been properly under the anæsthetic. The same danger arises at another stage in the administration, namely, when the patient is threatening to return to consciousness after he has been anæsthetised. The towel saturated with vapour is quickly reapplied, and the patient, with a few deep, gasping inspirations, inhales a quantity of chloroform for which his respiratory centres are quite unprepared, and cessation of function is too often the consequence. This danger can be entirely obviated by the intelligent use of an inhaler, which accurately regulates the quantity supplied to the patient during any inspiration. I say the "intelligent use," for the same danger is present if chloroform be recklessly pumped through an inhaler as when it is given unmeasured on a towel, though to a less extent.

The secret of its safe administration lies in attention to two points:

(1) A very gradual increase in the quantity supplied to the patient whilst putting him under. If this be carefully graduated so that the quantity of vapour reaches the maximum by almost imperceptible degrees, the two disagreeable and dangerous symptoms (struggling and vomiting) are almost invariably done away with. This is attained by attending to the amount of compression given to the bulb. At the start, during several respirations, only the slightest compression is used. A slightly deeper compression of the bulb is made for several ensuing respirations, and so on until a full compression is reached, which is kept up till the reflexes are abolished.

(2) Once the patient is under, the amount must be reduced to the minimum, or something approaching it, and by continuing to supply him constantly with this minimum dose complete anæsthesia may be maintained continuously for hours with perfect safety.

The regulating inhaler made by Krohne and Sesemann meets every requirement. I may remark, however, that the feather which is supposed to guide the administrator as to the continuance of respiration is an unnecessary part of the apparatus, as the anæsthetist should have eyes for nothing but the movements of the chest wall itself. I have used this apparatus over 150 times during the past two years, and on no single occasion has the condition of the patient given rise to any alarm.

There is a great difference in the quantity of chloroform used by this method and that required when the ordinary means of administration on a towel is employed. With the inhaler the amount is from one-half to one-quarter that required when other methods are used. There is an almost uniform absence of the unpleasant symptoms of struggling and vomiting. [From a table with which Mr. Arnold has furnished us it appears that of twenty consecutive cases struggling occurred in one only—a confirmed alcoholic—and vomiting in one.] The time occupied in putting the patient under varied from a minute or two up to ten, fifteen, or twenty minutes.

The struggling in alcoholics is not that of asphyxia, but appears to be due to an action on the higher centres in some way altered by continual soaking in alcohol, and so rendered peculiarly susceptible to the excitant properties of chloroform which normally should not be evident. It betrays the fact of alcoholism at some period of the patient's history, and is almost pathognomonic.

ON AUSCULTATION OF THE HEART DURING CHLOROFORM NARCOSIS.

By ROBERT KIRK, M.D. EDIN., F.F.P. & S. GLASG.,
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THE present communication is a brief discussion of 200 cases of chloroform administration in which I have auscultated the heart. An ordinary binaural stethoscope, sufficiently lengthened by india-rubber tubing, was at first employed, but after some time I adopted the phonendoscope, connecting it, however, with the upper half of a binaural, and having a watch fitted in.

In a few cases the heart was auscultated in bed, either on the morning of the operation or the previous day, and it was found that a considerable acceleration of its action sometimes

occurred, while in one case coupled beats developed, when the patient was afterwards placed on the operating table. The further investigation may be divided into the following stages:

1. The effect of the continuous inhalation of chloroform on the heart, as determined by the rate and character of its action before and during the process.
2. The effect on the heart ensuing when the inhalation was stopped or interrupted at any time.
3. The effect of retching and vomiting on the heart, as determined by a comparison of its action before and after these events.

Speaking generally of the entire results, it may be said that nearly every irregularity or variation in the action of the heart described in clinical textbooks may come under observation during chloroform narcosis. The most marked changes have their starting point either (1) at the beginning of inhalation, or (2) soon after the inhalation is stopped, or (3) within a minute after retching or vomiting. The effects which may be observed at either of these three periods are in some respects alike, and generally consist of acceleration, irregularity, or retardation of the heart's action. The first of these is most commonly the primary occurrence, and the other two secondary, but this is not always so.

The commencement of inhalation may be signalled by a very sudden increase in the frequency of the heart's action on the one hand, or the equally rapid supervention of irregularity on the other, and it may suffice to cite two cases to show this.

