

**An experimental enquiry into the effects produced by hydrocyanic acid upon animal life, with an aattempt to determine the real value of presumed antidotes and remedies.**

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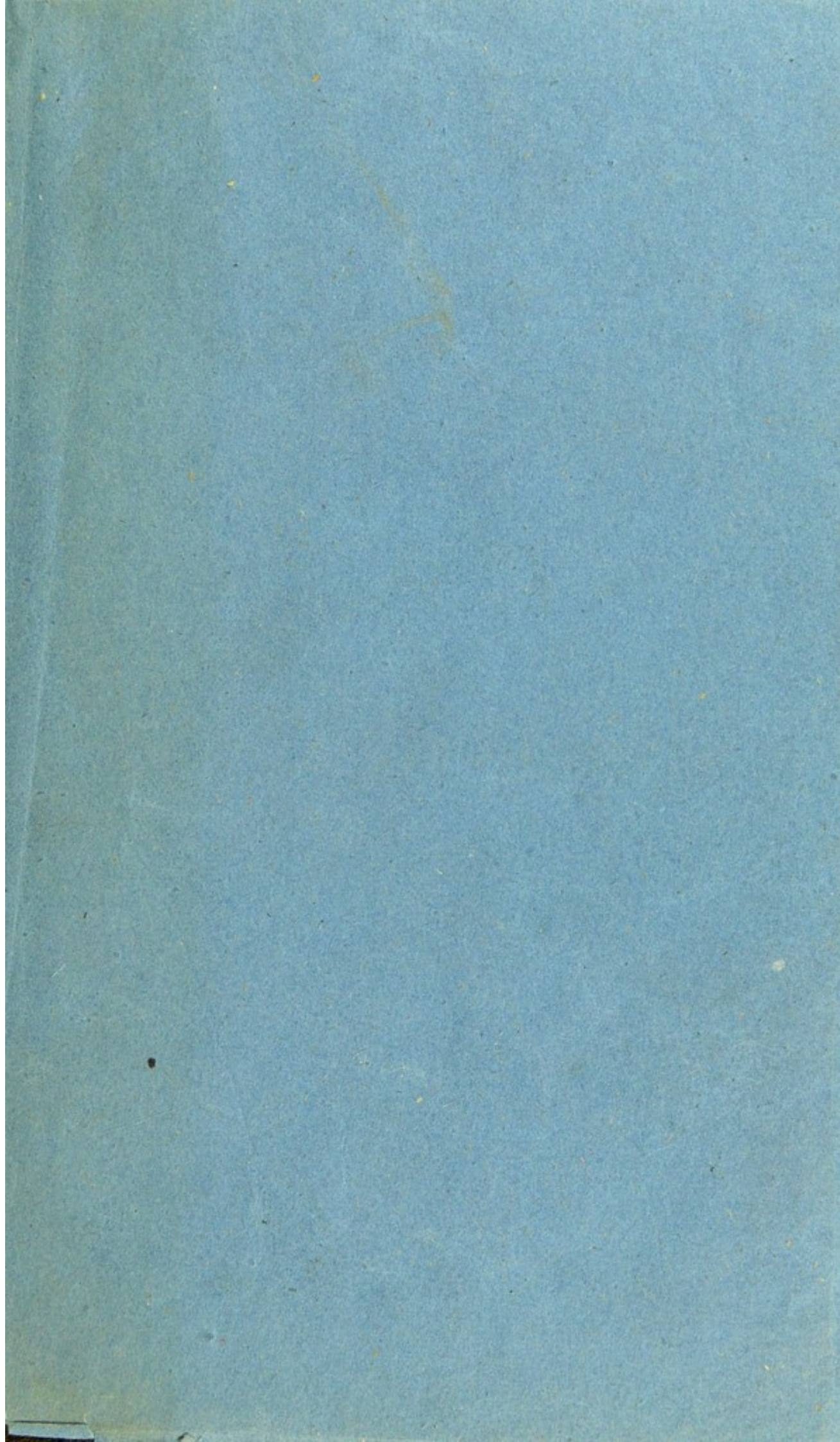
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# EXPERIMENTAL INQUIRY

INTO THE EFFECTS PRODUCED BY

# HYDROCYANIC ACID

UPON

# ANIMAL LIFE;

WITH AN ATTEMPT TO DETERMINE THE

REAL VALUE OF PRESUMED ANTIDOTES & REMEDIES.

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AN  
EXPERIMENTAL INQUIRY  
INTO THE  
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Though the deadly effects of hydrocyanic acid upon animal life have been for so many years known to the profession, and the facility with which it may be used as an instrument of destruction by the suicide or murderer fully recognized, it is only within a comparatively recent period that the public have become sufficiently familiar with its properties to choose it as a means of death in preference to the other methods of getting rid of life. The knowledge, however, which had been gradually, but surely, becoming widely distributed, has within the last two years, in consequence of the great publicity and notoriety given by the journals and newspapers to two or three trials where the acid had been the cause of death, (particularly those of Belany and Tawell,) been so forced upon every person, that a sort of popularity has been given to hydrocyanic acid; and for the future, or, at least, for some time to come, we may expect to meet with many cases in which it has been used. It appears, indeed, by no means improbable that it may as frequently be employed as arsenic and other mineral preparations, and it becomes, therefore, of the utmost importance to determine the precise effects of it upon animal life; whether these



are always uniform or not; what dose may destroy life; if the same dose always produces the same effects; if the effects vary according to the quantity taken, or to the manner and mode in which it is exhibited; if the degree of concentration or dilution alters the effects, and if there be any means of counteracting its action—if so, if we are to look for an antidote to the poison, or only to a remedy for the effects of it;—if to an antidote, what is the most potential; if to a remedy only, which should be selected. In fact, when called to a person suffering from the effects of a poisonous dose of hydrocyanic acid, what is to be done? Though many experiments have been made, and many cases of poisoning by hydrocyanic acid have been reported, it will, I apprehend, be readily admitted by every one who has attended to the subject, that upon some of these points the evidence is most contradictory, while upon others scarcely anything more than conjecture is known. If there be any who doubt this, I would refer them to the reports of the two trials above alluded to, and to the most recent works upon poisons for the truth of it.

Some years ago I made many experiments upon animals, (at the time of the trial of the druggist at Leicester, in 1829,) and at various times since. I had given the acid to different animals without, however, having arrived at any definite result, when last year, soon after the trial of Tawell, and occasioned, I have every reason to believe, by the parties reading and dwelling upon that, I witnessed within a few days of each other two cases in which hydrocyanic acid had been taken for the purpose of self-destruction. In one, the person after I had been with him some time, died;\* in the other, the man recovered, having taken the largest known dose of any one who has recovered.† In both the effects were so different in many particulars from what was commonly believed to be produced by hydrocyanic acid, that I was strongly impressed with the importance of something more certain being known. Soon after this, circumstances enabled me to institute an extended series of observations upon dogs. I determined to endeavour, if possible, to obtain more precise information upon the foregoing questions. The number of experiments made upon dogs is eighty, and upon other creatures (vertebrata and

\* *Provincial Medical and Surgical Journal*, July 23, 1845.

† *Provincial Medical and Surgical Journal*, August 13, 1845.



invertebrata,) still greater. To these I have added some made upon plants. I am aware it may be objected that the effects of the acid upon animals is different from what it is upon man. To this objection I attach little value, as from what I have seen of the effects of the acid upon warm and cold-blooded animals, as compared with what I witnessed in the two cases of poisoning which I have seen in men, and the accounts of other observers, as well as from analogy, I believe the action is essentially the same upon all, and that inferences drawn from experiments upon animals, of which the dog, from his not very dissimilar organization and diet is, perhaps, as favourable, if not more so, than most others, if fairly deduced, are in their application to man to be relied upon.

I shall, in the first place, put before the reader as concise an account as possible of many of the experiments, from which he can draw his own deductions. I shall then venture to add the conclusions which I have drawn from them. It may be stated, that during each experiment an assistant was present, who, like myself, was provided with a watch. He was placed at a table with pens and paper, so that each observation was recorded at the moment it was made. This will account for some of the expressions used. Some may think the time is stated with unnecessary precision and minuteness, but it must be borne in mind that the exact period at which effects are produced is not only one upon which there is the greatest contradiction, but which is one of the most important. In all cases where the strength of the acid employed is not mentioned, it was Scheele's. This I selected as that most generally met with in this country, and consequently of the strength most likely to be employed in poisonous doses by the public. It also is of a convenient degree of dilution. The acid used in many of the experiments was obtained from Allen and Co., Plough Court; in the remainder, from Gale, Baker, and Co., Bouverie street. In both cases it was recent, as I am informed by both was of the exact strength of Scheele's acid, viz., five per cent. of real acid, and I did not observe any difference in the effects. The strong acid I made by distilling at a low heat ten drachms of Scheele's acid, until two drachms had passed over into a receiver kept constantly as cold as possible; it, therefore, should be equal to twenty-five per cent. of real acid, or four drops to one of anhydrous



acid. Throughout the following pages I have purposely not made any reference to the experiments of others, not that I undervalue them, but my object was to experiment for myself, and not merely to echo those of others; besides this, I must, in truth, add that it was not until some time after the whole of those upon the dogs had been made that I had seen the account of the longest set of experiments with which I am acquainted—those of Dr. Lonsdale. Though some of his and mine are somewhat like, his object was, in a great measure, different from mine, not nearly so extensive, and from some of his opinions upon a most important point I differ materially.

No. 1.—Strong, rather large, mongrel bitch (old). Gave two drachms of acid: in twenty-five seconds she fell, struggled hard, and howled very little; eyes prominent and pupils excessively dilated; mouth intensely red; jaw rigid and closed until one minute, when it fell, and the muscles became relaxed; heart ceased to beat in two minutes and a-half; during the last minute the dog had scarcely moved or breathed.

No. 2.—Full-grown rough terrier dog. Gave one drachm of acid: he ran about distressed, staggered and fell backwards in thirty seconds, limbs very rigid and stretched out; eyes exceedingly prominent and pupils dilated; mouth very red; one minute and a half flaccid; heart continued to beat exceedingly quick and very feebly until three minutes; there was no other sign of life after one minute and a-half.

No. 3.—Strong terrier dog (old). Gave one drachm of acid: he ran away, fell in twenty-five seconds, struggled for one minute, then lay still till three minutes, when he moved once; heart ceased to beat at five minutes, having breathed only three or four times; neither urine nor fæces passed; no noise made.

No. 4.—An active half-bred small terrier. Gave forty minims of acid: it ran about, wagged its tail when spoken to, and followed the man about the room; fell backwards in one minute and a-half; convulsed, but no rigidity; mouth open, tongue protruded, and quite scarlet; dead in three minutes and a half; no howling.

No. 5.—Gave forty minims of acid to a fat spaniel dog, of moderate size: he licked his lips and stood still, as though



confused and stupid; respiration short and hurried; the eyes immediately started and became prominent, with the pupils much dilated; he soon staggered and fell backwards; jaw fell and tongue protruded; fæces passed, but not urine; he was convulsed, but not violently so; no indication of life after three minutes; there was no howling, and he scarcely moved from the spot where the acid was given.

No. 6.—Strong dog. Gave thirty minims of acid, not quite the whole swallowed: he ran bounding off, wagging his tail, playing, and following a person who ran quickly about the room calling him for thirty seconds, then fell; urine passed; no noise; mouth intensely red; continued rigid and convulsed for two minutes; did not stir nor breathe afterwards; heart continued to beat feebly until five minutes, and even for ten minutes more could be felt feebly fluttering.

No. 7.—Small mongrel (young). Gave fifteen minims of acid by mouth: it ran quickly away for about fifteen yards; suddenly stopped, stood still for a second, then fell backwards; struggled, but not greatly, and howled a little; ceased to breathe in three minutes, heart to beat in five; neither fæces nor urine passed.

No. 8.—A mongrel terrier, not fully grown (not so large as No. 70). Gave six minims of acid: in fifteen seconds it fell; urine passed; pupils dilated; mouth not very red; in ten minutes heart ceased to beat.

No. 9.—Small mongrel terrier bitch. Gave ten minims of acid: pupils almost instantly became widely dilated; in one minute fell backwards, perfectly rigid; mouth widely open, tongue protruded; heart acted with a sudden jerking beat thirty-five per minute: no appearance of life two minutes and a quarter after taking the poison.

No. 10.—Small mongrel bitch in pup. Gave ten minims of acid: soon affected; howled very little; in five minutes passed urine and fæces; in forty minutes heart ceased to beat; she lay still, at first breathing very slowly, then quickly.

