Observations upon two cases of Cheyne-Stokes' respiration / by Frederick Taylor [and others].

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OBSERVATIONS UPON TWO CASES OF CHEYNE-STOKES' RESPIRATION.

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Two patients in Guy's Hospital presented the phenomena of Cheyne-Stokes' respiration in so characteristic a form that further observations were made to supplement those already recorded in the preceding paper.

Case 1.—*Observations upon the Results of the Clinical and Post-mortem Examination.* By Frederick Taylor and Herbert French.

George J—, aged 46, a gas-work stoker, was admitted into Guy's Hospital under the care of Dr. Frederick Taylor on July 17th, 1905, and died on February 4th, 1906. During the whole of this time, six and a half months, he had typical Cheyne-Stokes' respiration, except during the three days immediately preceding death.

He had been known to have kidney disease for at least ten years, and he was admitted for an exacerbation, with

some œdema of his legs. The condition of his urine was variable. It always contained albumen, and moderate numbers of hyaline and granular tube-casts. The amount of albumen varied from a mere trace to 3 parts per thousand. The specific gravity was always low, and varied from 1006 to 1012, though on two occasions it rose to 1018. The quantity was above normal; even in the middle of August he passed as much as 92 ounces in 24 hours upon one occasion, and he frequently passed above 70 ounces.

The diagnosis was granular kidney, and this was confirmed by autopsy.

The heart was much hypertrophied, the impulse being in the fifth left intercostal space, three quarters of an inch outside the left nipple, heaving in character. There were no bruits; the first sound was prolonged at the apex, and in the aortic area the second sound was much accentuated. The pulse rate was usually between 60 and 70 per minute, and the maximum systolic blood-pressure, measured in the brachial artery by Martin's modification of the Riva Rocci apparatus, varied from 165 mm. Hg. to 178 mm. Hg. During hyperpnœa cardiac dulness could only just be detected to the right of the sternum; during apnœa this dulness increased a full inch further to the right.

The lungs were at first congested at the bases; the signs of this cleared up. Just before death there was dry pleurisy over the right lower lobe. There was no emphysema.

The gastro-intestinal viscera were natural, as were also the nerve reflexes.

There was well marked albuminuric retinitis in both eyes, with white patches of exudation, and hæmorrhages both old and recent. The patient, however, always said his eyesight was good.

The persistent Cheyne-Stokes' respiration is fully described below; it was very characteristic all the time the patient was under observation. In addition to this there

were several attacks of uræmic "asthma" during the first few days after admission. These disappeared with rest in bed, restricted proteid diet, purgatives, and digitalis.

When first admitted the man was muscular but thin. The initial œdema entirely disappeared, and relief was at first great. A month from admission the patient was able to be up and about, notwithstanding that he had Cheyne-Stokes' respiration all the time. A month later he took to his bed again, and remained there till his death. The observations upon his respiration were not begun until January, 1906, six months after he first came in.

He was always conscious, and, except for the "asthma" mentioned above, had no uræmic symptoms. He could read the newspaper with pleasure, but towards the end he took less interest in things, and when spoken to he would sometimes delay as much as half a minute before answering. This slowness of response was always more marked in apnœa than it was in hyperpnœa.

Though he took his food well he wasted markedly. His legs and body became mere skin and bone. Latterly he passed his urine and fæces into the bed, less from incontinence or unconsciousness than from simple lethargy. If a nurse were near he would ask for urinal or bed-pan; but if no nurse were near he would not be bothered.

After the first few days there was no œdema; the heart did its work well, without any of the recognised signs of failure.

Three days before death acute dry pleurisy set in, and simultaneously the Cheyne-Stokes' respiration disappeared. Death was very easy, the end coming during a deep sleep.

The autopsy showed the following organic changes:

Kidneys.—Both of the kidneys were small and granular in appearance. The capsules were adherent, the cortex thin, the arterioles prominent and thick-walled. In the right kidney there were also a series of sacculated, tuberculous abscesses. The ureters, bladder, and urethra were natural.

Heart.—The heart was much hypertrophied, more especially the left ventricle. There was no valvular disease beyond some atheroma of the aortic valves. The coronary arteries were tortuous and thick-walled, but quite pervious.

Lungs.—Small. There was recent pyogenic membrane over the right upper and lower lobes, and a recent infarct in the left lower lobe. There was no chronic lung disease.