The first was that of a man, aged 29 years, in whom the rate of the heart, which beforehand was 68 and regular, was doubled in frequency the moment the chloroform was applied, 33 being counted in the first quarter of a minute, that is, a rate of 132 a minute.

The other was that of a female, aged 40 years, in whom the heart's rate beforehand in bed was 108, the sounds very loud, especially the first; afterwards on the table 132, sounds very loud, and so alike in character that I was uncertain which was first and which second. Chloroform being commenced, almost at once there was irregularity, tumultuous action ushering in coupled beats¹ in half a minute, which were of curious rhythm at first, but soon assumed the ordinary form. At this time I tried the pulse, but it was weak, and I could not count it. At the third minute, the heart's action became quite regular, 112, and remained so till anæsthesia was complete (six minutes altogether), when it was 60.

The last case was a type of what generally happened when the chloroform was steadily continued, acceleration or irregularity giving place to slow and regular action in deep anæsthesia; and this was even observed in some cases where the heart was irregular on the table before the inhalation was commenced.

Seven cases of apnoea, or that temporary stoppage of the respiration occasionally seen early in the administration, were observed, the pause in the breathing varying from ten to thirty seconds. It was only in the case of the briefest stoppage that any alarm arose, or that artificial respiration was resorted to for a few seconds. Now, we read in some fatal cases that the breathing stopped in the course of the first minute or two, and that the chloroformist desisted and performed artificial respiration. Here I must record the opinion, which I have long entertained, that any such stoppage is a mere pause, and that to stop the administration and have recourse to artificial respiration are both alike wrong—are, in fact, a double blunder which must be held accountable for all the disasters that have followed.

The most important question is that with which we have now to deal, namely, the effects which may ensue when the inhalation is stopped. The first result is that the vapour in the lungs is expelled in a few seconds with the first two or three expirations, although this period may be longer when the breathing is slow and shallow. It follows that any effect

¹ On the subject of coupled beats see Sir William Broadbent *On the Pulse*, pp. 107-123, where it is stated that the only drug known to cause them is digitalis. The inhalation of chloroform, and probably of other poisonous gases, must be added, while they are also to be seen on some of the blood-pressure tracings of Liver and Schäfer, illustrating the effects of intravenous injection of suprarenal extract. (*Journal of Physiology*, vol. xviii, p. 242.)

on the heart observed ten or fifteen seconds after the inhalation has been discontinued cannot be due to any further absorption of chloroform, but must be ascribed either (1) to an abnormal state of the respiration or circulation, as apnoea, tachycardia, or irregularity already existing when the chloroform was left off; or (2) to a train of events setting in at the same time, the chief features of which are generally acceleration of the heart and rise of blood pressure, and which may be aptly characterised by the term reaction. The latter is probably the most common cause of after-effects, and these may vary with the stage at which the process is interrupted, and the condition of the patient under various circumstances which cannot be discussed here.

The following is an illustration of what may ensue from a break in the inhalation at an early stage:

A female, aged 70, heart beforehand, on the table, 60, regular. Under chloroform it rose in one minute to 80, and so continued during the next; at the third minute the table and patient were shifted a little, and the chloroform was stopped for a period which I carefully noted, and estimated at half a minute. My observations were of course interrupted during this interval, and on again listening, just as the chloroform was about to be reapplied, the heart's action was irregular, coupled beats being heard for a few seconds; these then gave place to three successive rattles of very quick and loud beats, with intervening pauses, like so many volleys of musketry on a small scale. The sounds soon after became faint and scarcely audible, and just as anaesthesia was established, a few minutes afterwards, it was noted that the heart became more regular and slow. Two or three minutes later coupled beats were again going on, with the dropped beat at the wrist, the cardiac rates being 96 and pulse 48. A little later still both pulse and heart were 60, and, it is noted, of very good strength.

Let the above case be compared with No. 48 of the fatal cases in Dr. Snow's work,² a case which has been reported with the utmost exactitude. It was that of a boy of 9 years, and in the course of the description we read, "A few seconds later his pulse, which had been carefully watched, and had been to this time normal, suddenly began to beat very quickly, then it ceased for two or three seconds, then beat rapidly several times with a kind of flickering movement, and then ceased to be perceptible." It is then added, "Just before this change of the pulse was observed the chloroform had been withdrawn."