No. 11.—Very large Newfoundland bitch. Gave three minims of strong acid, equal to fifteen of Scheele's, by mouth: in thirty seconds, breathed quickly and staggered; forty-five seconds, struggled hard; pupils not much dilated, purged; one minute and three quarters, strong convulsions; four minutes, able to support herself upon legs



when put up, and to crawl a few paces; pupils more, but not excessively dilated; seven minutes, respiration very rapid; nine minutes, able with assistance to get up and walk; passed urine freely; fifteen minutes, walks about, not much affected—did not lose consciousness. Gave three minims more of the strong acid by mouth: in forty-five seconds she fell, and struggled much; again purged; takes no notice of patting this time; lay about eight minutes, breathing slowly, without any other motion, when respiration became very rapid; twenty-four minutes, after lying until now, with hardly any motion, has got up and walked away perfectly conscious, and but little affected in the limbs. Thirty minutes, gave three minims more of strong acid by mouth; thirty seconds, fell; one minute, again purged; ten minutes, all consciousness and reflex action lost; twenty-five minutes, lies in the same state, perfectly still and powerless, but appears likely to continue. Put two minims into the eye, (twenty-five minutes after third dose and fifty after first); in thirty seconds, respiration deeper, about five per minute, then rigid; *pupils quite contracted*; again purged; did not breathe in two minutes and a-half after the acid had been put into the eye.

No. 12.—Same bitch as No. 40, to whom the acid twenty-four hours before had been given per vaginam. She continued dull, weak, and cold for some hours, with the saliva dribbling from the mouth, but now appears to be quite recovered; six minims, given by the mouth; while giving it she passed urine, apparently from fear and struggling; when set down she instantly ran quickly about and licked the vagina; in twenty-five seconds the breathing became quick; she then staggered, and fell in thirty seconds, lay still until one minute and a-half, then howled and lay still; at two minutes and a quarter she vomited thick frothy mucus, and soon recovered. Twelve minutes after, six minims more given; in twenty seconds she howled very loudly and struggled hard for one minute, then lay perfectly still; at six minutes heart ceased to beat.

No. 13.—Gave to a rather large, rough-haired terrier bitch, twenty minims of the same acid as that taken by Jackson, whose case I have reported in the *Provincial Medical and Surgical Journal*, for August 13, 1845, (sold as Scheele's, but containing three and a quarter per cent. of real acid.) She ran about for a minute and a-half, staggered, and then fell backwards; limbs convulsed;



pupils not excessively dilated until near death, the degree of dilatation, however, varied much; at five minutes after the acid had been given there was not much dilatation; urine, but not fæces, expelled; mouth open, tongue red and protruded; lived at least ten minutes; at first was rigid, then relaxed, again rigid, and before death perfectly flaccid; she began to breathe more freely, and seemed so to revive that I thought she would recover, but she died quietly; no howling.

No. 14.—Gave twenty minims of same acid as No. 13 to a small, half-grown mongrel dog: it licked its lips, ran about, and followed the attendant for a minute; fell forwards upon belly, with fore legs stretched out; no rigidity; mouth open; tongue protruded, but not very red, though the fauces were; eyes not very prominent, pupils dilated; howled, voice natural; urine passed; dead in two minutes and a half.

No. 15.—Moderate sized mongrel bitch. Gave one drachm of acid in two drachms of water; not more than half swallowed, being retained in fauces, as though these were completely paralyzed: dropped down without stirring; did not move until one minute and a-half, when she breathed; mouth not so red as usual; pupils dilated, but eyes not very prominent; heart ceased to beat in three minutes and a-half; the only other signs of life after the acid was given being one or two inspirations; no howling.

No. 16.—Small well-bred rough-haired terrier bitch. Gave forty minims of acid in four drachms of water; about a fourth part of it lost: ran about, but fell in about the same time as No. 4, (one minute and a-half;) much convulsed and rigid; body drawn forwards and the legs together; pupils not much dilated until near death, when they were fully so; eyes apparently not sensible to light, but the reflex action perfect, for when the cornea was touched winking was instantly induced; fæces expelled in small quantity; urine not, but the man said that she had passed water just before the acid was given; lived seven minutes and a half; no howling.

No. 17.—Small, half-bred, terrier bitch. Gave thirty minims of acid in two drachms of water; not more than half was swallowed: she ran some little distance under a form and fell backwards; howled much in a natural voice; mouth open and red; tongue out; pupils at first not much dilated, but afterwards excessively so; breathed



convulsively; heart at first beat slowly and convulsively, then quickly, at least 100 per minute; urine not expelled until shortly before death; lived nine minutes and a half; limbs before death as flaccid as possible, indeed, in most they became so.

No. 18.—Half-grown terrier. Gave ten minims of acid in one ounce of water: it fell instantly, without a struggle; mouth open, but not red; eyes not prominent, pupils dilated; at one minute and a-half breathed very slightly. This was the only indication of life, even the pulsations of the heart being scarcely perceptible.

No. 19.—Strong rough-haired terrier bitch. Gave fifteen minims of acid diluted with three drachms of water, introduced by means of a funnel into the vagina; only a small quantity remained: she ran about, but the hind legs were weak; there was no convulsion nor loss of consciousness; in five minutes, she vomited some thick white frothy mucus. Seemingly being perfectly well in fifteen minutes, I introduced two drachms of undiluted Scheele's acid into the vagina; she ran about, and once or twice licked the vagina; the hind legs almost immediately became very weak, and were dragged; she soon staggered; in one minute, the respiration was hurried; the mouth open and red, tongue protruded; eyes prominent, pupils dilated and insensible to light; fell in one minute and a-half; rigid for a minute, then perfectly flaccid; no motion, except slow and convulsive respiration. At the moment of inspiration the limbs were moved, especially so at six minutes, which was the last inspiration; heart continued to beat for two minutes more; both urine and fæces expelled. In this case the eyes were not so prominent, nor the pupils so much dilated, as often. The redness of the mouth evidently, in a great degree, depends upon two causes,—one the violent contraction of the muscles, for as soon as the rigidity ceases the redness in part disappears, being congestion—the other the local action of the acid, which acts by inducing dilatation of the blood vessels—stimulant?

No. 20.—Small terrier bitch, same size as No. 27. Gave thirty minims of acid per vaginam. The mouth was tied up with a piece of string, to prevent it biting; when set down it tried hard to get the string off with its feet; one minute, respiration very hurried; one minute and a half, passed urine very freely; at two minutes, introduced six grains of nitrate of silver in two drachms of water



into vagina; she became rigid, and lay with little sign of life; in four minutes, began to breathe slowly and deeply; strong liquor ammoniæ held to the nostrils; respiration more rapid, with rigidity; in seven minutes gave twenty minims of liquor ammoniæ in two drachms of water; nine minutes, heart ceased to beat, there being no other sign of life after seven minutes; pupils were not excessively dilated nor eyes very prominent or red; no howling.

No. 21.—Rough-haired otter dog, rather less than No. 19. Introduced fifteen minims of acid into the rectum: he ran about, hind legs soon became weak; staggered and fell in one minute; howled, but not so much as No. 19; respiration very hurried; tongue protruded; mouth open and red; after two minutes limbs ceased to be rigid; heart ceased to pulsate in six minutes; gave no indication of feeling when pricked by pins.

No. 22.—Mongrel dog, same size as No. 40. Gave six minims of acid in one drachm of water, by the rectum: he ran about as though nothing had happened; in two minutes fell, tried hard to get up again; whined, and moaned as though distressed from weakness but not in pain; sooner and more affected in the hind legs than in the fore legs; three minutes, pupils excessively dilated; twenty-five minutes, breath smells of the acid; thirty-five minutes, strabismus; thirty-seven minutes, slight convulsions, urine expelled and heart immediately ceased to beat. This dog continued to breathe freely until just before his death, and appeared to be improving; he was not sensible, and appeared to be in deep sleep, with the limbs powerless. I thought he would recover. He was not an old dog.

No. 23.—A very strong bull-terrier bitch (suckling). Cut a portion of the skin of the size of a sixpence out of the middle of the back, by means of a pair of sharp strong scissors; wound scarcely bled; dropped into it two minims of strong acid, equal to ten minims of Scheele's: in two minutes and a-half she passed urine, but was in no other manner affected; ran and jumped about, very pleased to be noticed; eighteen minutes, put into the wound two minims more of the strong acid, without the least effect, (she paid not the smallest attention to the wound, as though it were not felt;) thirty minutes after put upon the tongue



three minims of the strong acid; fifteen seconds, affected; thirty seconds, fell, struggled hard, then lay perfectly still, breathing slowly; four minutes, breathes quickly; eighteen minutes, conscious, but unable to stand; twenty-five minutes, breathes naturally and is recovering, though not able to use limbs; put two minims of strong acid into the eyes; twenty seconds, affected, breathing very quickly; forty seconds, rigid, fæces passed; two minutes, unconscious, reflex action lost, lay perfectly still; thirteen minutes, heart ceased to beat, there not having been respiration nor other sign of life for the two previous minutes.

No. 24.—A moderate sized, rough-haired terrier bitch, in pup. Put two minims of strong acid—equal to half a minim of real acid—to ten minims of Scheele's, into the eye: she ran down three steps and up again; twenty seconds, fell, howled very much, but struggled little; mouth, tongue, and eyes as usual, except, perhaps, mouth not quite so red. The eye into which the acid has been dropped is much more prominent, and the pupil much more dilated than the other eye; lay quite still until four minutes, when there was a strong convulsion,—again still; heart ceased to beat at eight minutes, there having been no other indication of life for two minutes before.

No. 25.—Same bitch as No. 71, after she had apparently lost all effects of previous dose. Gave five minims of acid by right eye: the pupil became instantly dilated; forty seconds, fell and howled excessively; mouth not red; breathed quickly, with rigidity of muscles, for one minute and a half; respirations then became less frequent, and for two minutes she lay as though dead; at eight minutes there was one convulsion, and heart ceased to beat in ten minutes. The dose by the eye produced much more decided effects than that by the mouth. Neither fæces nor urine passed, but these had been very freely evacuated shortly before.

I arranged a coil galvanic battery in good action ready to apply instantly.

No. 26.—An average sized mongrel terrier. Gave fifteen minims of acid: almost immediately respiration became hurried and it staggered; in less than a minute it fell; mouth open and red; tongue protruded; eyes prominent and pupils dilated; no howling;



galvanism applied immediately it fell; muscles all rigid; urine passed; heart ceased to beat in five minutes; the jaws opened and shut, as did the eyelids, as the connection of the wires was made and broken. In fifteen minutes the battery produced very little convulsion, the rigidity not having extended beyond the head after the first twelve minutes; one pole was applied within the anus, the other within the eyelids, ear, mouth, fauces, or nostrils; the appearance of life, beyond the convulsions ordinarily produced by the battery, did not continue longer than where nothing is done. In twenty minutes scarcely any effect was produced,—not nearly so much as in No. 29. In two hours not the least effect, at which time the jaws were very firmly fixed, and the muscles, especially those of the back, were excessively rigid. There was no howling.

No. 27.—Small terrier bitch. Gave thirty minims of acid in two drachms of water: she only moved a step or two, seemed paralyzed at once; howled slightly; galvanism applied in thirty seconds; muscles instantly very rigid; eyes excessively prominent and red, as was the mouth; so long as the connection was maintained the jaw was closed, when broken, it fell; urine expelled during rigidity, at two minutes and a half; heart ceased to beat in five minutes.

No. 28.—A very large strong savage bull bitch; she had pupped about sixteen hours before. She was so strong and violent that she had knawn through an inch and a-half plank to which she was fastened. Gave fifteen minims of acid in two drachms of water; not quite the whole was swallowed: when set down she fell, but immediately got up again, hung her head, breathed quickly and hard, ran about, staggered, and fell forwards; she tried hard to get up, but could not raise herself; she then fell upon the side and was still; galvanism applied in less than a minute. This rendered the muscles stiff and rigid, especially as the connection was made; pupils not fully dilated; head drawn backwards, and the mouth shut and opened as the connection was made and broken; respiration very quick and sighing; in two minutes she evidently felt the galvanism: the jaws were so firmly closed upon the wire that it could not be withdrawn while the connection was kept up; in four minutes she could see the wires, she tried to move the head away as they were brought near; in eight minutes she was able to get up, she walked about a yard and then stood still, as though she was afraid of falling, being scarcely able to



keep upon the limbs, but she was perfectly conscious and wagged the tail when spoken kindly to; she was very watchful and cautious; water was offered her but refused; a spoonful was now dashed in the face; she immediately voluntarily passed a large quantity of urine (she had not passed any previously,) and avoided any more water being dashed upon her; in ten minutes she walked about the room; respiration continued quick and laborious. I could not ascertain the state of the heart, as she was too savage to be handled; in a quarter of an hour she was perfectly recovered. I now tried to give ten minims of acid in three drachms of water, but not more than half of it was swallowed, as she struggled so violently; in a minute, she fell, and tried hard to rise but could not. Subjected to galvanism: muscles became rigid; heart's action feeble, and it soon ceased to beat; in six minutes only a little motion of the head and neck could be induced by the battery, and at the expiration of twelve, none; a little nodule of fæces passed; no howling.