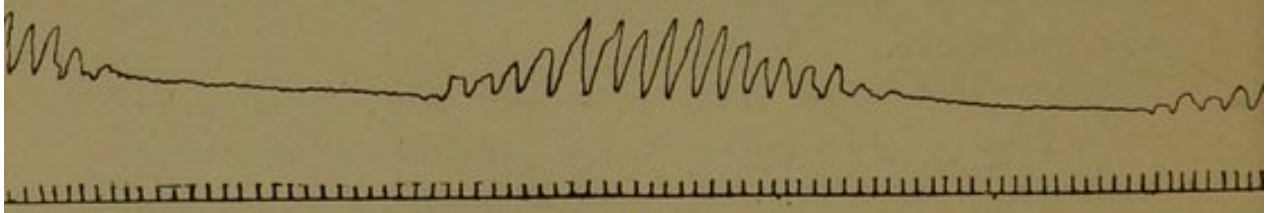
Brain.—The cerebral arteries were widely patent, thick-walled, and atheromatous. There was a small patch of softening in and around the left internal capsule. There was no hæmorrhage. The pons and medulla looked healthy to the naked eye, and were sent to Dr. Farquhar Buzzard for further examination. We are greatly indebted to him for the report given on page 42.

The remaining viscera showed no macroscopic abnormality.

Experimental Observations, especially in Relation to the Causation of Periodic Breathing. By M. S. Pembrey and Herbert French.

The patient exhibited a typical waxing and waning of the respiratory movements (Fig. 1) accompanied by a

Fig. 1.



Cheyne-Stokes' respiration. The curve reads from left to right, and the time is marked below in seconds. The small undulations during the period of apnœa are due to the beats of the heart (January 23rd, 1906).

general overflow of motor impulses; during this period he moved uneasily and complained of pain in the abdomen. During apnœa he remained conscious, but did not

speak of his own accord, and only answered questions after great delay. The duration of apnœa and breathing is shown by the tracing (Fig. 1) and the following consecutive determinations.

	Apnœa.			Breathing.			
Date.	Duration in seconds.	Rate of Pulse. Actual.	Per minute.	Duration in seconds.	Rate of Pulse. Actual.	Per minute.	Respirations.
13/1/06.	25	26	(62)	20	27	(81)	11
	22	28	(76)	20	25	(75)	10
	25	28	(67)	20	20	(60)	12
	25	25	(60)	20	33	(99)	11
13/1/06.	25	37	(89)	20	26	(78)	10
	22	32	(87)	25	27	(65)	11
	25	32	(77)	23	26	(68)	10
	22	28	(77)	21	25	(71)	10

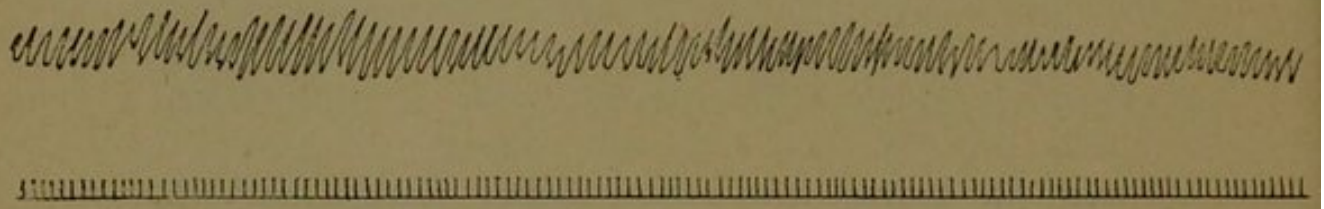
Three or four days before death (February 4th, 1906) his breathing lost the periodic type and became continuous; at this time there were signs of pleurisy, upon the right side. When the patient was asleep on January 29th his breaths were deep and regular, 30 per minute; after he awoke they were somewhat irregular, but still of the continuous type. The colour of his face was much fresher than it had been in the days when Cheyne-Stokes' respiration was present; he was, however, complaining of pain. Again on January 31st he was observed asleep; his respirations were regular and deep, and showed no periodic changes either in frequency or depth. After he awoke his respirations were still of a continuous type, but they undoubtedly showed a periodic change in depth; a series of deeper breaths followed shallower ones, and this alternation was repeated again and again. Percussion of the chest caused pain, especially upon the right side.

This disappearance of the Cheyne-Stokes' respiration is interesting; it would appear that, owing to the pleurisy, the patient was no longer able to take the very deep breaths which had characterised the height of the waxing respiration; carbon dioxide would therefore not be re-

moved so freely, and its mean partial pressure would be maintained at a higher level. It is possible that the pain caused by the pleurisy not only limited the expansion of the lungs, but also raised the excitability of the respiratory centre by impulses passing up the vagi and other nerves.

Our observations were made during the time when the Cheyne-Stokes' phenomena were at their height, and consisted chiefly in an investigation of the effects of oxygen and carbon dioxide upon the periodicity of the breathing.