The identity between the action of the heart in the former case and the state of the pulse in the latter must be apparent, and both of these were due to the same cause. And I am bound to express the opinion that in the latter case also the proper remedy, when this condition of the pulse supervened, was the immediate reapplication of the chloroform, which would have righted everything in half a minute, as certainly as it did in the other case.

I have notes of 21 cases of a kind somewhat similar to that of the above old woman, exclusive of some cases of minor irregularity. Thus, in four cases, on the patients being allowed to breathe fresh air for 15 seconds or more, the heart's rate suddenly ran up from 108 or 120 to 160, with a striking increase in the loudness of the sounds. The same thing happened in a fifth case, the chloroformist stopping twice because the patient wanted a "breath of air," and later on in this case the heart's sounds were feeble, and coupled beats were for some time heard. While they were going on the operating surgeon felt the pulse, and detected a large and a small beat alternately (*pulsus bigeminus*). Another case afforded an excellent opportunity of marking a gradual transition from the normal rhythm of the two sounds to perfect coupled beats, the ear at first detecting merely a slight inequality between alternate beats, which gradually became more pronounced. In this case volleys of quick beats, and also tripled beats, were afterwards heard. In a few cases the results were still more serious, as the following cases will show:

Male, aged 25; heart beforehand on the table, 84, regular. Under chloroform it rose only to 100. At the second minute the chloroformist, on renewing the dose, removed the towel for ten seconds or so, allowing four inspirations of air. At the fourth minute he gave the towel to another house-surgeon (generally the chloroformists in the Scotch infirmaries are house-surgeons), and here there was a somewhat longer interruption to the administration. The patient hereupon struggled and became rigid, while opisthotonos with lividity, stertor, and blowing expiration supervened. During inspiration the suprasternal notch and supraclavicular spaces were drawn in, and then markedly inflated with expiration. The rigidity, with loud respiratory sounds, rendered it difficult to hear the heart, but the rate was fast, and, as far as I could ascertain, 144. A few minutes afterwards this turmoil ceased, and the rate fell to 84.

Another case occurred presenting identical symptoms in even a worse form, but the loud mucous *râles* in this case, ac-

companied the expectoration of an enormous quantity of frothy mucus, quite prevented me from ascertaining the state of the heart. The last case of this class I shall refer to is, perhaps, the most interesting of all.

Male, aged 42 years; heart beforehand on table, 116, regular. The chloroformist stopped twice for about fifteen seconds to renew the dose of chloroform, and in the second of these intervals the patient struggled, and as the towel was reapplied I heard the heart fly off at a gallop, but could not count it. In four minutes (from the first) the struggling ceased, the chloroform being at the same time discontinued, and I could now determine the rate of the heart to be exactly 248. The second sound was much intensified; the action violent, and it might be represented thus: *a-dub-a-dub*, *a-dub-a-dub*, where *a* represents the short and almost imperceptible first sound, and *dub* the loud second one. The heart went thundering on at this furious pace for five minutes, during which chloroform was again given. I twice tried to count the pulse, but I could only feel a vibration occasionally. A difficulty arose from the muscles being rigid, but on the second attempt the rigidity ceased, and yet I had no better success. On turning again to the heart I found it now slow and irregular, and I had missed the moment of transition from the one to the other mode of action. In a minute more it became quite regular, 120.

Several cases occurred, for the most part in subjects under 15 years of age, in which anaesthesia was supposed to be induced, and the operation was consequently commenced in two minutes. In one of these cases, a boy, aged 10 years, the chloroform was stopped in little more than two minutes, and great irregularities ensued shortly afterwards; successive series of the rapid and loud beats, followed after a pause by a succession of slow and fainter beats; while here, as almost invariably happened, coupled beats also set in. In another, a lad, aged 15 years, in which drops were administered for less than three minutes, great irregularities with lividity supervened in half a minute, and lasted for three quarters of a minute. Several other cases were almost the exact counterparts of these two.

To be brief here, I would merely state the opinion that the insensibility which may follow one or two minutes' inhalation of chloroform is due to the reaction already mentioned, leading to an irregular action of the heart, or even to actual delirium cordis, when the organ fails to supply the cerebrum with blood; and hence that the most profound unconsciousness, syncope, or even death itself, proves nothing as to the presence of the anaesthetic in the circulating fluid.