No. 29.—A springer dog, same size as No. 26. Gave fifteen minims of acid at the same moment: it howled, staggered, and fell in less than a minute; urine expelled; mouth, eyes, and tongue as usual; still and motionless in two minutes; nothing done for twenty minutes, when galvanism was applied, as in No. 26; much more decided convulsions were produced than at the same period in No. 26; in another hour no effect was induced; after two hours only just becoming rigid.

No. 30.—Large mongrel dog (old and savage). Gave fifteen minims of acid in two drachms of water; nearly, but not quite, the whole swallowed: it soon fell; mouth open, tongue protruded; eyes prominent, pupils dilated; galvanism applied in less than a minute after acid had been given; immediately became rigid, and jaw closed; much mucus and foam at mouth; respiration hurried; urine expelled and a small bit of fæces; after six minutes no general convulsions, and heart ceased to beat; after twelve minutes galvanism did not produce the least effect; the muscles of the jaw and back remained very rigid.

No. 31.—Gave forty minims of acid to a black and tan terrier, of same size as No. 5, but not nearly so fat: it ran away to a corner of the room; respiration short and panting; staggered and fell



backwards; eyes prominent and injected, pupils dilated; shrieked loudly; jaw fell; tongue protruded; whole mouth very red; convulsed much more than No. 5; in four minutes it lay as though dead, except that the heart pulsated; head and neck plunged in cold water, it instantly breathed convulsively, and heart acted more vigorously, but the effect soon ceased, and although the plunging was several times repeated, after the second time no effect was produced by it; before death, and after the water ceased to produce any change, I opened a blood-vessel in the hind leg; the blood did not flow freely, no effect was perceptible from it; I thought life was prolonged by the cold plunging.

No. 32.—A rather small, half-grown mongrel. Gave fifteen minims of acid: it ran about for twenty seconds, but was unsteady; staggered and fell forwards; mouth intensely red; tongue out; pupils dilated, but not excessively so; seemed dying, when the head was plunged in cold water, it instantly breathed convulsively, the head was drawn backwards, and it howled in an unnatural voice. The effect of the water soon ceased; plunged successively three or four times, but no effect after the first time was produced; perfectly still in two minutes and a half, and soon afterwards the heart ceased to beat; urine expelled, but not fæces.

No. 33.—A large mongrel dog, in very poor condition. Gave thirty minims of same acid as Mr. A——— took: \* immediately he was let loose he ran to a bitch, No. 76, in the room, who was in heat, and licked the vagina; not the least effect produced by the acid; fifteen minutes after, gave forty minims of the same acid; no effect; twenty-five minutes, † having no more of the acid left, gave thirty-five minims of the Kirkstall‡ acid; he fell in forty seconds; struggled hard to get up; howled a little; convulsed, but not violently; mouth very red; six minutes, respiration rapid, upwards of one hundred inspirations per minute; eight minutes, head placed under a stream of water without effect; on being placed upon the legs slips down upon the belly, the legs slipping out extended and powerless; perfectly sensible; threatened to be beat

\* See case reported in the *Provincial Medical and Surgical Journal*, July, 1845, p. 461.

† This acid had remained in the possession of Mr. West; it had been excluded from the light, and was perfectly limpid.

‡ *Provincial Medical and Surgical Journal*, August 13, 1845.



violently with a piece of rope, and struck several times gently; though he sees the blow coming, and from his looks fears it, yet is unable to make the least effort to avoid it; eleven minutes, gave one drachm and a half of liquor ammoniæ fortis in one ounce of water; no effect; eighteen minutes, purged; twenty-two minutes, vomited a very large quantity of thick, frothy, slimy mucus; thirty minutes, having sufficiently recovered to move the limbs, though still unable to rise, (he had not lost sensation,) I gave ten minims more of the same acid; twenty seconds, struggled hard and passed urine, then convulsed for four or five seconds, afterwards muscles relaxed; three minutes and a-half, does not appear to retain sensation, but reflex action is not lost; nine minutes, lies perfectly helpless, and reflex action is nearly lost, pulsations of heart scarcely to be felt; died soon after.

No. 34.—Strong rough-haired, cur. Gave ten minims of acid: in thirty seconds, it fell backwards; in one minute, repeatedly dashed cold water upon him; convulsed, but not greatly, during one minute, then lay perfectly still, even respiration not perceptible, until five minutes; eight minutes, one long continued convulsion; until now had been perfectly motionless, except breathing deeply; thirteen minutes, heart ceased to beat; small portion of fæces passed, but no urine; did not howl.

No. 35.—A good-sized mongrel bitch, but not fully grown. Gave six minims of acid: she ran about, and fell in twenty seconds; mouth very red; pupils excessively dilated; thirty seconds, plunged into cold water; did not stir after forty seconds, though plunged repeatedly in the water; heart ceased to beat in five minutes; urine expelled, but not fæces.

No. 36.—A large bull-terrier dog. This was a most violent and ferocious brute, and one of the strongest dogs for his size I ever saw. The only way to hold him was by a pair of tongs with circular ends, which fitted round his neck: his mouth was forced open, and fifteen minims of Scheele's acid put into it. This took effect immediately; he did not move from the spot, but fell and struggled; breathed hard and quick; tongue protruded; mouth open and red; eyes prominent, pupils dilated, but not excessively so; heart beat vigorously; the limbs rigid; in five minutes he breathed better, and the muscles became relaxed; water now thrown in the face, and I thought he would recover; he continued to



breathe slowly, at intervals of about twenty-five seconds; water dashed in the face four times; he attempted to howl, but could not; pupils not so much dilated. He lived twenty-three minutes, the pulsations of the heart ceasing to be perceptible for at least three minutes before respiration ceased; the pupils were now excessively dilated. For a quarter of an hour I thought he would rally, and would have put his head into water, but he was so savage a brute that none dare touch him, lest he should suddenly recover; sensation was lost, or nearly so, for he gave no indication of it when pricked with a sharp point, but reflex action remained; a small nodule of fæces passed; not any urine, but this was passed just before acid was given.

No. 37.—Small full-grown mongrel spaniel dog. Gave five minims of acid by the mouth: in thirty seconds it fell, when it was placed under a cold water tap for ten seconds; howled loudly while under the douche, then lay as though dead; at two minutes, breathed for the first time since it howled once; at four minutes douched again, when it instantly became rigid, but perfectly flaccid on removal; at six minutes and a-half the heart ceased to beat.

No. 38.—Strong, smooth-haired terrier dog. Gave ten minims of acid in an ounce of water: thirty seconds, vomited; one minute and a quarter, turned round several times in succession, apparently dizzy; two minutes and a-half, passed urine, ran about for some time; six minutes and a-half, again vomited freely; eight minutes, unable to stand; passed urine again; muscles rather rigid and convulsed; ten minutes, cold water dashed upon him; when he got up, ran away, jumping over No. 78, and went staggering about, getting into the corners of the room; thirteen minutes, again vomited,—recovering. At half-past three p. m., nine hours and a-half after acid had been given, appears to be perfectly well. Gave thirty minims of acid in an ounce of water: he ran about the room, and *jumped across the top* of an open staircase; thirty seconds, fell and struggled hard to rise; rigid, with head drawn forwards; for one minute and a-half, *jaw firmly closed* until four minutes, when he vomited, and the muscle became flaccid; matter smelt strongly of acid; died at fourteen minutes, having only breathed a few times during the last few minutes; urine and fæces both passed.



No. 39.—Small mongrel spaniel dog. Gave ten minims of acid diluted with four drachms of water; the whole not swallowed, being retained in fauces, when let loose it came out: he ran about; respiration soon became hurried; in one minute and a-half, fell backwards and became rigid; howled slightly; mouth open, tongue protruded. In giving the acid the mouth was slightly wounded with the funnel; the blood was of a brick-red appearance; two minutes and a-half, limbs became flaccid and motionless; urine passed; respiration hurried and convulsive; twenty-five minutes, convulsed; lies with head thrown back; pupils rather contracted; perceives the light when the candle is held close to the eyes, but gives no indication of feeling; forty minutes, pupils less contracted; respirations, seventy-four per minute; lies perfectly still, as though in a deep sleep; forty-five minutes, pupils not now dilated; gave a good shaking, which roused him, and dashed water into the face, licked the lips; fifty-five minutes, put some water into the mouth, which was swallowed and induced coughing; at one hour the limbs continued perfectly paralyzed; no indication of sensation when pricked, but appears to hear a noise; sixty-five minutes, being supported, able to stand; moans feebly; is quite conscious; seventy minutes, has walked about two feet with great difficulty, the hind legs being wide apart and the fore doubled up, not having any command over them; seems perfectly aware of its feeble state, and likes to be petted; during the night it crawled about, but was unable to stand; seemed very cold, and sought warmth; was, during the night, two or three times seized with violent tremblings; would neither eat nor drink, but water was poured into the mouth two or three times, which it swallowed; the jaw was rigid. — Twenty-four hours after, is quite sensible and lively but is unable to stand; legs appear paralyzed; can crawl two or three yards upon belly. Subjected to the galvanic battery, when it seemed to move better, but it did not enable it to stand. I now gave it fifteen minims of Scheele's acid, when it immediately *ran about*, and fell in forty seconds; in sixty it howled very loudly; convulsed; eyes, mouth, and tongue, as usual; did not stir after two minutes and a-half; heart ceased to beat in five minutes; neither fæces nor urine passed.

No. 40.—Rather small mongrel bitch. Gave eight minims of acid in one drachm of water by the vagina, by means of a funnel;



not more than two-thirds passed in, and of this part immediately escaped. She ran about as though nothing had happened; in two minutes and a half fell struggling, and rose alternately; retched violently, and vomited thick frothy mucus; eyes prominent and red; pupils not excessively dilated; breathes with excessive rapidity, and cannot stand; five minutes and a half, plunged into water, then placed under a strong douche, so as to allow the water to fall down the back; not much effect upon the symptoms, but she appears to dislike it very much; seven minutes and a-half, tried to raise herself, but could not; douche used again; fæces passed, but no urine; twenty-three minutes, retched violently, but did not vomit; thirty minutes, peculiar spasmodic action in all the limbs, and head, and neck, which rapidly move in regular succession; thirty-nine minutes, got up, came and smelled at No. 43, and showed great disposition to lie down beside him; appeared cold; thick, frothy saliva running from the mouth; fifty-five minutes, pupils now excessively dilated. The symptoms were as similar as possible to those to whom the cyanuret of silver had been given; he did not lose consciousness nor sensation. (*Vide* No. 12.)

No. 41.—A young, not quite half grown, spotted coach dog. Put five minims upon the left eye, holding the lids open and apart, but not more than half of it passed in; conjunctiva became instantly red; thirty seconds, fell; one minute and a half, low continuous moaning, then howling; two minutes, all the limbs convulsed in rapid succession, as though galloping rapidly, the head being drawn backwards at the same time;\* pupils somewhat dilated; the left most so; seven minutes, appeared to be recovering, when it was placed under the cold douche, which seemed to stupify it; eight minutes, purged freely; twelve minutes, got up and walked off. Eighteen minutes, put three minims into the eye; fifteen seconds, it breathed hard, fell, and howled loudly; two minutes, struggled hard to get up, but could not; died soon afterwards.

No. 42.—A spotted coach dog eat some bread and butter, upon which cyanuret of silver, made immediately before by dropping a solution of nitrate of silver into distilled water containing twenty minims of Scheele's acid, had been spread; in two minutes and

\* The motion was very similar to, but not exactly identical with, that observed in No. 41.



a-half he passed fæces freely, which he also did afterwards; in three minutes and a-half he got hold of the paper in which the bread and butter had been wrapped, and, running about, chewed it; twelve minutes, is not so much disposed to run about; seems weak; breathes quickly, with the mouth open, which is red; in one hour he vomited a large mass of white frothy mucus mixed with food; quite disinclined to move; two hours, continues dull, but otherwise not affected.

No. 43.—Very strong and savage moderate-sized mongrel dog. Attempted to give by the rectum the cyanuret of silver made from twenty-five grains of the nitrate, but could not, as he struggled so hard that prolapsus of the gut came on, and the funnel became filled with fæces; then tried by the mouth, but before he took much he seized hold of the bottle out of which I was pouring it, (mixed with water,) bit this in two, and only had about a fourth part of it: he ran off, soon became affected in the breathing, and weak in the limbs; in eight minutes he was much distressed, and retched violently for at least two minutes, then vomited a large quantity of thick, frothy, bloody mucus, which relieved him; but he continued dull, heavy, and indisposed to stir, thick, frothy saliva draining from the mouth; thirty minutes, vomited again thick, frothy mucus, but not bloody; forty minutes, much the same; attempted to give twenty minims of acid by the mouth, but he again got his head loose and seized the minim measure, which he bit in two, and lost half of the acid; when let loose he ran away, but soon fell and passed urine; did not lose consciousness, nor all muscular power; five minutes, he suddenly raised his head and neck, but could not stand; now put ten minims of acid into his ear; this did not seem to produce any effect, and when put upon his legs ten minutes after he walked off; he was allowed to walk about for ten minutes, when I attempted to give him fifteen minims, but he again struggled so hard as not to swallow more than about seven minims; he now soon fell and was convulsed, but was not very rigid, nor were the pupils excessively dilated; he continued to breathe, alternately convulsed and flaccid for five minutes, when two minims were put into the eye; he *instantly* became more rigid, and was dead in two minutes afterwards.

