

through the usual stages of activity, decay, and re-utilization; while the silicious brain and the asbestos nerves quivered with sensations of pleasure for ever denied to us combustibles. Yet it is not too much to claim that no sufficient reason can be given for confining the material out of which sentient beings can be constructed to the four type elements above referred to; nor is there any reason apparent why a gradual change in the organs of assimilation as well as in the material assimilated should not accompany and compensate all gradual changes in the outside world, thus rendering the thread of life continuous through beings more diverse than any that we yet know.—*American Naturalist*.

ON THE SOFTENING OF MAGNESIA-HARD WATER.

By J. GROSSMANN, Ph.D.

I HAVE lately had an opportunity of making some experiments on the softening of so-called magnesia-hard water by Clark's process. Although from a theoretical point of view there is no reason why such water should not be softened as easily as ordinary (lime-)hard water, it was thought convenient to try the experiment on a somewhat large scale, especially as I have not been able to find that any experiments on the softening of magnesia-hard water have been published before in detail.

The water in question is pumped from a colliery at Collins Green, near St. Helens. The bottom of the well is about 96½ yards from the ground, and I give for completeness sake the different strata, as well as the quantity of lime and magnesia per hundred, which hydrochloric acid dissolved out of them, the samples being previously dried at 240° F.

	P.c. CaO.	P.c. MgO.	Yards.
Depth of alluvium and clay from surface of ground to top of the red sandstone.....	—	—	17
New red sandstone.....	0.16	0.24	34
Yellow sandstone.....	0.10	0.22	13
Compact red sandstone.....	4.72	0.37	12
New marl or metal.....	2.16	0.52	6
Dun rock.....	0.40	0.46	1
Coarse porous red sandstone.....	1.88	0.27	13
Coarse red sand.....	0.72	0.32	½
			96½

This water is organically very pure and contains only small quantities of chlorides and sulphates. The hardness is almost entirely temporary, though in estimating the permanent hardness it is sometimes difficult to remove the lime and magnesia by boiling. I may as well point out in this place a common fallacy, which is that hard water by being boiled before being used for domestic purposes becomes soft. As it is generally only heated to boiling just before being used for washing or cooking it makes not much difference in the hardness of the water. The following is taken from the sixth report of the Commissioners appointed in 1868 to inquire into the best means of preventing the pollution of rivers. Thirteen samples of water drawn on thirteen different days from the kitchen boiler of a dwelling house, and from that of the Athenæum Club, were found to be usually nearly as hard as the cold water with which those boilers were supplied, as is seen from the following results:

Hardness of cold water.	Hardness of hot water.	Hardness of cold water.	Hardness of hot water.
14.6	13.6	15.4	14.3
14.4	13.9	15.9	11.9
14.4	13.4	16.1	11.9
14.6	11.6	18.7	18.4
14.6	7.6	18.7	18.6
14.4	11.7	18.7	18.4
14.4	12.1	—	—

I boiled Collins Green water that tested 27.8° total hardness in an ordinary tea-kettle for five minutes, and even that exceptionally temporary hard water tested then still 17.6° total hardness. The experiments for softening this water by Clark's process were made in two series; in the first milk of lime was used, and in the second lime water. The milk of lime was prepared by mixing 5 lb. of slaked lime of 70 per cent. CaO with 6 gallons of Collins Green water. In performing the softening of the water the milk of lime was gradually added to the water during the operation, the mixture being well agitated during the whole experiment.

In three experiments the hardness was reduced from 23.3°, which the water tested originally, to 5.0°, 5.5°, and 5.7°. The total solids were reduced respectively from 33.9 to 13.0, 33.6 to 12.2, and 33.6 to 13.6 grs. per gallon. The softened water, after it had been standing in stoppered bottles for a few days, formed a little deposit, and its hardness was then 3.5° in all cases. The analysis showed that then the lime had been reduced from 9.13 to 1.62; the magnesia from 5.23 to 0.23 gr. per gallon.

There were used on an average 1,465 gallons of water to 3.5 lb. of CaO, corresponding to 2.67 lb. of lime of 90 per cent. per 1,000 gallons. Theoretically to precipitate the lime and magnesia as far as I have done in my experiments would require 2.31 lb. of CaO per 1,000 gallons.