Four cases remain in which a sudden onset of tachycardia (rate 200, and in one 220) resulted, all due to elimination. In one of these the chloroform was stopped when the rate of the heart was 160, a fact sufficient in itself to suggest a doubt as to whether the anaesthesia was satisfactory. In two the tachycardia appeared as the patient was emerging from apparently profound narcosis, in one after artificial respiration, and in the other after pulling forward the tongue. In the former of these the tachycardia ended by an instantaneous drop from a rate of 180-200 to one of 90, the action at the same time continuing regular. The other we may notice in some detail. In this case a good many minutes after the operation had been commenced, and when I was assisting the surgeon by holding the knee forward, etc., the chloroformist pulled the tongue forward, and on looking at the patient I saw but the slightest abdominal respiration. On now auscultating the heart I found the rate 44, but between each beat there seemed to be an indefinable sound. This, I believe, was an imperfect second of coupled beats, for in about half a minute these were quite distinct, the pulse being 44, and heart 88. This lasted but a short time, when, the chloroform having now been left off for two minutes or more, tachycardia suddenly ensued, rate 180 to 200; sounds comparatively loud. In about a minute and a-half sudden slowing and irregularity took place, and the patient retched a good deal. The irregularity changed again soon to tachycardia of 152, and this shortly gave place a second time to slow and irregular action. At this period I also observed that the pupils were considerably dilated, and that there was a distinct pulsation in the jugular vein. The heart soon became regular, 96.

A special feature in this case was the occurrence of tachycardia at two distinct periods, alternating with brief periods of irregularity. Although it is the only case in which I have met with this in the human subject, it is curious that it is of common occurrence in cats during the elimination of chloroform, and a Committee, of which I am a member, which has been investigating this subject in Glasgow, have obtained a blood pressure tracing in an identical case, and have recorded

² Snow On Anaesthetics, p. 192.

the facts revealed by the stethoscope as the cylinder of the kymograph revolved.

Two cases came under observation where the condition of the heart and pulse was worse than in either of the two last cases. One was an adult and the other a child, and for several minutes in both I could neither hear the heart nor feel the pulse, and in one of the two another observer tried the pulse for some time, and said he could detect none. Fortunately, as I am inclined to believe, neither the operating surgeon nor the chloroformist knew anything of the circumstance. Artificial respiration was not performed, and both patients did well.

The few cases in which tachycardia has hitherto been observed as a clinical affection have shown it to be very dangerous, and liable to end in sudden and fatal syncope. And it is in the midst of phenomena such as I have described above that syncope from chloroform is prone to occur. A rapid running pulse has sometimes proved to be the precursor of syncope, while in other cases we read that the pulse first flickered and then stopped. We seldom if ever find the frequency of the pulse stated in figures in these cases. The reason is obvious: the pulse in tachycardia may become a mere vibration or thrill, which can hardly be felt, much less counted, while the irregular action of the heart which so often follows it may produce no pulse at the wrist at all. The character of the pulse may be no index to the force of the cardiac action; it may be thready or imperceptible when the heart is thumping as if it would burst through the chest wall. It seems reasonable, therefore, to suggest that the above descriptions of the pulse apply to the tachycardia which may ensue during the elimination of chloroform, and, if any doubt remain on this head, I appeal to the phonendoscope and further investigation.

I must be content with a mere allusion to the last stage of our inquiry—namely, as to the action of the heart in connection with sickness and vomiting after chloroform. I am not aware that this subject has received any special attention, and the result of auscultation in these cases took me by surprise; for I found that immediately after retching or vomiting there might occur very considerable acceleration of the heart on the one hand or irregularity on the other. I have noted such rises in rate as from 110 to 152, 96 to 144, 108 to 176, and 72 to 160. In one case, noted as slow and irregular before vomiting, there was a rise in a few seconds to 172. In such cases there was generally also a marked increase in the loudness of the sounds. The heart generally slowed down again to its previous rate in a few minutes. When the heart became irregular in these circumstances the coupled beats were liable to occur. In one case of irregularity a sudden transition took place to a regular rate of 176. In considering the significance of these facts, let it be remembered that fatal syncope has sometimes occurred under these circumstances. The cases observed seemed to countenance the idea that patients whose hearts had previously exhibited peculiarities of action were most liable to after-sickness.