No. 44.—Small mongrel bitch. Gave fifteen grains of cyanuret of silver, but she did not swallow the whole: tongue and mouth



became very red; three minutes and a half, begins to affect her; respiration hurried; urine expelled; retches; unsteady on legs; then sick; pupils very widely dilated; after sickness seemed to rally, but made constant attempts to pass urine; nine minutes, vomited violently, and brought up a large quantity of thick, white, tenacious mucus; up to this time had stood as though stupid and afraid of stirring, now lay down in a corner of the room; twenty-five minutes, has lain dull and motionless, with thick white saliva draining from the mouth; sat up on the hind legs, in a sitting position, in which it remained more than a minute without stirring, then fell and lay still. An hour afterwards, when one of the dogs howled, it was much frightened, started up, ran away, and was immediately sick.

No. 45.—A good-sized mongrel spaniel. Gave thirty grains of cyanuret of silver, but more than half lost: in three minutes the respiration was quick and the pupils dilated; four minutes, begins to be unsteady on the limbs; five minutes, retched violently, and after much straining brought up thick white frothy mucus; crept to No. 44, close to which it laid down, breathing very hurriedly, and continued to do so for an hour, most of which time it ran about the room, but the limbs were weak and unsteady; purged and often sick; was perfectly sensible, but appeared cold and desired to be petted; like the last it repeatedly strained to pass water after the bladder was emptied, and thick mucus-like saliva drained from the mouth. After waiting two hours I left them, No. 44 still crouched motionless in the corner, but quite able to move if forced to do so; No. 45 had crept under some sacks. For some hours these two dogs would not move unless forced; refused drink and food, the same thick saliva running from the mouth, but in the morning they had quite recovered and continued well during the day. The unsteady staggering and weakness in the limbs of these two dogs *closely resembled the reeling of a very drunken man*, the muscles having lost much of their force as well as power of combined action. The quantity of white thick mucus vomited by both dogs was large, and exactly alike. Twenty-four hours after, gave No. 44 eight minims of acid; she ran away, and fell; in forty seconds, struggled hard, became rigid, and remained so for one minute and a-half, during which she did not breathe, nor could the heart be felt; the limbs then became flaccid and motionless, the



respiration slow, and the heart's action tumultuous, then very quick and feeble, and the respiration hurried; these ceased in fifteen minutes, having gradually become slower; tongue, mouth, and eyes as usual, but eyes not quite so prominent nor red as often seen.

Twenty-four hours after, gave No. 45 six grains of nitrate of silver, in order to be certain of its effects; in ten minutes, it vomited, but not otherwise affected; thirty minutes after, gave five minims of Scheele's acid, but not all taken, as it struggled so hard; two minutes, began to breathe quick and stagger; vomited thick white tenacious mucus; ran staggering about the room, fell, and tried very hard to rise, but could not; eyes prominent and pupils dilated; six minutes, lies unconscious, breathing quickly and laboriously; ten minutes, becoming sensible; purged; twelve minutes, sat up with the limbs in a bent uncomfortable posture, but made no attempts to alter it; fifteen minutes, can just stand when placed upon legs, but cannot walk nor get upon legs; it is, however, recovering; twenty-five minutes, put two minims into right eye; in thirty seconds, affected; fell, struggled hard; attempted to howl but could not; during twenty minutes lay motionless and respired laboriously, but deeply, at first very slowly, afterwards rather better; head now repeatedly plunged in cold water; it instantly became convulsed and rigid, and the respiration quick; the effect soon ceased; twenty-five minutes, gave one drachm of liquor ammoniæ fortis (diluted) without effect; dead in thirty minutes after acid had been put into the eye. When this bitch began to move, after having the head plunged in water, the motions were peculiar, all four limbs were moved at the same time in quick succession, with a short rest between, and resembled the effect of electric shocks passed in quick succession. (See 40 and 41.) The struggling and unsteady walking were exactly like those dogs to whom the cyanuret of silver had been given, indeed, up to the falling the symptoms were the same.

No. 46.—Young bull-terrier bitch. Gave fifteen minims of acid, and instantly afterwards nine grains of nitrate of silver in three drachms of water: in thirty seconds she fell and became rigid; howled a little; the rigidity soon ceased, and she lay perfectly still, except at two minutes when the tail alone was violently convulsed; mouth and tongue as usual; the pupils dilated, but eyes not injected; at seven minutes the heart ceased to beat. During the



whole time she did not breathe more than four times, and after rigidity ceased only moved once.

No. 47.—A large water-spaniel dog. Gave twenty minims of acid and instantly (it being ready poured out and held in the hand ready,) nine grains of nitrate of silver in three drachms of water; in thirty seconds, respiration hurried; fell backwards and howled much in an acute shrieking voice; one minute, pupils not dilated; urine passed; four minutes, up to this time, since he fell, the respiration had been very slow, it now became hurried; eyes much injected, but pupils not much dilated; ten minutes, lies perfectly still, the heart beating irregularly; fifteen minutes, in the same state; applied ammonia to the nostrils, and put a little into the mouth; twenty-five minutes, respiration quick, very laborious, and panting; limbs rather stiff; gave half a drachm of liquor ammoniæ in water, which was swallowed, the limbs being moved once; thirty minutes, gave forty minims of liquor ammoniæ, which was swallowed, but no effect produced; was also well fanned without any effect; pupils dilated. As he had lain so long in the same state, and I had an engagement, I put five minims of Scheele's acid upon the left conjunctiva with decided effect; in fifteen seconds he was convulsed, and became excessively rigid for a minute, then relaxed; moaned; respiration much slower; conjunctiva very red and vascular; forty minutes, became rigid for a moment; heart's action and respiration ceasing together. When the solution of nitrate of silver was dropped into the mouth, this became covered with white flaky matter, evidently the cyanuret of silver, and not the chloride from the saliva.

No. 48.—Moderate-sized dog. Gave thirty minims of acid in two drachms of water: it fell in fifteen seconds, perfectly insensible; howled slightly; jaw firmly closed; in forty seconds gave ten grains of nitrate of silver in three drachms of water; it neither stirred nor respired after; no pulsation of heart after two minutes.

No. 49.—Moderate-sized spaniel dog. Gave ten minims of acid with ten minims of liquor potassæ, in one drachm of water: in twenty seconds it fell and howled; mouth perfectly scarlet; pupils excessively dilated; heart ceased to beat in four minutes; did not stir after one minute and a-half.

No. 50.—Fat mongrel (rather large) dog. Gave ten minims of the



*strong acid*, equal to fifty of Scheele's, with twenty of liquor potassæ in one drachm of water; he struggled very hard against it, and squeezed the funnel flat with his teeth; affected almost immediately; thirty seconds, very rigid and jaws fixed, but mouth forced open, and a mixture of oxide of iron\* poured in by means of a funnel; but little seemed to pass the fauces, all power of deglutition being lost, even the passage of fluids not taking place; heart ceased to pulsate in one minute after the acid had been swallowed.

No. 51.—Spaniel dog, old, and same size as No. 52. Gave ten minims of acid; in fifteen seconds gave as much of a thick mixture of the carbonate of iron as I could get into him, (about six drachms of iron were swallowed;) in one minute from the giving of the acid he was put down, perfectly paralyzed, when the greater portion of the iron drained out from the mouth and nostrils, as though the œsophagus were also paralyzed; in three minutes a white foam passed from the mouth; at six minutes the heart ceased to beat. This dog did not breathe more than three times, and scarcely stirred after being put down.

No. 52.—Rough-haired Scotch terrier—a strong old dog. Gave ten minims of acid; in fifteen seconds gave a thick mixture of carbonate of iron, (the red oxide;) he dropped, and did not stir until two minutes, when he breathed, but laid otherwise motionless; pupils much dilated; eyes red; in five minutes and a-half heart ceased to beat.

No. 53.—Mongrel dog. Gave ten minims of acid; in fifteen seconds, an ounce of strong solution of sulphate of iron, during the giving of which he howled slightly, and dropped on the ground; he struggled hard; eyes very prominent and red, pupils dilated; mouth red; three minutes, muscles perfectly flaccid, but tremulous; in four minutes and a half heart ceased to beat; only breathed once after the first minute; neither urine nor fæces expelled.

No. 54.—Good-sized spaniel bitch. Gave twenty minims of acid, and in thirty seconds an ounce of strong solution of sulphate of iron: she dropped at once; howled and struggled a little; heart ceased to beat in four minutes; just before the heart

\* This was made immediately before by adding potass to a solution of sulphate of iron.



ceased to beat the tail (alone) was much convulsed; otherwise, after first minute, gave very little indication of life.

No. 55.—Terrier dog. Gave two drachms of a saturated solution of chlorine: no effect in any way; he continued very active and cheerful.

No. 56.—Large, rough-haired, mongrel dog. Gave (July 23rd, six a.m.) ten minims of acid: he *ran down and up a flight of steep winding stairs, and down a second time*, when he fell at the bottom, and howled a great deal; fæces passed; was carried up stairs, and at three minutes one drachm of a saturated solution of chlorine given; lay breathing hard, with scarcely any motion; eyes and mouth as usual; twenty minutes, gave another drachm of solution of chlorine, for which he was, to all appearance, worse rather than better, lying perfectly helpless; respiration slow; thirty-eight minutes, gave one drachm of liquor ammoniæ fortis in one ounce of water, which induced increased respiration; this soon became very hurried, the chest being but little expanded, with mucous rattle; he lay apparently dying until one hour and a-half, when he was convulsed and became rigid, with mucous râle still louder; at four hours appeared to be dead, but on attentively watching, was seen to breathe at distant intervals very slightly; four hours and a-half, water dashed gently upon the face revived him; gave now fifteen minims of liquor ammoniæ in one drachm of water, when the jaw became rigid, and he immediately barked quite loudly six or seven times in succession; breathed hard for two more minutes, then lay just as before, as though in a profound quiet sleep, breathing slowly and gently; indeed, he lay so still that I thought he was dead. In same state in the evening. July 24th, six a.m., twenty-four hours after the acid had been given: late last night barked very loudly for some time; lies just where, and as he was left yesterday, but breathes better; is quite conscious, but has not the least power in the limbs; will not drink; pupils *quite contracted*. In the course of the morning he appeared to be very much starved, though the day and room were hot; put into a warmer place. At noon, thirty hours after the acid had been given, he made so much noise, barking and howling, still lying as before on his side and unable to stand, that he disturbed the whole building, and in my absence, to my great annoyance, four minims



of the strong acid—equal to one of anhydrous, and to twenty of Scheele's—were given to him; in thirty seconds he became affected in the usual manner, but lived for thirty-five minutes; though he struggled for some time he ceased to howl.

No. 57.—Strong, bull-terrier dog. Gave twenty minims of acid; in forty-five seconds gave three drachms of saturated solution of chlorine, diluted with water. Before he got the chlorine the dog howled; he dropped, and lay without stirring until one minute and a-half, when he became very rigid; two minutes, became flaccid; three minutes, passed a little urine, pupils becoming very widely dilated; four minutes and a-half, heart ceased to beat; he only respired three times after falling; the eyes were not very prominent nor red, and the pupils not widely dilated, until three minutes after the acid had been taken.

No. 58.—A large strong cattle-dog, (like a wolf dog,) weighing, at least, 40lbs. Gave fifteen minims of acid, and in thirty seconds, one ounce of solution of chlorine: he howled excessively and struggled hard; one minute and a quarter, ceased to struggle, and lay as though dead until two minutes and a-half, when he began to breathe; four minutes and a-half, convulsed and howled a little; eyes not much injected nor prominent; mouth not red; ten minutes, heart ceased to beat; the respirations were distant, but violent; the pulsations of the heart during the last three minutes were very feeble; no urine passed, but before the heart ceased to beat fæces were passed.

No. 59.—Large strong woolly old French dog. Gave eight minims of acid; thirty seconds, gave four grains of sulphate of copper in three drachms of water: he immediately fell, and retched violently, but vomited only a little; five minutes, heart beat laboriously; opened an artery in the hind leg, *blood arterial* in colour flows slowly; seven minutes, passed fæces; nine minutes, blood flowed more quickly, and heart beat more freely; fifteen minutes, the number of inspirations per minute, as nearly as can be counted, is 130; bleeding stopped, four ounces having flowed; breathing continued as rapid, but gradually became almost imperceptible, until thirty-five minutes, when the dog slightly moved for the first time, and the respiration became stronger; he appears never to have been altogether insensible, and is now perfectly



sensible; thirty-eight minutes, cannot rise, but is able to sit when put into the position; forty minutes, could stand, and at forty-five, with assistance, able to walk; retched, but did not vomit; sixty minutes, nearly recovered: hanged.