The experiments for softening with lime water were carried out in a similar way. A measured quantity of the lime water was put into the mixing tank, and the Collins Green water run into it until nearly all the lime of the former was taken up, which in these experiments as well as in those with milk of lime was ascertained by the well-known silver test. The mixture was well agitated during the whole experiment. A great advantage in working with lime water is that it requires less agitating than working with milk of lime.

In four experiments the hardness was reduced from 23.3°, which the water tested originally, to 3.5°, 3.3°, 3.5°, and 3.5°. The total solids were reduced respectively from 34.3 to 12.0, 34.4 to 11.2, 34.6 to 12.0, and 34.7 to 11.2. The lime had been reduced from 9.07 to 1.67, and the magnesia from 5.24 to 0.18 grs. per gallon.

There were used on an average 1,670 gallons of water on 530 gallons of lime water, which latter having been exposed to the air for some time before being used tested only 69 grs. CaO per gallon. This corresponds to one volume of lime water of 60 grs. CaO per gallon to 3.15 volumes of Collins Green water, or corrected to 90 grs. of CaO per gallon, which strong lime water should contain, the proportion of lime water to Collins Green water would be 1 to 4.72. This result is not quite correct, as the lime water had undergone a further susceptible decomposition while lying in the mixing tank; so that at the time of its action on the Collins Green water it contained less than 60 grs. CaO per gallon. Both in working with milk of lime and lime water the softened water settled perfectly clear after three to five

hours, taken from the time that the agitation was suspended.

From these experiments it follows that magnesia-hard water softens as well and as easily by Clark's process as ordinary (lime-)hard water.

I wish to point out here that in my opinion, with our present knowledge of the behavior of magnesia-hard water toward soap solution, the hardness test in cases of water of that description cannot be relied on in any way. Mr. Wanklyn, in his book "On Water Analysis," says that magnesia takes up as much soap as 1½ equivalents of lime would take up. If that were so the Collins Green water should have tested 35.9° total hardness, instead of 23.3°, which it gave on the most careful testing. It will be noticed that this is even less than the water would require if it contained an equivalent of lime for the magnesia present; for the calculated hardness would then be 29.4°. It appears to me that in the case of magnesia-hard water a determination of the lime and magnesia is the only means of showing the quality of the water. On the other hand, I quite agree with Mr. Wanklyn in putting little reliance on the distinction between temporary and permanent hardness, unless the estimations have been performed very carefully; and there are cases in which, even with the most careful working, figures for temporary and permanent hardness may be got which are not trustworthy.—*Chemical News*.

THE INTRAVENOUS INJECTION OF AMMONIA.

By GASPAR GRISWOLD, M.D., House Physician to Bellevue Hospital, New York.

DURING the winter of 1877-78, while serving as assistant in the physiological laboratory of Bellevue Medical College, I made a number of experiments upon dogs with reference to the action of intravenous injections of ammonia. For this purpose I used the ordinary aqua ammonia (containing ten per cent. of ammonia gas), diluting it with an equal bulk of water. This solution, if dropped upon the tongue, is highly pungent and irritating, but does not vesiculate, the stinging sensation caused by it passing away entirely in a few minutes. I chose for experiment dogs in whom the viscera had been exposed for purposes of vivisection, and who had become exhausted with loss of blood and the depression attending the entrance of cold air into their thoracic and abdominal cavities. I waited, in such a case, until the heart had almost ceased to beat, its rhythm being disturbed, and its inefficient contractions no longer deserving to be called pulsations. I then injected into a convenient vein half a drachm of ammonia solution. After a period varying with the distance of the vessel selected from the heart, and with the rapidity of the circulation in the particular case, a marked change was observable.

The heart had a moment before been dark and congested, its right cavities engorged, and the contraction of its fibers weak and uncertain. Suddenly the systole acquired a new energy, which emptied the distended right ventricle into the lungs, and filled the aorta with fresh oxygenated blood; the heart itself became bright red again as the new supply flowed in through the coronary arteries. It is impossible to do justice to the striking picture presented by these phenomena as they rapidly succeed each other beneath the eye of the experimenter. The circulation was almost immediately re-established, and the animal, if anæsthesia were not too complete, moved and showed signs of life. In the course of fifteen or twenty experiments I never failed to obtain the result above described.

