there is no article of clothing confining the neck, and we never continue beyond the point when the patient is fully unconscious. The Commission has demonstrated that the aim of the administrator must be to give chloroform so that the blood-pressure must be kept regular throughout the whole administration, and that the blood-pressure can only be kept free from irregularities by absolute regularity of the breathing. The chloroform must therefore be inhaled in such a way that the breathing is natural and regular throughout. Feeling the pulse during chloroform inhalation is no guide whatever to the blood-pressure or to the breathing. It must therefore be inhaled in such a way that the breathing is regular and not stilted; and it has been shown above that the pulse is of no value as a sign of approaching danger, since it is only affected dangerously when the respiration has been stilled with ether by an overdose. Lastly, in order to keep the breathing regular, the whole of the administrator's attention must be concentrated upon this point alone; and it is therefore clear that if, as is now recommended in most books, part of the chloroformist's attention is to be given to the pulse, an important element of danger comes into the administration.

We can no longer contend, with regard to chloroform, that the results of clinical experience and of experimental research do not agree. The investigations of the Hyderabad Commission have brought to light a strikingly precise exclusion of the poison from the system, and not the direct effect of the absorbed poison upon the heart or its nerves.

APPENDIX.

The above paper was written before the Glasgow Committee's criticism appeared in the British Medical Journal of the 14th inst. I lose no time in exposing the Committee's fallacies, as I am obliged shortly to return to India.

The first point to notice in the Glasgow Committee's remarks is their reference to the paralysing effect of chloroform vapour on the muscular tissue of the heart. Chloroform vapour has a paralysing effect upon the muscular tissue of the heart, and indeed upon all kinds of protoplasm when directly applied. When the heart of a frog is exposed to the direct action of chloroform vapour, it became rapidly cyanosed; the pulse ceased; and the heart may be said to be paralysed. The heart can be rendered paralysed for an indefinite period, by distending the right ventricle almost immediately begins to distend; the heart presently stops, with the right ventricle engorged with blood. It is evident from this description that the serious saturation of the heart is not paved into a rabbit. The distension of the right ventricle must mean damage to the circulation through the lungs. It is the first effect of stasis in the lungs. Sir Joseph Lister has shown (vide Professor Carse's, paper in the British Medical Journal of April 28, 1879, p. 323) that when chloroform is applied directly to the web of a frog's foot stasis immediately takes place; and the same effect is undoubtedly produced in the same manner in the lungs, and is sufficient to account for the ventricular stasis observed in the administration of chloroform. Air saturated with chloroform into the lungs of rabbits and dogs through an opening in the trachea. It soon became apparent that when chloroform is given in this way there is at once a most serious effect upon the heart; the right ventricle almost immediately begins to distend; the heart presently stops, with the right ventricle engorged with blood. It is evident from this description that the serious saturation of the heart is not paved into a rabbit. The distension of the right ventricle must mean damage to the circulation through the lungs. It is the first effect of stasis in the lungs. Sir Joseph Lister has shown (vide Professor Carse's, paper in the British Medical Journal of April 28, 1879, p. 323) that when chloroform is applied directly to the web of a frog's foot stasis immediately takes place; and the same effect is undoubtedly produced in the same manner in the lungs, and is sufficient to account for the ventricular stasis observed in the administration of chloroform. Air saturated with chloroform cannot do this. In any case, the fact stated by the Committee—that the right ventricle almost immediately begins to distend; the heart presently stops, with the right ventricle engorged with blood; and the Committee observed when they gave chloroform, we should never directly apply the air saturated with chloroform into the lungs of the rabbit. It is incorrect to imply that driving chloroform into the lungs brings it into direct contact with the heart, or to the effect of tissue distension in the heart.
form freely diluted with air killed a monkey in eight minutes and eighteen seconds. In the ether experiment 15cc. of ether freely diluted with air killed a similar monkey in nine minutes and fifty-six seconds. The difference corresponds with the recognised difference in the strength of the two anaesthetics in the ordinary practice of surgery.

With reference to the committee’s statement that the heart was beating as vigorously at the end of an hour as at first, we are not told whether there was any natural respiration. It is not therefore necessary or even whether the animal was alive; and in the absence of reliable information on these points we cannot consider this experiment trustworthy. Either the ether which the committee had lost its effect on, or the ether administration was stopped; or the committee fell into the error of supposing that because the heart was still beating the ether had not interfered with its action.

The same vigorous action of the heart after prolonged anaesthesia, brought forward by the committee in support of their theory of an asthmatic condition of the heart, is no new phenomenon, as is shown by the committee itself. Fick, in 1879, and have repeated without confirmation in 1890. Facts we cannot accept the vague statements of experimenters, Dr. James, who was cut and the rabbit was thrown aside dead. The traction was opened at 1h. 3m. 56s., and the heart was seen by the committee to be beating vigorously and rhythmically.” At 1h. 15m., it is stated, “the heart was still beating rhythmically; auricles and ventricles both contracting strongly, but the action of the ventricle is intermittent.” At 2h. 5m., one hour after death, the auricles were still contracting rhythmically, but the ventricle was beating in an intermittent way. This continued till 3 o’clock, two hours after death, after which no more notes were taken. In this case, we are left in ignorance as to the cause of death. The committee refer to the observations of the Glasgow Committee attributed to some slight fall with struggling, which interferes with respiration; (3) to asphyxia; or (4) to electrical stimulation of the vagus. This is clearly stated on the tracings, and the Ludwig tracings were written on the tracings, as the drum revolved, at the time it actually occurred. The committee says:—”

The committee proceed: “Turning to experiments recorded in the Ludwig tracings, we have ‘mouth closed,’ but the action of the ventricle is interrupted, we have been astonished to find that the traces do not bear out the statements of that paragraph.” It is true that in this short extract, the committee refer to the observations of the Glasgow Committee, but they do not have any opportunity of examining the tracings themselves.