Fig. 2.



The effect of pure oxygen administered by means of a mask provided with inspiratory and expiratory valves. Respiration is of the continuous type. (January 23rd, 1906.)

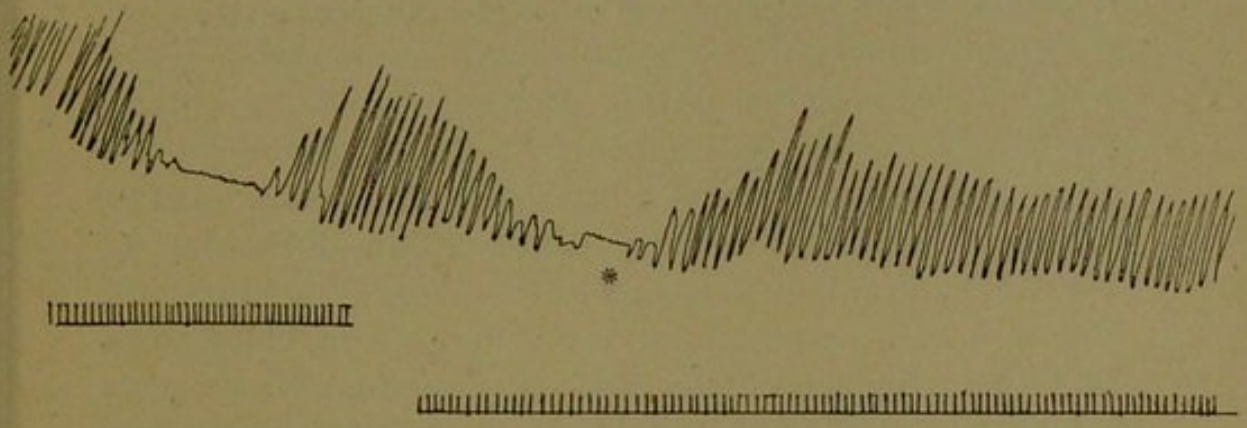
The administration of oxygen through a mask provided with inspiratory and expiratory valves caused the apnœic pause to disappear within one minute and a half. In one record, when the patient was breathing air through the mask and valves the period of breathing lasted thirty-nine seconds, and included twenty respirations; it was followed by apnœa for a period of nineteen seconds. During the breathing of pure oxygen the respirations were shallow, rapid, and continuous in type, 48 respirations in fifty-eight seconds (Fig. 2). Oxygen gave the patient much relief and removed the dusky ash-grey colour of the face.

Air containing 4·67 per cent. carbon dioxide and 20·48 per cent. oxygen was administered towards the beginning of a period of breathing; the tendency to apnœa was promptly abolished, the respirations became continuous in type, deep, and of a frequency of 48 in a minute (Fig. 3). The breathing of air containing 4 to 5 per cent. of carbon

dioxide caused the patient no distress, but several times made him cough.

Apnœa was also abolished when the patient breathed through a mask with a long rubber tube; the "dead space" was increased, and thus the inspired air, by admixture with some of the air just expired, contained a higher percentage of carbon dioxide and a lower percentage of oxygen than in normal air. Even the slight

FIG. 3.



The first portion of the tracing shows Cheyne-Stokes' respiration when the patient was breathing air through the mask and valves. At the point marked by the star a mixture of air and carbon dioxide, 20·48 per cent. oxygen and 4·67 per cent. carbon dioxide, was administered. The respirations became continuous in type. The small undulations during the period of apnœa are due to the beats of the heart. (January 23rd, 1906.)

disturbance of respiration produced by the application of the mask and valves tended at first to prolong the period of breathing and to shorten the period of apnœa, although in this case there was but a very small increase in the "dead space."

Samples of the alveolar air of the lungs were collected at different stages of the periodic breathing. The results of the analyses are given in the following table:

		Waxing Respiration.	
Date.		Carbon dioxide. Vols. per cent.	Oxygen. Vols. per cent.
13/1/06.	5th Expiration.	2·70	17·19
	,,	2·01	18·01
23/1/06.	Height of Hyperpnœa.	1·87	18·51

Date.		Waning Respiration. Carbon dioxide. Vols. per cent.	Oxygen. Vols. per cent.
13/1/06.	10th Expiration.	2·05	18·89
	13th „	1·76	19·22

There is no doubt that the true percentages of oxygen were lower and of carbon dioxide higher, for the mask did not always fit absolutely tight to the patient's bearded face. The first few respirations of the waxing respiration were, moreover, so shallow that it was difficult to obtain reliable samples, just as in the previous case.