In my wards in Bellevue Hospital, I have several times injected one drachm of ammonia solution into the veins of patients apparently moribund, and have always succeeded in stimulating them much more powerfully than I could do by other methods. The prompt and marked effect in some cases is almost startling to those who have been accustomed to see hypodermic injections of whisky and ether, inhalations of nitrite of amyl, etc., employed to no purpose under similar circumstances.

On one occasion a man came in a great hurry, having been notified that his brother was dying of phthisis in one of my wards. Notwithstanding his haste, the sick man was already moribund and unconscious when he arrived. Pitying his disappointment at being too late for a few last words, I injected a drachm of ammonia solution into my patient's cephalic vein. In five minutes the man who had appeared almost dead was sufficiently restored to speak, and half an hour elapsed before he again became unconscious. The effect of the stimulant was so marked that I had some difficulty at first in convincing the astonished visitor that his brother had not "taken a turn and was getting well again."

Case.—Man forty-five years of age, with cirrhosis of liver and ascites. Has been tapped three times, fluid reaccumulating rapidly; has grown weaker very fast during the past three weeks; now dying of asthenia; unconscious; pulse scarcely perceptible; surface cold and moist.

1st. Six half drachm doses of whisky administered hypodermically. No effect.

2d. Six half drachm doses of ether administered hypodermically. No effect.

3d. Inhalation of ammonia. No effect.

4th. Inhalation of nitrite of amyl. Slight increase in force and rapidity of pulse. No sign of returning consciousness.

5th. One drachm of ammonia solution injected into a superficial vein of forearm. In twenty seconds increased action of heart. Pulse good at wrist. In three minutes patient answered incoherently something about being uncomfortable, and tried to turn on his side. Could be roused, and his attention attracted, for about fifteen minutes; then became unconscious again. Died half an hour later.

Case.—Moribund from phthisis. Unconscious; heart acting very feebly. Intravenous injection of ammonia caused the heart to act vigorously, and partially restored consciousness for about ten minutes.

Three cases, like the last, presenting no feature worthy of special description, but important as corroborative evidence.

The next case deserves more careful attention, being the first in which I have been able to observe the patient long enough to satisfy myself that no bad effects follow the injection of ammonia directly into the circulation.

Hester Mahar, aged forty-seven, Irish; single. Admitted to Bellevue Hospital, April 29th. On admission there was ascites, which had commenced a month before, and was probably due to cirrhosis of the liver. Right pleural cavity nearly full of fluid, heart displaced to the left. No evidence of cardiac or renal disease. Patient very weak, and compelled, from dyspnoea, to maintain a sitting posture. Abdomen tapped, seven quarts and eight ounces of clear serum

withdrawn. Patient much relieved. Stimulants and nutritious diet ordered.

May 1st.—Patient very weak. Does not seem to suffer much from dyspnoea, though the right side is nearly full. Considered advisable to postpone thoracentesis until the patient is stronger.

May 3d.—Patient still very weak. Dyspnoea not marked.

May 4th.—Called by nurse to see patient. Found her breathing very little; weakness seeming to obscure the expression of dyspnoea. Almost unconscious. Cannot be made to notice anything, or swallow what is put to her lips. Fluids poured into her mouth run out again. Eyes vacant, pupils dilated; jaw fallen; tongue dry and brown.

Thoracentesis performed with the assistance of three members of the house staff. Ninety ounces of clear serum drawn off.

During the operation, which lasted about twenty minutes, fifteen or twenty half drachm doses of whisky were administered hypodermically. In spite of these efforts at stimulation, the pulse, which had before been weak, disappeared entirely at the wrist. The impulse of the heart could scarcely be felt over the præcordia, and the respirations were shallow and ineffectual, not seeming adequate to the inflation of the lung just relieved from the pressure of fluid. The condition of the patient was so unpromising that my colleagues of the house staff, who had been assisting me, were of opinion that she was dying, and that further treatment was useless, and even absurd. Expressing themselves to this effect, they left me, giving up the case in their own minds, and taking no further interest in the matter. While I was obliged to admit that the case was hopeless, judged by ordinary standards, and beyond the reach of ordinary stimulants, I could not help feeling that heroic measures were specially indicated. The source of trouble—fluid compressing a lung and displacing the heart—had been removed; if the patient could be stimulated to breathe deeply, and profit by its disappearance, there seemed to be good reason to hope for her recovery.