The action of atropine is to paralyse the vagus and produce a condition in which the heart “bounds on again, and the blood then becomes oxidised. If the committee regard the effect of atropine as a paralysing of the vagus, then it undoubtedly explains the beneficial action of chloroform in producing this condition. The committee refer to the observations of the Glasgow Committee, but they do not have any opportunity of examining the tracings themselves. It is clear that the action of the vagus in the heart is very soon involved, the respiratory centre becomes paralysed, and the blood-pressure falls, and there is the additional fact that this seems to depend very little on the action of the vagus. In support of this conclusion which the committee quote from Fick, readings 3 and 6 of Experiment 151. But Fick 3 of No. 151 is a reading during simple smothering, the vagus being intact. The effect of the smothering is to almost immediately lower the blood-pressure and retard the pulse to the point of paralysis of the vagas. Then the vagus becomes paralysed, and the blood-pressure falls, and there is the additional fact that this seems to depend very little on the action of the vagas.

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that it may be a safeguard to the organism in poisoning by an anesthetic. If the views of the Glasgow Committee are right, then a patient is in much less danger with the pulse at 105, carrying 105 atoms of chloroform to the medulla in a minute, than he is when the pulse is 31 and only 31 atoms of chloroform are being conveyed to the medulla in a minute. This is manifestly an absurdity. In actual practice the amount of atropine employed as an adjunct to chloroform administration would probably be so small as to be of no effect at all, it must be to do more harm than good.

The Glasgow Committee's tracings have been reproduced in the British Medical Journal. They are given above for the sake of comparison with tracings 148 and others of the Hyderabad Commission. The committee state that the evidence which furnished tracing C the chloroform was administered "by a cloth saturated with the agent being held over the mouth and nose. This exactly bears out the conclusion of the Commission. The animal got chloroform with insufficient air, and the 'Glasgow trace,' which the Hyderabad Commission produced over and over again in their experiments, was due to the stimulation of the nerve centers with saphyphial blood. It only remains to add that the Glasgow Committee's remarks on the condition of an animal whose pressure is "minus" require explanation. As they stand, it looks as if the committee were describing the pulse and respiration curves as, indeed, they are represented in trace C, below the zero line, the line of no pressure, which is, of course, an impossibility. The animal in trace C was never in any danger except from the improper manner in which the chloroform was administered to it, and does not disside the committee's argument about the danger of chloroform to the heart, which is based upon the faulty tracing, has its foundation, not in physiology, but solely in imagination.

Corollary conclusions of the Hyderabad Commission for the inspection of Fellows and Members. 3. That it is desirable that the administration of chloroform is a proceeding in which there is practically no danger. The statistics I have given elsewhere prove the great danger in chloroform administration of dividing the attention between the respiration and the circulation. For this danger the report of the Glasgow Committee in 1879 must be held to be very largely responsible. The committee now argue as if it were wise to keep up the unfounded dread of chloroform the public have acquired, so that whenever an operation is about to be performed under chloroform the patient is nearly frightened to death beforehand, not by the operation itself, but by terror of the effect of the chloroform. The committee, however, fail to consider all matters relating to the constitution, government, and administration of the College, whether in the corporate, examining, academic, or political capacity; and in the advice which the committee give to the Fellows of the Royal College of Surgeons of England.

The principles contained in these resolutions were approved by over 250 Fellows of the College. On the initiation of Mr. Paul Swain, of Plymouth, this led to a meeting of the Fellows in June, 1884, when the following resolution was moved by Mr. Tweedy, and carried—viz: "That a Society be formed to promote the general interests of the Fellows of the Royal College of England. From 300 to 350 favourable answers were returned to the honorary secretary. It would be remembered that on March 24th, 1884, the following resolutions were carried at an annual meeting of Fellows and Members convened to discuss such alteration.

1. That it would materially conduse to the welfare of the college if the Fellows and Members were invested with a larger share of its management. 2. That it is desirable that the Council of the College be elected by the consent of the Fellows and Members convened to discuss such alteration. 3. That there shall be an annual meeting of Fellows and Members at which the annual report of the Council shall be presented, and of which the Fellows and Members shall be appointed as a body, and at which all matters relating to the constitution, government, and administration of the College, whether in the corporate, examining, academic, or political capacity; and in the advice which the committee give to the Fellows of the Royal College of Surgeons of England."

In January, 1885, a scheme drawn up by a committee appointed for that purpose contained the following recommendations:—1. Any Fellow who has been a Fellow for ten years, or a Member for twenty years, shall be eligible to a member of the Council. 2. Any member of the Council, other than the President, who may be absent from more than four successive meetings without leave shall ipso facto cease to be a member of the Council. 3. That the President and the Secretary of the Council shall be placed in the procession connected with chloroform administration, just as a man with a certain condition of heart may die of heart failure from running to catch a railway train, the Hyderabad Committee record these deaths as cases of heart failure, and the death of a heart is not a risk of chloroform itself. If the surgeon is to have constantly before his mind the fear of the sudden death of his patient by stoppage of the heart from the mere action of the chloroform, it is to him, if he advert to the warnings given by the respiration, by which alone danger can be averted. The conclusion of the Hyderabad Committee is wrong, and if it is followed deaths with chloroform will be as inevitable in the future as they have been under the same circumstances in the past.

Vide The Lancet, p. 1281.