Observations on the blood pressure of the brachial artery were made by means of Martin's modification of the Riva Rocci sphygnometer. At the height of hyperpnœa the readings for the maximum pressure were 178, 174, and 178 mm. of mercury, in the middle of the apnœic pause 178, 172, and 173, and at the end of apnœa 168, 168, and 165. Apart from the difference in blood pressure the influence of the periodic breathing was shown upon the area of cardiac dulness, which was increased by 18 mm. to the right of the sternum and 20 mm. outward to the left during the apnœic pause.

The point most to be noted is that the administration of either excess of oxygen, or of excess of carbon dioxide, in the air breathed caused disappearance of the Cheyne-Stokes' type of respiration.

The Structural Changes in the Pons and Medulla Oblongata.

Report by E. Farquhar Buzzard, M.D., F.R.C.P.

"The pons and medulla were hardened in 5 per cent. formalin, and then cut transversely into a number of thin slices. With the naked eye these slices appeared normal, except for the presence of numerous small areas of softening, some of which were of a bright red and others of a dirty yellow colour. The largest of these areas was scarcely larger than a pin's head, and they were more numerous in the medulla than in the pons. In both

regions they were more often seen in the neighbourhood of the median raphe than in the more lateral parts. A number of slices were embedded in paraffin and cut; the sections were stained either with methylene blue or with logwood and eosin.

"*Microscopical.*—Although degenerative cell changes in the various nuclei of the medulla were striking, they could only be regarded as secondary to the vascular disease which was very marked throughout the sections. In the first place, nearly every arteriole and capillary in the substance of the medulla showed general thickening, chiefly of the media, with hyaline degeneration. Some of the larger vessels, especially those near the median line, presented, in addition to the hyaline change in the media, marked periarteritis, indicated by the presence of numerous round cells in the adventitia and perivascular spaces.

"In the second place, there were many recent and some older capillary hæmorrhages, especially just beneath the floor of the fourth ventricle, in the region of the dorsal nuclei of the vagus.

"Thirdly, evidence of numerous areas of softening was to be seen in the form of fibrous scars, remains of vessels surrounded by necrotic tissue and altered blood pigment. One of these involved and destroyed a considerable part of one of the inferior olives, and others were situated more dorsally near the median raphe.

"In addition to these conditions, small vessels with hyaline walls were occasionally to be seen lying unsupported in small patches of necrosed tissue, the appearance suggesting the origin of some of the capillary hæmorrhages.

"Changes in the nuclei were chiefly of a degenerative type, the cells being shrunken, misshapen, and homogeneously stained. Chromatolytic changes were also present in some parts. The hypoglossal nucleus was less involved than any of the others. Amylaceous bodies were fairly numerous around the periphery of the medulla."

Conclusions.

These observations upon Cheyne-Stokes' respiration confirm the results obtained in another case by Pembrey and Allen.[1] It would appear on the same grounds that the periodicity of Cheyne-Stokes' respiration is in great part due to "a diminished excitability of the nervous system associated with a defective supply of arterial blood; the carbon dioxide accumulates, and the oxygen diminishes, until at last the nerve-cells are stimulated, the waxing respirations begin and culminate in hyperpnœa, whereby a large quantity of carbon dioxide is washed out and sufficient oxygen taken in; apnœa then follows, due, apparently, to the absence of sufficient carbon dioxide to stimulate the nerve-cells.

"The inhalation of air containing more than 2 per cent. of carbon dioxide abolishes apnœa, by maintaining the partial pressure of the carbon dioxide in the alveolar air and blood at its stimulating valve.

"The administration of pure oxygen by means of a mask and valves abolishes apnœa by maintaining the partial pressure of carbon dioxide in the blood at its stimulating valve. The respiratory centre is no longer excited by lack of oxygen to send out the forcible impulses which had previously resulted in excessive ventilation of the lungs, whereby carbon dioxide had been washed out of the alveoli and blood."

Case 2. F. H—. Observations by M. S. Pembrey and A. P. Beddard.

F. H—, aged 45, was standing in a lift on January 3rd, 1906, when the wire cable broke, and he fell in the lift a distance of forty feet. Both his thighs and the fingers of his left hand were broken, but his head was apparently uninjured, and he was able to crawl out of the lift.

On admission to the Hospital he was in a dazed con-

[1] See the preceding paper.

dition, but was able to answer questions sensibly. Thirty-six hours after the accident he slowly passed into a delirious condition. His respirations were rapid, about 40 per minute, his pulse about 120, his temperature varying, but never rising above 100°. He then gradually became comatose, and, after remaining in this condition for two or three days, improved, and by January 9th was sensible at times, but often very restless, stupid, and semi-conscious. His mental condition slowly improved, and by January 13th was apparently normal.