No. 60.—Old, very strong, savage, but not very large, brindled bull dog. Gave eight minims of acid, and instantly afterwards three grains of sulphate of copper in six drachms of water: he walked about, not much affected, until forty-five seconds, when he began to stagger very much, falling and getting up again, exactly like the dogs to whom cyanuret of silver had been given; did not rise after one minute and a-half; five minutes, able to stand still, with the legs widely stretched out; fæces passed; ten minutes, vomited thick, frothy matter, mixed with food; he continued for half an hour to vomit and retch most violently, when he could stand better and walk; forty-five minutes, gave eight minims of acid; fifteen seconds after, fell and howled a little; lay until twenty minutes as though about to die, breathing very slowly, when he altered, became more sensible, and the respiration very hurried; thirty-five minutes after the second dose, and eighty after the first, quite sensible to all that is passing, and looks very much as though he would like to bite any body or thing he could, but he lies with all the limbs perfectly paralyzed; well shaken, became instantly rigid for a minute, and passed water; forty-four minutes, cold water dashed over him, when he was immediately roused, got up, shook himself, and was able to stand; forty-seven minutes, water dashed on him for the fourth time; this he tried to avoid, and staggered much; sixty minutes, so far recovered as to be only weak and stupid, and very much indisposed to move; hind legs the weakest. Now put ten minims of acid upon the tongue, when he *instantly* passed a large quantity of water and fell; he lay perfectly still, breathed several times for five minutes, when he died.

No. 61.—A small spaniel (young). Five minims of acid, placed upon the tongue, took effect in seven seconds; the respiration becoming very hurried, three grains of sulphate of copper in one ounce of water given; in twenty seconds it fell backwards and howled slightly; forty seconds, urine passed; one minute and a quarter, retched a little, but did not vomit; lay perfectly paralyzed, until five minutes, breathing slowly, when it died. In this case the eyes were not very red nor prominent; the pupils were not



much dilated, and did not altogether lose their sensibility to light; the mouth, as usual, red, with jaws open, and the tongue hanging out flaccid.

No. 62.—Rough cur bitch, rather small and aged. Gave seven minims of acid: she dropped, struggled, and attempted to howl, but could not; passed both fæces and urine, in thirty seconds gave three grains of sulphate of copper dissolved in one ounce of water; in two minutes she retched violently, but did not vomit; at five minutes gave another similar dose of the sulphate; eyes prominent, pupils dilated, as usual; fifteen minutes, lay perfectly still, with much thick froth about the mouth; but when another dog's leg was brought into contact with her mouth, she tried to bite it; twenty minutes, became rigid for a second or two; only breathed once after this; heart ceased to beat at twenty-four minutes; a large quantity of thick froth passed from mouth and nostrils; the respiration was very feeble for some time before death.

No. 63.—Large strong springer dog. Gave ten minims of acid in two ounces of water, but he struggled so hard that not quite the whole was swallowed; howled slightly, and dropped as though dead; one minute, gave six grains of sulphate of copper dissolved in two ounces of water; lay as though dead until three minutes, when he began to breathe, and respiration became very quick and panting, 110 in the minute; thirty minutes, though apparently breathing violently, the least pressure upon the ribs suspends respiration; thirty-five minutes, poured down the throat four drachms of water, without any effect; fifty minutes, a large quantity of bloody water drained from the mouth; gradually becomes weaker and weaker; fifty-three minutes, slightly convulsed; sixty minutes, dead. During the whole time he scarcely moved the limbs; they lay stretched out powerless, but without the least rigidity. I could not satisfy myself as to whether he retained any sensibility or not; and indeed it is, in nearly every case, very difficult to do so, the eyes appear so very bright and expressive, while the limbs, when not rigid, are so completely paralyzed that they are unable to be moved when pricked, even though pain be induced; the pupils were not affected by variations in the degree of light, but when the ciliæ were touched there was winking; he appeared to feel very sick, without having any power to vomit.



No. 64.—Small full-grown mongrel bitch. Gave six minims of acid in one drachm of water; from her struggling, not more than four minims were swallowed; in thirty seconds gave two grains of sulphate of copper in half an ounce of water; one minute, she fell powerless; one minute and three quarters, retched and vomited a very small quantity of fluid; lay perfectly still, breathing deeply, but slowly, till seven minutes, when four grains of sulphate of copper in one ounce of water were given; it was swallowed with great difficulty, and produced no perceptible effect; continued sensible up to twenty minutes, when she became insensible; thirty minutes, respiration very slow and feeble; heart can only be felt pulsating at the instant of complete expiration;\* thirty-two minutes, white foam passing from the nostrils; thirty-three minutes, dead.

No. 65.—Mongrel bitch. Gave six minims of acid in one drachm of water; fifteen seconds after, four grains of tartarized antimony in ten drachms of water: she struggled and fell in one minute and a-half, then lay perfectly still, and appeared insensible for six minutes, when she got up and tried to stand; twelve minutes, purged and able to walk about; thirty minutes, quite recovered. Gave six minims of acid in one drachm of water; thirty seconds, fell, having stood perfectly still; unable to move, having lost all command over limbs; howled loudly; very rigid for a short time, then became perfectly paralyzed; breathed heavily up to nine minutes, when she was dead.

No. 66.—Moderate-sized mongrel terrier dog. Gave six minims of acid, and in fifteen seconds three grains of tartarized antimony in one ounce of water: forty-five seconds, fell suddenly backwards, and lay perfectly still and motionless, except slowly respiring, to eight minutes, when he was strongly convulsed, then lay still again; fifteen minutes, heart beating rapidly and feebly, respiration slow and laborious, these became weaker and slower, as though he were just about to die, up to thirty-five minutes, when he rallied and tried to sit up, but could not; fifty minutes, placed under the douche, without effect; gave a good shaking, which induced him

\* This is to be explained, I apprehend, merely from the fact of the thoracic parietes, at the moment of complete expiration, being in closer proximity with the heart than at other stages of the respiratory act, permitting the feeblest motions to be perceived.



to howl a little; sixty minutes, seems nearly recovered, except weakness. Gave five minims of acid; thirty seconds, struggled hard, then lay still up to twelve minutes, when he was convulsed, passed water, and ceased to live.

No. 67.—Young moderate-sized mongrel. Directly after No. 60 had vomited, he ate the whole of the ejected matter without any effect being produced upon him; thirty minutes afterwards I gave him six minims of acid, but not more than four were swallowed; forty-five seconds, he fell and struggled hard to rise, but could not; one minute and a-half, gave three grains of tartarized antimony in one ounce of water; dropped motionless when put down, and lay so for two minutes, when he gradually recovered; was able to sit when put up, and stagger a few steps; six minutes, purged and vomited freely; fifteen minutes, able to stand when set up, but not to rise; seventeen minutes, can walk, and seems nearly recovered. Twenty minutes, put five minims of acid into the eye; in thirty seconds fell, struggled hard, and howled very loudly; ten minutes, dead. After he fell and struggled he scarcely stirred or breathed, but the heart continued feebly to pulsate.

No. 68.—Mongrel terrier, same size as last. Gave six minims of acid; twenty seconds, it began to breathe hard; thirty seconds, fell and howled a little; in one minute, gave forty-five grains of sulphate of zinc in six drachms of water; it lay perfectly powerless, with a discharge of thick white foam from the nostrils; six minutes and a half, heart ceased to beat; neither urine nor fæces passed.

No. 69.—Mongrel spaniel, same size as last. Gave six minims of acid, and *instantly* afterwards forty-five grains of sulphate of zinc; it ran about backwards and forwards as though distressed; fell and howled very loudly; one minute, struggled, and then laid perfectly still and flaccid; pupils much dilated; two minutes and a half, began to breathe convulsively; five minutes, fæces and urine passed; seven minutes, one ounce of solution of zinc, (one drachm); unable to swallow much, part returned through nostrils; continued motionless; nine minutes, heart ceased to beat. I never saw the pupils so much dilated, the irides were scarcely to be seen.

No. 70.—Rough-haired terrier dog, not fully grown. Gave six minims of acid: he ran about as playful as though nothing had



happened; thirty seconds, staggered, fell, and howled much; forty-five seconds, gave half a drachm of sulphate of zinc, dissolved in four drachms of water; lay without stirring until four minutes, when there was one convulsion; seven minutes, the heart ceased to beat. Only stirred once after the sulphate of zinc had been given.

No. 71.—Full-grown mongrel bitch, larger than last, in pup, but not far gone. Gave six minims of acid, and *instantly* after half a drachm of sulphate of zinc in four drachms of water; ran about; in one minute, fell and howled slightly; three minutes, lies perfectly still, but is, I think, sensible; respiration very quick; four minutes, pupils not much dilated; urine and fæces passed; seven minutes and a half, perfectly conscious, can just wag the tail; is unable to rise, indeed, seems perfectly powerless; twelve minutes, got up and passed fæces again; fourteen minutes, purged again; sixteen minutes, ran about, with constant efforts to pass fæces; pupils now fully dilated; twenty-five minutes, vomited a mass of thick white frothy mucus; forty-five minutes, has vomited two or three times. There continued great weakness of the limbs, with an indisposition to move, but at the expiration of an hour this had disappeared, and he seemed as well as ever and lapped water freely.

No. 72.—Very large terrier dog. Gave two drachms of strong liquor ammoniæ in two ounces of water; no effect produced.

No. 73.—A brindled cur dog, of good size, strong and active. Gave ten minims of acid, and in fifteen seconds one drachm of liquor ammoniæ in one ounce of water; he immediately fell down, howled a little, and was convulsed; in three minutes, breathed convulsively; four minutes, became motionless; in six minutes the heart ceased to beat; pupils not much dilated; urine and fæces passed; mouth perfectly scarlet.

No. 74.—Large rough terrier. Gave ten minims of acid, by mouth; in forty seconds, gave one drachm of liquor ammoniæ fortis in two ounces of water; he struggled while held to give this, but when let go dropped down; placed under the douche twice, but without effect. He did not stir nor breathe after he dropped, nor could the heart be felt to pulsate.

No. 75.—Small mongrel dog. Put three minims of acid in the



right eye, the pupil of which almost instantly became dilated. He soon began to stagger, and ran about, getting into the corners of the room; in forty-five seconds he fell, and lay breathing hard; in three minutes, forty minims of strong liquor ammoniæ in two ounces of water were given with but little effect; at twelve minutes a similar dose of ammonia was given, when he instantly retched violently, soon rallied, and became able to stand, though he breathed hard and thick; at thirty minutes, put five minims of acid into the eye; in fifteen seconds after this he fell down; in thirty seconds, howled very loudly, passed urine, became convulsed, and in eight minutes the heart ceased to beat.

No. 76.—Moderate-sized spaniel bitch. Gave twelve minims of acid in two drachms of water; twenty-five seconds, she fell; one minute, strong liquor ammoniæ applied freely to the chest and abdomen, with good friction; four minutes, pupils *not* dilated; eyes injected; mouth red, with a large quantity of mucus about it; twenty-two minutes, dead; respiration and the action of the heart ceased at the *same* time, the breathing having been very slow and slight, and the pulsations of the heart very feeble for some minutes. Before death the pupils became much dilated; neither fæces nor urine passed; no howling, and but little struggling.

No. 77.—Rather large French poodle dog, recently shorn. Gave twenty minims of acid: he ran actively away; twenty seconds, fell, struggled hard, and howled a little; one minute, well rubbed with strong liquor ammoniæ; five minutes, eyes injected, but the pupils not much dilated; heart ceased to beat in eight minutes. At five minutes he had a strong convulsion, with rigidity, after which he only moved once. This dog was much convulsed; neither urine nor fæces passed.

No. 78.—Rough poodle bitch (young). Gave six minims of acid; in twenty seconds she fell, and howled a little; no struggling; instantly rubbed well with strong liquor ammoniæ; pupils excessively dilated almost immediately the acid had been given; mouth not red; dead in four minutes, having scarcely struggled or been at all rigid; a little urine was passed.

No. 79.—Large bitch, same size as No. 56. Gave ten minims of the acid diluted with an ounce and a half of water; she did not get quite the whole; in twenty seconds fell, struggling; lay until



one minute and a-half, when she got up and stood until three minutes, then fell again; four minutes, worse, struggled hard, and vomited; six minutes, bled in the hind leg to three ounces; howled; thirty minutes, quite conscious, but unable to stir; fifty-five minutes, gave one drachm of liquor ammoniæ in one ounce of water; struggled hard against it; no other effect; when put down limbs appeared completely paralyzed; sixty-five minutes, water dashed in face without effect, unable to move a limb; seventy-five minutes, when noticed seemed pleased, and wagged the tail; limbs stronger, but unable to support herself; eighty minutes, got up and walked about; ninety minutes, yelped much. Three p.m., nine hours after acid had been given, appears perfectly recovered. Gave thirty minims of acid; ran about the room, followed me, when called, went down three or four of the stairs, saw the door at the bottom shut, came up again, now staggered, and fell in forty seconds; howled but little; rigid for one minute and a-half; heart ceased to beat at six minutes, having only breathed twice after the second minute; urine, but no fæces, passed when she fell.