It is evident that the effects on the heart which may be produced by chloroform, as described in this paper, must be referable to one or both of two causes—either (1) to susceptibility on the part of the patient; or (2) to the method employed. It would appear that the following are indications of dangerous idiosyncrasy: (1) Forcible impulse of the heart, with loudness of one or both sounds; (2) irregularity of the heart before inhalation; and (3) liability to tachycardia or irregularity during inhalation. In the last case there is reason to fear a return of the same symptoms in a worse form during elimination. If we might judge from a few cases, syphilitic subjects seemed to be liable to dangerous results.

If I may venture to add a word on administration I must say that I have often seen two faults in it. First and most important is the fault of stopping in superficial anaesthesia; the second, that of exhibiting an unnecessarily strong vapour at the very first. I cannot but believe that by avoiding these faults evil effects on the heart would be reduced to a minimum, and to determine whether we attain this object we must avail ourselves of the help of the phonendoscope.

Dr. W. R. GOWERS, F.R.S., has been elected an honorary member of the Société Psychiatrique Néerlandaise.

A CASE OF CHYLURIA.

By HENRY J. DAGGETT, M.A., M.B.,

Boroughbridge, Yorks.

CASES of chyluria occurring in India and due to the presence of the ova of the *filaria sanguinis hominis* are recorded in the textbooks. Little reference is made, however, to those rare cases of chylous urine which are met with from time to time in England, and which are not dependent on the presence of the filaria or their ova. The pathology of this condition is apparently little known. I venture to think, then, that the following short notes may be of interest.

W. S., aged 52, a farmer, came to me on September 1st, 1896, with the history of passing urine of a white colour. He told me that this had been going on, practically without intermission for some three years, but that the white colour varied in degree, the urine being of a darker and more natural colour at one time than another. He had never consulted anyone about his condition during these three years as his health did not seem to suffer. In fact when I first saw him he expressed himself as "never feeling better in his life." The reason why he came for advice was that his wife worried. A sample of urine proved to be a pure milky white fluid, with hardly any smell, alkaline in reaction, specific gravity 1015. There was a distinct white opaque curd settled at the bottom of the vessel. This dissolved to a great extent after keeping the urine for a day or two. Microscopical examination revealed a few leucocytes and red blood corpuscles, also some crystals of triple phosphate intermingled in a finely granular groundwork.

The patient is a thin but particularly "wiry" little man, of a very active and hard-working habit of life. He occasionally, as I understand, gives way to intemperance in drink. He has never at any time lived out of England. At a second interview with Mr. S. I learned that the general milky appearance of the urine was much worse during the hot weather, but that meals had not been noticed to affect it. On questioning him closely he admitted that he occasionally felt very tired and languid, but nothing more than that seemed to affect his general good health. Occasionally, too, he had some little difficulty in passing water, that is, he had had to strain a little before micturition. There was no increased frequency of micturition at night.

The above, then, I take it, is the case of a man passing chyle in his urine, the condition not being in any way due to the presence of the filaria.

There is evidently some leakage of the chyle from the lacteals somewhere along the urinary tract. Judging from analogy to tropical cases, I presume the leakage may be due to a "block" (with subsequent dilatation and rupture) somewhere in the course of these vessels. As to the cause of the block and where it occurs I am unable to make any suggestion.

Dr. Barrs, of Leeds, to whom a specimen of the urine was sent, has kindly interested himself in the case. He writes: "When examined the urine had all the appearance of ordinary milk or nearly so. It had undergone just a little putrefactive change, and was alkaline, specific gravity, 1015. Some small coagula (lymph) were at the bottom of the vessel after standing. Under the microscope it presented all the appearance of chyle."

An attempt was made to preserve a specimen for the Leeds School of Medicine Museum, but this unfortunately failed.

THE ROYAL INSTITUTION.—Among the courses of lectures to be given before Easter are twelve lectures on Animal Electricity, by Professor Augustus D. Waller, F.R.S. The Friday evening meetings will begin on January 22nd, when a discourse will be given by Professor Dewar.

A MEETING of the French Anti-alcohol League was held in Paris in the Great Theatre of the Faculty of Medicine on December 6th, under the presidency of Professor Brouardel. Addresses were delivered by Dr. Laborde (on The Physiological Effects of Alcohol and Spirituous Drinks, with experiments) and by Dr. Legrain (on The actual State of Things as regards Alcoholism in France).