Selecting a prominent superficial vein in the radial region, I exposed it by an incision through the skin. I then injected slowly into it a drachm of ammonia solution, taking care that the point of the hypodermic needle was free in the lumen of the vessel. This done, I placed my hand over the patient's heart and waited. In fifteen seconds I felt a marked increase in the force of pulsation. In about two minutes there was a strong pulse of a hundred, which was plainly perceptible at the wrist. A minute later the patient sighed deeply; the color came back to her lips; her eyes moved and began to show signs of returning intelligence. On being urged, she swallowed without difficulty two ounces of strong egg-nog. After a few deep inspirations, she breathed more regularly and easily; her pulse was strong and tense, ranging between 100 and 110. Half an hour afterward she was perfectly conscious, and reported herself comfortable, though weak. Pulse 90, regular and strong. Respirations 26, easy and natural. Swallowed easily and willingly small quantities of egg-nog. During the afternoon and evening patient continued to improve. Pulse 80-90, and strong. Respiration 20-30, and easy. Patient passed a good night, sleeping most of the time. Was bright and refreshed in the morning.

May 7th.—Steady improvement since last note. Sat up for two hours to day and ate a lamb chop with relish.

May 17th.—Patient sits up nearly all day and is gaining strength.

N. B.—Improvement has been uninterrupted since the injection of ammonia. No depression has been observed following the stimulant action of that remedy, nor has there occurred an unpleasant symptom which could be attributed to it.

The cases described seem to satisfactorily establish:

1. That the intravenous injection of ammonia is a prompt and powerful means of stimulation, acting efficiently in cases where other measures are of no avail.

2. That no bad effects follow its employment.

While the importance of the above deductions is obvious as a matter of general therapeutic interest, they seem to have a special significance in connection with those operations whose object is the removal of mechanical obstructions to respirations—I mean thoracentesis, and more particularly laryngotomy and tracheotomy. Thoracentesis is not, perhaps, very often an emergency; but laryngotomy and tracheotomy, done in cases of croup, oedema glottidis, etc., generally fail to save life, because performed too late—the patient being too much exhausted to breathe in the air for which a new entrance has been made. Artificial respiration, hypodermics of whisky and ether, cold affusions, etc., are resorted to in vain in many instances—the machinery of life cannot be set in motion again, and the cases die for want of efficient stimulation. Now, would not the intravenous injection of ammonia, in connection with artificial respiration, save many of these patients? It being proved that the treatment is without danger and followed by no bad effects, this question should not long remain unanswered.

In conclusion, I would call attention to the fact that it is not easy to perform intravenous injection through the skin. The vein collapses under the necessary pressure, and the needle is apt either to stop short and not enter the vessel at all, or to transfix it and direct the injection into the cellular tissue beyond. The only safe method to pursue is to dissect down upon the vein and expose it; the needle may then be carefully introduced until the point is felt free in the interior of the vessel.—*Medical Record*.

REMARKABLE FIRE CAUSED BY LIGHTNING.

In the storm of June 11th, at 10.30 A.M., lightning struck on the extensive wharf, of 1,000 feet front on the Schuylkill river, at the petroleum refinery of the Atlantic Refinery and Storage Co., located at Point Breeze, about four miles south of Market street, Philadelphia. This company has the most extensive petroleum refinery in the United States, and perhaps the largest in the world. Some accounts state that the electricity first struck the can store-house on the wharf. Others, with more probably correct statement, declare it struck first an immense pile of about 30,000 tin cans containing refined petroleum, exposed uncovered on the wharf, ready for shipment. Each wooden case contained two five gallon cans.

The *American Exchange and Review* says: The pile of cans was more probably the point of origin of the fire, because there was in it a great mass and large surface of metal to attract electricity, while all the buildings and tanks were well protected by lightning rods.

[There was, of course, the usual percentage of leakage from the cans, and we think it probable that the light vapor from the petroleum, which rises to a great height, formed the conductor which directed the lightning to the cans.]