No. 80.—Large strong savage old bull terrier dog. Gave fifteen minims of acid: in twenty seconds it began to affect him; in thirty seconds he fell and lay still; one minute and a half, opened a vein in the neck, lost eight ounces of blood; three minutes and a-half, passed a large quantity of urine; eyes very prominent; heart ceased to beat in nine minutes, there having been no other indication of life after the sixth minute. The bleeding did not produce any effect that I could perceive; indeed, in proportion to the size of the dog and the quantity of acid, he died sooner than many others. The blood, as it flowed, was not so dark as human venous blood, and in an hour afterwards it was of a bright fluid hue.

No. 81.—Moderate-sized strong cur, having a cross of the bull dog. Gave ten minims of the acid: at first he ran briskly about the room, became unsteady, and fell at thirty seconds, but struggled hard, and made many efforts to get up; the limbs became extended and perfectly rigid until two minutes and a half, when they became flaccid, and he lay for a minute without breathing, and as though dead; the heart could not be felt to beat; then a violent convulsion; at six minutes, opened the jugular vein, the one in the



leg not having bled freely ; lay still and only breathed once after nine minutes. The saphena vein was opened in one minute and a half after the acid had been given ; at first blood flowed, but soon ceased, and not more than half an ounce passed ; from the jugular the blood passed freely, and three ounces escaped. The blood was brighter, and more of a brick colour than venous blood in health. The heart and respiration were less distressed than in most cases ; sensibility was never entirely lost until death took place. This dog, like many others, did not howl.

No. 82.—Half-grown cat. - Gave three minims of acid ; it jumped off the table and ran into a corner of the room ; twenty seconds, affected ; twenty-five seconds, fell convulsed, but not violently ; fæces passed at forty-five seconds ; dead in one minute and three quarters.

*Body examined three days after Death.*—Decomposition sufficiently advanced to produce a smell, but not to destroy rigidity ; brain and spinal marrow natural ; vertebral sinuses (veines meningo-rachidiennes,) much distended, as were the veins generally, particularly the superficial ; left ventricle perfectly empty ; right contained one drop of blood ; left auricle two or three, and the right auricle more, but not distended ; all the large vessels near the heart almost empty ; blood partly coagulated.

No. 83.—Half-grown cat. Gave three minims of acid, and *instantly* ten grains of nitrate of silver in one drachm of water ; nearly, but not quite the whole was swallowed ; affected in the ordinary manner, but not so much convulsed as some ; made some little noise, but did not howl ; urine, but not fæces, passed ; dead in two minutes and a quarter.

*Body examined three days after.*—Vertebral sinuses not much distended, nor were the veins generally ; left auricle and ventricle, and right ventricle, perfectly contracted and empty ; the right auricle contained a little dark fluid blood ; the venæ cavæ and pulmonary veins contained very little blood ; the aorta and pulmonary arteries not any.

No. 84.—Small rabbit. Gave two minims of acid ; it attempted to run, but could not ; fell in twenty-five seconds ; convulsed, cried, but not loudly ; still in less than two minutes.



*Opened immediately.*—Heart actively contracting; all the cavities contained blood, but none of them particularly full; venæ cavæ much distended, blood dark; on the aorta being opened, blood flowed; heart continued for some time to contract, gradually becoming empty and small. Thirty-six hours after, the vertebral sinuses were found extremely distended throughout the canal; the marrow itself and brain, with their membranes, were not engorged.

No. 85.—Same-sized rabbit as the last. Put two minims of acid upon the left eye, the lids being held apart for fifteen seconds to secure its full application: in twenty-five seconds it fell upon the side, was convulsed, and cried louder than the last; dead in rather less than two minutes; eyes not prominent nor injected; the pupils dilated, but the left most so.

*Opened at the third minute.*—Heart and large vessels in the same condition as the preceding, as were the head and spine thirty-six hours after.

No. 86.—A rabbit one month old, and a kitten fourteen days old, were put together into an oval preparation glass jar, of sufficient size to hold eleven pints, and to allow them to move about. Into this jar four minims of acid were dropped, and it was covered over. The kitten showed decided symptoms of being affected in twenty-five seconds: it struggled as though attempting to run, but unable to get a holding for its feet, it soon fell upon the side, and cried out feebly three or four times; at four minutes it had rather a strong convulsion, then lay still, breathing with great convulsive movement at intervals of a minute, the respiration becoming shorter and feebler until twenty-eight minutes, after which it did not stir. Examined one minute after it ceased to breathe.

The rabbit was not decidedly affected until forty seconds, when it moved in a similar manner to the kitten, soon fell upon its side, breathed convulsively, making a low whining noise with each inspiration. It was dead in two minutes and a half, not having had any violent general convulsion; the pupils were natural, rather contracted than dilated; the eyes were not prominent nor injected; the mouth was as pallid as after death from any other cause. Examined five minutes after it ceased to breathe.

No. 87.—It having been suggested to me by a scientific friend that probably sulphuric æther might be usefully employed against the effects of hydrocyanic acid, I first ascertained that the vapour



of it was not prejudicial to the animals by placing one for a quarter of an hour in the jar with twenty minims of æther, without any ill effect. I put a rabbit and kitten of the exact size (from the same litters,) as No. 86, into the same jar, with a similar quantity of acid (four minims,) and twenty minims of sulphuric æther. In ten seconds, the kitten cried out, in fifteen seconds, struggled hard, and in twenty seconds, fell upon its side; its mouth became intensely red, and the jaw closed with some foam about the lips; after breathing a few times it lay as though dead until three minutes and a half, when it was strongly convulsed, very rigid, and cried loudly in a natural voice; it then breathed at intervals of about one minute until twenty-four minutes, after which it did not stir; before death, as rigidity went off, the redness of mouth disappeared. The rabbit was affected in twenty-five seconds, fell with hardly any struggling or noise, and did not breathe after one minute and forty-five seconds; mouth not red; eyes natural, pupils rather contracted than otherwise.

No. 87.\*—A half-grown cat, was put into the jar with two minims of acid and twenty minims of sulphuric æther: in forty-five seconds she became strongly convulsed for twenty seconds, then paralyzed; at five minutes she was slightly convulsed, otherwise lay without any motion; the respirations gradually became feebler up to ten minutes, after which she did not breathe; both urine and fæces passed. In this case all the cavities of the heart contained blood; the right side and the two cavæ were more distended than I ever saw them.

No. 87.\*\*—A kitten, five weeks old, was put into the jar with two minims of acid and twenty of æther: it cried and made many voluntary efforts to escape for two minutes, when it gradually became weak and paralyzed. It was kept in the jar for fifteen minutes, during which time it continued slowly to respire, which was the only motion observed. There was not during the whole period the least appearance of convulsion. When first removed it breathed more freely, but only continued to do so for a minute. All the cavities of the heart contained blood, but not to the same extent as the last.

Nos. 88 and 89.—Strong half-grown cat, put into the eleven-pint jar with three minims of acid at one end of it and ten minims of liquor ammoniæ fortior at the other: she immediately sneezed



and coughed from the ammonia, and mewed in a natural manner; thirty seconds, decidedly affected; forty-five seconds, howled loudly, much convulsed, and mouth intensely red; two minutes, has continued rigid, pupils rather contracted; two minutes and a-half, pupils rapidly dilated; eight minutes, has for the last five minutes laid still, breathing about once in twenty-five seconds, at which time there is a little motion in the muscles; fæces passed; pupils not quite so much dilated; removed so that the vitiation of the air by respiration shall not have any influence; neither sensation nor reflex motion; fifteen minutes, has lain perfectly paralyzed, breathing about once in thirty-five seconds; thirty-five minutes, since fifteen minutes has been gradually improving, the respiration has gradually become deeper, more powerful, and much more rapid, being now thirty-five per minute, while the heart beats one hundred and twenty per minute; sensation appears to be returning; with each inspiration makes a low howl; one hour, has continued to improve, is now perfectly sensible; muscles have acquired some power, she can just crawl a step or two, but cannot stand; the fæces and urine have been freely passed; she has howled loudly with each inspiration, not as though in pain, but as vexed and distressed. On laying the hand upon the muscles there is felt to be a constant and rapid quivering of them; all that has been done to her is two or three good shakings, which materially roused her; put into a box with a warm soft bed and left for the night. In the morning, ten hours after, found under a table in a corner, perfectly able to run about, but was unsteady upon the legs, and she moved with some difficulty, cried, and appeared uneasy, liking to be petted and kept warm. Twenty-four hours after, having recovered so as to run about with other kittens, but not so actively, (it was cross, and disposed to fight them,) it was put into the same jar, with three minims of the acid, without the ammonia. It was not materially affected until forty-five seconds, when it fell and was strongly convulsed for at least a minute; the pupils became much dilated, and the mouth intensely red; it mewed, but did not howl; two minutes, paralyzed, after which it did not stir.

*Body examined three days after death.*—Perfectly rigid, scarcely any sign of putrefaction (weather warm, and it was exposed to the air in a room.) The vertebral sinuses distended, but not so much so



as in many cases; veins generally distended; left ventricle empty and contracted; left auricle contained two or three drops of blood; right ventricle held some little blood; right auricle and venæ cavæ distended, with partly coagulated dark blood.

The two last experiments appearing to support the idea that, under some circumstances, ammonia might possess some beneficial power, to test this the following were made, as it might be supposed that the cat in the second experiment was likely to be more easily affected, not having entirely recovered from the effects of the ammonia and acid, twenty-four hours before.

No. 89.\*—To a kitten, three weeks old, gave one minim of acid: in twelve seconds it was affected, and soon became violently convulsed for nearly one minute; it howled loudly, then lay paralyzed; in eight minutes it ceased to breathe.

No. 89.\*\*—To a kitten, from the same litter, gave one minim of acid, and instantly put it into a covered jar containing ten drops of strong liquor ammoniæ; in twelve seconds it was affected, and became violently convulsed for thirty seconds, then howled and was paralyzed; it ceased to breathe in seventeen minutes.

No. 90.—A young kitten, about fourteen days old, was put into the same jar, with three minims of acid: it mewed and crawled about unaffected for a minute, when it staggered and fell; it continued convulsed for a second minute, then lay paralyzed, breathing at distant intervals up to eight minutes, when it was removed from the jar; it immediately breathed better, mewed, and at ten minutes was convulsed, crying out loudly at the time, but appeared insensible; two hours after, has gradually improved, and now breathes well; it has frequently been convulsed and cried out; it is just sensible to pinching, but can neither stand nor crawl, nor, indeed, voluntarily stir a limb. Next morning, eleven hours after, can just stand, if it attempts to crawl it falls from side to side; heart beats very rapidly; twenty-four hours, improved, but still very feeble; fifty-six hours, can crawl a little; heart's action not so rapid. Three days after, being perfectly recovered it was put into the same jar with the same quantity of acid, but it was not *nearly* so much affected as before, and ten minutes after being taken out was almost well.

No. 91.—Kitten of exactly the same age as the last, put into the same jar with three minims of acid and six of strong liquor



ammonia: it was affected in twenty seconds, but not violently before a minute, when it cried out and was convulsed for nearly another minute, then it lay paralyzed until six minutes, at which time the fore part of the animal alone was convulsed; at eight minutes, it was removed; consciousness was not lost quite so soon as in the last; its eyes and nose were much affected by the ammonia. Two hours after, has lain as though in a most profound sleep, (exactly like the dog No. 56;) if well shaken it cries out in a distressed manner, and is able, in the very least degree, to stir its legs; like the last, put into a warm place for the night; eleven hours after, heart beats very rapidly, cannot walk, lies asleep, and cries if disturbed; twenty-four hours, not quite so strong as the last kitten. For the first time since the experiments, they (Nos. 90 and 91,) have taken a little milk, by having it poured down the throat. Thirty-six hours, can crawl, but is still weak. Three days after, being perfectly recovered it was put into the same jar with the same quantity of acid and ammonia; it was much affected by the ammonia and somewhat paralyzed, but did not become insensible; in fifteen minutes, being able to move, about four minims of acid were given by the mouth; it was affected in the usual way, being stimulated at first, but lived much longer than most of the others had done.

No. 92.—Rather larger kitten than No. 88, (I learnt afterwards it had not been well;) put into the same jar, into which three minims of acid had first been dropped: thirty-five seconds, affected, mewed hurriedly, was convulsed and rigid to one minute and a half, when it became flaccid, with the pupils intensely dilated; breathed slowly for four minutes, after which it did not stir; taken out at eight minutes, but gave no indication of life, and in less than two hours was very rigid.

*Post-mortem examination twenty-four hours after death.*—Lungs perfectly scarlet, they collapsed but little, owing to the air-cells being distended with thin frothy mucus and air; the crepitation and distension were so great that at first sight it appeared as though the cells were ruptured, however, on examining a thin slice with a lens this was seen not to be the case; mucous membrane of trachea not red. Left ventricle contracted and empty; the right contained some dark fluid blood, but was not distended; right auricle and venæ cavæ full; left contracted upon some little blood.