The exact date of the onset of the Cheyne-Stokes' respiration is uncertain, but on January 12th it was well marked. Examination then showed no abnormality in the heart and lungs, no signs of fractured skull, no paralysis; his pulse was of good tension and regular; his urine was normal; his breathing was of the Cheyne-Stokes' type; a period of waxing and waning respirations was followed by a period of apnœa. During apnœa he either closes his eyes, as if he were asleep, or shows conjugate deviation of the head and eyes to the right, the eyes remaining open. He makes no attempt to answer questions. During the period of breathing he rapidly wakes up and makes a series of forcible movements, which are nearly constant in form at the corresponding stages of succeeding periods of breathing; this repetition is especially seen in the movements of the right arm and head, and the movement of the right hand over the top of the head. He slowly answers questions during this time. The following figures give the duration in seconds of several periods of apnœa and breathing.

Date.	Apnœa.	Breathing.
12/1/06. ...	15 ...	25
	15 ...	
	10 ...	25
	15 ...	25
18/1/06. ...	25 ...	17
	17 ...	21

The number of respirations in the periods of breathing varied from 10 to 20 at different times, and were not easily recorded owing to the movements of the right arm and head.

The following figures give the duration in seconds of consecutive periods of apnœa and hyperpnœa, when the patient was breathing air through a mask and valves.

Date.	Apnœa.	Breathing.		Apnœa.	Breathing.
18/1/06.	12	26	→	22	27
	16	22		8	123
	18	23		21	21
	20				

Pure oxygen was then given; the respiration in ten minutes became continuous, the rate of breathing being 14 per minute. Breathing through a mask and long tube abolished apnœa, and any disturbance of the patient tended to shorten the apnœic period.

Samples of the alveolar air of the lungs were collected, but they were obtained with difficulty owing to the forcible movements which, as already described, always occurred during the period of breathing. The patient, moreover, had a thick beard, which rendered difficult the adaptation of the mask in an air-tight manner.

		Waxing Respiration.	
Date.		Carbon dioxide. Vols. per cent.	Oxygen. Vols. per cent.
13/1/06.	2nd Expiration.	3·82	15·03.
	3rd ,,	3·97	15·75.
	4th ,,	4·13	15·75.
12/1/06.	5th ,,	2·63	17·99.

Samples taken on January 17th, when the patient's breathing was of the continuous type, gave results:— Carbon dioxide 3·60 and 4·29, oxygen 16·88 and 15·77 vols. per cent.

The Cheyne-Stokes' respiration was more marked during sleep; it disappeared on January 22nd, but as late as

February 18th it recurred from time to time in a well marked form, especially during sleep and after the patient had complained of a bad headache.

The blood-pressure in the brachial artery was determined on January 13th by Martin's modification of the Riva Rocci sphygmometer; for apnœa the readings were 152, 146, and 142 mm. of mercury, for the period of breathing 160 mm. It must be remembered that the latter period was accompanied by forcible movements of the arm and upper part of the body.

The exact lesion of the brain in this case is uncertain. There was no wound on the scalp, no evidence of fractured skull, and no sign of hæmorrhage on the surface of the brain. It seems likely that the cortex of the brain was bruised, and that the symptoms of cerebral irritation and compression were due to that cause. From the nature of the forced movements, it would seem likely that the frontal lobes had been contused. The question arises whether this cerebral injury had any connection with the Cheyne-Stokes' respiration, and if so, what was the nature of that connection. The symptoms of cerebral compression had passed off before the Cheyne-Stokes' respiration ceased, and this fact makes it unlikely that a gross change in the cerebral circulation was the cause of the periodic breathing. On the other hand, there is the possibility that the cerebral respiratory centre located by various observers in the cortex of the frontal lobe may have been injured, and thus brought about the periodic modifications in the excitability of the bulbar centre.

During the time of observation the patient received no drugs, such as chloral and morphia, to the action of which the periodic breathing might be attributed.

The patient, who was under the care of Mr. Lane, made a satisfactory recovery.

Conclusion.

In this case the condition of the nervous system could not be determined, and direct evidence of a defective

supply of arterial blood was wanting. The administration of pure oxygen abolished apnœa, but not so readily as in the two other cases recorded.

A preliminary account of these cases was communicated to the Physiological Society on February 24th, 1906 ("Proc. Physiol. Soc.," 'Journ. Physiol.,' vol. xxxiv, 1906).

The expenses of the investigation were defrayed from a grant from the Royal Society.

Our thanks are due to Mr. Lane for the facilities we received of observing the patient under his care.