The blood under the microscope appeared to consist of a homogenous mass of very small reddish gelatinous granules.

No. 93.—Strong three-quarters grown cat. Put into the jar with three minims of acid: after being in it for thirty seconds she turned round and smelt strongly at the acid, as though to ascertain what it was; one minute, strongly convulsed; fæces and urine passed; eight minutes, taken out; she, however, had not breathed nor stirred after the third minute.

*Post-mortem examination forty minutes after.*—No motion of the heart; left ventricle perfectly contracted and empty; the three other cavities full, but not distended; venæ cavæ and pulmonary vessels full; aorta empty; lungs of a pale pink red, with a little frothy mucus, but not nearly so much as the last.

No. 94.—Same-sized cat as No. 93, but very inactive and sleepy; put into the jar, three minims of acid having been put at one end and six minims of strong liquor ammoniæ at the other: in fifteen seconds she was slightly affected, but at two minutes was able voluntarily to turn round; at four minutes, very strongly convulsed and pupils intensely dilated; eight minutes, taken out, having for the last three minutes been lying as though fast asleep and motionless, except breathing quickly and laboriously; neither fæces nor urine passed. Thirty minutes, has mewed loudly, in a distressed manner, and been convulsed, but is now able to sit up; forty minutes, walked about the room, purring and desiring to be noticed. Next morning, twelve hours after, perfectly well and able to eat a hearty breakfast of milk. Night, has been well, indeed, much more active than before the experiment, having played and jumped from chairs and tables without any sign of weakness.

No. 95.—Same cat as last, (twenty-four hours after,) put into the jar with three minims of acid: after one minute six minims of liquor ammoniæ were put into the jar; it had up to this time not showed any symptoms of being affected, but it immediately perceived the ammonia and tried hard to get away from it; one minute and a quarter, (from the first,) affected; one minute and half, fell, and continued convulsed to two minutes; breathed very rapidly to two minutes and a quarter, after which it did not stir.

*Post-mortem examination forty-eight hours after.*—Lungs crimson, but did not contain much mucus, and the trachea was nearly



free, its membrane being but little injected; left ventricle contained a drop of blood, and was not quite so closely contracted as usual; the three other cavities filled, as were the cavæ and the pulmonary vessels; the aorta also contained blood; this was dark in colour and scarcely at all coagulated.

No. 96.—Same kitten as No. 90. Four days after, being perfectly well, put into the jar with six minims of liquor ammoniæ: it was allowed to remain for six minutes, being not otherwise affected than the eyes watering, mucus discharging from the nose, and much sneezing; now, three minims of acid were given by the mouth; in thirty-five seconds it was affected in the usual way, and at eight minutes dead, having for the last four breathed only four or five times, and been otherwise quite motionless.

*Immediately opened.*—Lungs, pale bright crimson. Left ventricle contracted; the auricle somewhat distended; the right ventricle and auricle full, as were the venæ cavæ and pulmonary vessels; aorta nearly empty. Heart beating; put three drops of acid upon it; the right ventricle appeared to lessen somewhat, and the pulsations to diminish in force and number, but after two or three minutes these became again more active.

No. 97.—Full-grown, very active, strong cat. Gave four minims by the mouth: it jumped off the table, but in twenty seconds fell strongly convulsed; twenty-five seconds, placed in the jar in which twelve minims of liquor ammoniæ had been put; convulsed for fifteen seconds after being put in the jar, when it became perfectly paralyzed, and did not stir nor breathe afterwards.

*Chest opened eight minutes after the acid had been given.*—Ammonia had evidently been respired from the appearance of the lungs, which were of a pale scarlet colour, and contained frothy mucus, the lining membrane of the trachea being also injected and covered with mucus. But little motion of the right side of the heart; left ventricle contracted and empty; the other three cavities distended, as were the pulmonary vessels; the two cavæ were very full; aorta empty; blood fluid, but subsequently it formed a soft coagulum.

No. 98.—Kitten, about six weeks old. Two minims of acid put into the left eye, the lids being held apart for the space of one minute: in twenty-five seconds it was affected, became much convulsed, cried loudly, and passed urine; at one minute it was



placed in the jar, into which six minims of the liquor ammoniæ had been dropped; it continued convulsed for twenty seconds, after which it gave no indication of life, except breathing once at two minutes and a-half.

*Chest opened ten minutes after the acid had been given.*—Lungs of a pale bright pink colour, collapsed, but the cells contained some frothy mucus. Heart: left ventricle, as usual, quite contracted and empty; left auricle filled, but not distended with blood; both right cavities, the venæ cavæ, the coronary veins, and the pulmonary vessels, quite filled, but not so completely distended as I have some times seen them; the blood in all was of a *very* bright florid hue; aorta perfectly empty.

No. 99.—Rabbit, rather larger than No. 100; put into the glass jar: ten minims of liquor ammoniæ fortior were put at one end of it and three minims of hydrocyanic acid at the other: it showed little sign of being affected for one minute, when it became restless and tried to get out of the jar, but still perfectly conscious, and with control over motion of limbs; one minute and three quarters, became feeble; two minutes, fell and struggled; two minutes and a-half, cried out; three minutes and a-half, ceased to move and to breathe; eyes natural—pupils rather dilated.

*Body examined four days after.*—Smelt, but not putrid; rigidity partly disappeared; vertebral sinuses all distended; cerebral not.

No. 100.—Rabbit, about a third-grown. Attempted to give two minims of acid mixed with four minims of liquor ammoniæ fortior in a drachm of water; certainly not more than half, but, I believe, not more than a third, was swallowed: it scarcely struggled, and did not make the least noise; it was dead in one minute; in less than five minutes rigidity commenced.

*Post-mortem examination four days after.*—Smelling, but not very putrid; vertebral sinuses distended. Left ventricle entirely empty; right partly filled; both auricles filled, as were the larger veins; blood coagulated.

No. 101.—Two minims of acid put into a test tube. A young mouse was held with the nose put into the tube: in four seconds it was powerless; it only moved its limbs and breathed once after being removed.



*Opened in two minutes after.*—The ventricles did not stir, but both auricles contracted rapidly; the left ventricle was quite contracted and empty; the right contained some blood, but was by no means distended; the left auricle nearly, but not quite, empty; the right contained some blood, but was not at all distended; the venæ cavæ not engorged; the lungs shrunk, and as white as a calf's in a butcher's shop; the auricles continued to contract for six minutes, at the end of which time both appeared perfectly flaccid and empty, as did the venæ cavæ.

No. 102.—Very large old mouse; nose put into the mouth of a phial containing about one drachm of Scheele's acid; in five seconds removed; it struggled, was convulsed, and cried faintly; dead in forty seconds.

*Opened immediately.*—Lungs as above; heart perfectly empty; left ventricle very large, as though hypertrophied, perhaps, as Cruveilhier and others suppose, from its sudden cessation of action, though I believe the heart of the mouse is, in proportion to the size of the creature, larger than that of many animals.

No. 103.—The nose of a third mouse was held for only one second in a phial containing four or five drachms of acid: for a minute it appeared scarcely affected, but then became still and weak; its respiration was laborious, and its limbs were convulsed; it lived for five minutes.

*Chest opened four hours after.*—Lungs perfectly crimson; left ventricle contracted and empty; right nearly so; both auricles contained some blood, as did the venæ cavæ and the pulmonary vessels; blood dark and fluid.

No. 104.—Small snake, (*Coluber Natrix*.) Gave two *small* drops of acid by the mouth; I had intended to give only one, but in its struggles two fell from the bottle, (the drops of hydrocyanic acid falling from the lip of a bottle are often smaller than those of many fluids): for five minutes no effect whatever appeared to be produced; it then became dull and disinclined to move, but if the tail were pinched it crawled quickly enough during fifteen minutes; it then became still until thirty minutes, when it roused up and appeared as though it would recover, but it shortly became perfectly still and lay as though dead, except that at distant intervals it breathed up to sixty minutes. It did not lose per-



ception nor sensation until it became perfectly still and paralyzed, at thirty-five minutes.

No. 105.—Small green lizard, (*Lacerta viridis*.) Gave one drop of acid: in forty seconds, affected; it gasped, appeared weak and turned round, then lay nearly motionless and paralyzed; four minutes, convulsed, particularly the tail up to its junction with the body; four minutes and a-half, dead.

No. 106.—Large toad. Gave eight minims of acid: it jumped away, and continued to do so vigorously for six minutes, when it appeared weak and dull; it now crawled, but did not jump; fifteen minutes, the legs remain in any position they are placed in; at forty minutes it revived, and moved about a little, but soon became still again; one hour, no sensation in legs, but when nostril is irritated the eye of the same side is depressed, and it tries with the foot to push away the irritant; eighty-five minutes, dead.

*Opened five hours after death.*—Ventricle and auricles moderately full, but not distended; they immediately began to pulsate regularly twenty times per minute, but the cavities were not emptied; fourteen hours, the heart is now enormously distended, the ventricle does not contract, but, on being touched, the auricles do; a short time afterwards the ventricle could be made to contract, and the auricles continued to do so for thirty hours, at which time the ventricle was empty and contracted and the auricles much less distended; blood fluid.

No. 107.—Large frog. Gave eight minims of acid: it leaped about, as usual, for five minutes, then lay still and dull up to fifteen minutes, when it suddenly jumped off a chair; breathing much affected, swallowing large mouthfuls of air; up to forty-five minutes could jump a distance of two inches, soon after which all sensation appeared lost, though reflex action still continued good; sixty minutes, dead.

*Opened five hours after death.*—No motion could at first be excited in the ventricle, but, by pricking, the auricles could be made to contract feebly; *they did so separately*; the ventricle then contracted; after an hour the pulsations were stronger and regular, at sixteen per minute; fourteen hours, all motion has ceased; the auricles full, the ventricle empty.

No. 108.—Large toad. Gave five minims of acid: no effect



for five minutes, when it became dull and the limbs convulsed ; at seven minutes the breath smelt of the acid ; twenty minutes, very dull and weak, but if put on the back has sufficient strength to right itself ; sixty minutes, for the last fifteen minutes has lain across the top of a glass jar with the limbs all stretched out, without the least motion or indication of sensation, yet reflex action is retained, for if the nostril be irritated the eye of the same side becomes depressed ; seventy minutes, this is lost ; seventy-five minutes, dead.

*Body opened immediately.*—Strong odour of the poison ; lungs much distended ; heart moderately full, pulsated thirty-eight per minute ; ventricle emptied at the time ; pulsation soon sunk to sixteen ; at ninety minutes, one drop of acid being put upon the heart its motions quickened to eighteen per minute, but the ventricle now not nearly emptied ; two hours and a half, up to this time has continued to pulsate, varying from ten to twenty pulsations per minute, it has now ceased, but on being touched with the point of a needle again contracted for a few times ; having ceased, another drop of acid was put upon it, when its action was again immediately induced ; the motion of the auricles did not finally cease until after upwards of twenty-eight hours.

No. 109.—Gave to each of two frogs, not quite half grown, two minims of acid : they leaped about most vigorously, but in two minutes became dull and feeble ; in fifteen they lay with the limbs extended and paralyzed, without sensation, but with some reflex action ; the following morning they were found dead and rigid, apparently not having stirred from the spot they were left in. The heart of one was perfectly empty, and that of the other nearly so, and of both contracted.

No. 110.—Moderate-sized frog. Gave thirty minims of acid : not quite all swallowed, as the throat became paralyzed ; it seemed dull and flaccid, but on being put down leaped a distance of one foot and a-half three or four times in succession ; two minutes, gave ten minims more ; fauces paralyzed ; leaped a foot in distance on being put down ; seven minutes, unable to move, lies with the limbs outstretched, flaccid, and helpless ; thirteen minutes, dead.

*Opened.*—No motion of heart ; ventricle empty and contracted ; auricles somewhat distended.

No. 111.—Large toad. Gave ten minims of acid. In less



than two minutes opened: auricles and ventricle very much distended, they pulsate regularly twelve to fourteen per minute, but scarcely any blood is propelled into the vessels; twelve minutes, right auricle contracts much more vigorously than the left; cavities not nearly so much distended; ten hours, the ventricle empty and rigid; auricles filled, the right still contracts.

No. 112.—The following experiments show the effects upon toads of different quantities of acid, when administered by inhalation:—No. 1 put into a covered jar, into which two minims of acid had been dropped: in one hour it was dead. Opened at this time. All the cavities of the heart completely distended with florid blood, as were the veins; abdominal viscera much congested; vessels of the lungs most beautifully shown, on account of their distention; on being touched, the heart immediately began to contract, but was unable to empty itself; twelve hours after, the ventricle was contracted and empty, the auricles still acting and containing blood.—No. 2 put into a similar jar, with five minims of acid: in an hour dead. Cavities of heart, especially the ventricle, distended, with *bright florid* blood; although the heart contracts, it does not appear to propel any blood into the aorta; indeed, on their being divided near the heart, scarcely any blood escaped; all the viscera, as well as the lungs were filled with blood. Twelve hours after, ventricle empty and dense, auricles contracting and not so full.—No. 3 put into a similar jar, with ten minims of acid: in an hour dead. Heart distended, but especially the auricles, with *dark blood*; lungs, viscera, and veins, congested; the aorta empty; the right auricle, when pricked slightly, contracts; the left does not; the ventricle does not pulsate, but in five minutes became quite empty, dense, and white.—No. 4 put into a similar jar, with twenty minims of acid: in an hour dead; heart does not pulsate, nor can it be made to do so; ventricle perfectly shrunk, empty, and white; auricles contain some blood, but are not much distended; lungs and other viscera not so much congested as in the three former instances. The lungs of all the four were enormously inflated.

Soon after being put into the jars the toads became dull and indisposed to move, with laborious breathing; they were not convulsed, and the quantity of acid did not appear to produce any very marked difference either in the violence or the rapidity of



action of the poison, though this was somewhat greater when the larger quantity was employed.

To compare the appearance of the heart and lungs with that found after pure asphyxia, I put a frog and toad into a jar of water, and kept them at the bottom by a weight. All the cavities of the heart were excessively distended with black blood, the appearances, especially of the ventricle, being very different from those after death from hydrocyanic acid; the lungs, also, were more congested.

No. 113.—Two small Prussian carp (*Cyprinus Gibelio*,) were put into a large basin containing three pints of water, to which twenty minims of acid had been added: in twenty minutes they began to be dull, and to fall upon the side for a minute or two; they then roused up and swam vigorously about for another minute or two; the dullness, however, gradually increased, and the periods during which they remained upon the side longer; but if touched, they would still dash actively away, until one hour and a-half had elapsed, when I left them lying altogether upon the side. The following morning, eight hours after they were put into the water, they were found dead and rigid, and had evidently been dead for some time. Taken out, and two others of the same size put into the same water: in half an hour these began to fall upon the side, and to breathe laboriously, lying still upon the side and moving about alternately for six hours, after which, up to twelve hours, they moved but little; they now roused up, and swam about a good deal upon the back or side. Twenty-four hours, lying perfectly still, with only a *very* feeble motion of the gills; put into fresh clean water, when they *immediately* revived, and swam about in a natural position, but soon fell again upon the side; during the day they laid upon the side as though fast asleep, and with gentleness could be handled without being disturbed; but if roused they suddenly dashed away: in thirty-six hours appeared to be perfectly recovered.

No. 114.—Same-sized fish. Put two minims of acid into the mouth, and immediately replaced it in a large basin of water. It fell upon the side, but in a minute nearly righted itself; however, the least touch made it lose its balance, and it was inactive; thirty minutes, seemed better, though it was very feeble; twelve hours,



swimming actively about, a little on one side, otherwise not much the worse; twenty-four hours, as well as ever, except not quite so vigorous.

No. 115.—Gave three minims to a carp of the same size as last: it swam actively about for two minutes, then fell flat and still upon the side; twenty minutes, has several times suddenly dashed forwards and about the water in a convulsive manner; this it continued to do for some hours; twelve hours, lying flat and still, feebly breathing, with the mouth open, but if touched can move; during the day continued to improve, and at twenty-four hours, though lying upon the side, frequently swims about, apparently likely to recover; next morning, thirty-six hours after, found dead, but not rigid.

No. 116.—Put five minims into the mouth of a similar sized carp: less affected than last; twenty-five minutes, certainly convulsed; one hour, again convulsed, dashing furiously through the water; twelve hours, swimming about on the side; during the day improved, and at twenty-four hours appeared well, but weak.

No. 117.—Same-sized carp. Gave five minims of acid: it immediately dashed most violently about the water; continued at intervals to do so for three hours, like No. 118, but more actively; twelve hours after, lying dead. The dashings about in the water of this little fish were most violent. All the cavities of the heart were empty, the bulbus arteriosus being white.

No. 118.—Larger carp than the others. Gave ten minims of acid: it immediately breathed laboriously; moved quickly about the water, and in two minutes was convulsed, then lay flat upon the side, but almost immediately swam actively about; it continued for three hours alternately lying perfectly still upon its side and suddenly dashing violently about the water, becoming, however, more feeble, and the intervals between moving longer; next morning, twelve hours after, lying upon its side at the bottom of the vessel so motionless that I thought it was dead, until I took it out of the water, when it began to move and to breathe; on being replaced in the water it continued to move at intervals up to seventeen hours, when it died. All the three cavities of the heart completely empty.

No. 119.—Small carp. Put five minims of acid upon the gill: respiration was instantly affected; it opened and shut the mouth



in rapid succession; when put in the water it lay flat upon the side, as though about to die, but in twenty-five minutes revived, became stronger, and moved actively about; twelve hours, lies on the side, but swims about; gradually during the day became duller; at twenty-four hours, breathes quickly, but scarcely stirs, though it can change its position; it may, however, be rolled over without appearing to perceive it. In the morning, thirty-six hours after, found dead and rigid. Cavities of heart all empty.

No. 120.—Same size as No. 118. Put ten minims of acid upon each gill: it swam actively about, but soon became restless, with short convulsive startings from one side of the vessel to the other; for three hours this fish continued, at frequent intervals, the most violent irregular motions; it was several times nearly out of the vessel, though the water was at least three inches from the top, and this was splashed all over the table; the movements, however, became less violent; it swam about on the side, sensible and tolerably active, but during the day got gradually weaker, stiller, and more insensible, but did just move the gills up to twenty-four hours.

No. 121.—In order to ascertain if doses of different strength act with proportional rapidity, I made the following four experiments:—

To a small carp I gave thirty minims of acid, but could not get quite all swallowed as the parts became paralyzed: it was affected while swallowing, but on being put into water it swam about; twenty-five seconds, became unsteady, then still for ten minutes, when it appeared more active and dashed about, but soon became dull and indisposed to move; dead in four hours.

To a carp of the same size I gave twenty minims of acid: when put into water it was instantly convulsed for a minute, then still; these alternations were repeated at intervals; dead in three hours and a-half.

To a carp of the same size I gave ten minims of acid: in one minute it was floating upon its side, much drawn towards one side; it continued tolerably active for some hours, swimming about upon the back or side, and if touched moved quickly; the following morning it was quite well.

To a carp of the same size I gave five minims of acid: it was instantly convulsed; continued as the preceding; at three hours



and a quarter no motion, except very feeble respiration; at four hours and a quarter dead.

In the whole of these four fish the cavities of the heart (auricles, ventricle, and bulbus arteriosus,) were empty, as was the aorta.

From these fish being immediately returned to the water it was impossible to say if some portion of the acid might not be, almost as soon as given, washed away; and also it was difficult to say what influence the water, passing not only over the body but through the mouth and gills, might have; so that though these experiments were sufficient to show that hydrocyanic acid acts in a similar way upon fish as upon the higher vertebrata, they could not, from these circumstances, be regarded as altogether satisfactory, in accurately comparing the effects of corresponding doses upon different animals. I therefore made the following:—

No. 122.—To a small carp I gave two minims of acid, and kept it out of the water for thirty seconds: when put in, it rolled from side to side, and appeared about to die, but soon recovered, and swam unsteadily in sudden starts, gradually becoming weaker; it died in six hours.

No. 123.—Four small carp, of the same size, were removed from the water and placed upon a table. To No. 1 nothing was done: it lived for an hour and forty minutes,\* at least, it was this time before it altogether ceased to move when taken up, but for the last thirty minutes it scarcely moved more than the mouth and opercula when faintly breathing.—To No. 2 I gave five minims of acid: it was convulsed most violently, so as many times to jump from the table; after thirty-five minutes it moved but little, and after forty-five minutes did not stir the opercula, but up to an hour, when lifted up by the tail, was slightly moved.—To No. 3 I gave ten minims: like the last it was most violently convulsed, so as to jump from the table; it did not, however, move so much as No. 2, though it did not altogether cease to move the mouth and opercula until eighty minutes, but during the last thirty minutes the movements were very slight.—No. 4 had ten minims put under the right operculum: it was at once most violently convulsed, then lay as though dead, but when handled,

\* The extreme tenacity of life in the carp is well known to naturalists, and therefore renders this fish, perhaps of all others, the best adapted for such an experiment.



moved convulsively, though feebly; these motions did not completely cease until forty minutes.

No. 124.—Two small carp, of the same size; one was placed in an empty jar: it lay as though dead for upwards of two hours, but when put into water soon became active and apparently well, however, it died in a few hours. The other was put into a jar into which two minims of acid had been put: in forty minutes it was dead, there having been scarcely any motion after fifteen minutes.

No. 125.—To each of two moderate sized minnows (*Leuciscus phoxinus*,) one minim of acid was given: one died in fourteen, and the other in sixteen minutes, having been similarly, but not quite so convulsively, affected as the carp.

No. 126.—The active lively trout (*Salmo Fario*,) appears to be more easily affected by the acid than some other fish. To one just caught, weighing about six ounces, six minims of acid were given: it was dead in eight minutes; and another, weighing about ten ounces, to whom five minims of acid were given, was dead in ten minutes.

No. 127.—Put thirty water snails (*Lymnæus stagnalis*,) with four of the small flat spiral snails (*Planorbis Spirorbis*,) into a pint of water with twenty minims of acid; in a short time the animals retreated with their shells, and threw out some mucus; after twenty-four hours they were all living, and did not appear to have suffered materially.

No. 128.—Two garden snails (*Helix aspersa*,) Put three drops of acid upon the foot of each: instantly a large quantity of mucus was exuded, and the animals appeared in pain; but after lying within the shell for a short time they crawled away, and were not the worse on the following day.

No. 129.—Four snails (two *Helix aspersa* and two *Helix nemoralis*,) were put into a small covered garden-pot, in which there was a little dry mould; upon this ten minims of acid were dropped: at first little or no effect was produced, but after a few hours they became dull and quiet, and the following day were dead.

No. 130.—Three drops of acid were put upon the mantle of one large black slug (*Limax ater*,) and three upon the foot of another: both immediately curled themselves up, rolled about, and threw out mucus, but in a short time appeared no worse for the acid.



No. 131.—Four large black slugs were allowed to crawl about until the respiratory aperture was fully opened. I then attempted to drop into each one drop of acid. In consequence of the drop not falling exactly true, and the instantaneous manner in which the aperture is closed, not nearly the whole of the drop passed into the respiratory cavity: at the instant all appeared to suffer, but in two or three minutes they seemed nearly recovered, two, into which, perhaps, nearly half a drop had passed, being dull. They were all put into a glass jar: in two hours they were found to have crawled about, having left more mucus than usual in their tract; they were now still and dull; in the morning all were lying dead at the bottom of the jar.

This experiment I repeated upon two other slugs, hoping to succeed more perfectly in dropping in the acid; in one the drop, for the most part, passed into the lungs, in the other not quite so well; the first was dead in four hours, the second, in eight.

No. 132.—Four full-grown black slugs were put into a pint glass jar with some leaves; into the jar two minims of acid had been put: in the course of an hour they began to exude mucus; in four hours one was dead, and the others very dull and still; in twelve hours they were all lying dead at the bottom of the jar.

No. 133.—A small black slug was placed in a two-ounce phial, into which two drops of acid had been put: it scarcely moved from the spot it was upon, soon threw out mucus, and in thirty minutes was dead. The same result took place with the small slug of gardens and fields, (*Limax agrestis*.)

Shortly after death the slugs became soft, and appeared as though melting into thin watery mucus.

No. 134.—Ten worms (*Lumbricus terrestris*,) of various sizes, were put into a small vessel with three ounces of moist earth, with which ten minims of acid had been mixed: in a short time they were found rolled together, covered with mucus; in rather more than an hour they were dead. Ten more were put into a similar vessel, with a like quantity of acid, but without the earth: the effect was the same, except rather more speedy. Ten were put into one ounce of water, containing ten minims of acid: at first they moved actively about and tried to escape; they soon became dull and flaccid, sank to the bottom of the jar, and in about the same time as the last died.



No. 135.—A large millipede (*Geophilus subterraneus*,) was put into a two-ounce phial, into which two minims of acid had been dropped: it was soon affected; in rather less than an hour it was dead.

No. 136.—Three centipedes (*Oniscus Asellus*,) were put into a phial with a like quantity of acid: they ran about only for one minute and a half, after which they did not move.

A caterpillar (the larva of the tiger moth,) was put into the phial with the last: it moved but little from the place it was put upon, and was dead in seven minutes.

No. 137.—A caterpillar (I do not know of what insect,) was put into a two-ounce phial, with one drop of acid: in five minutes it appeared dead; its fæces had been passed; it was taken out and laid upon a sheet of paper; in half an hour it moved a little; it gradually acquired more power, and in three hours had recovered. It was placed in a jar, with some leaves, upon which it crawled actively and fed: one drop of acid was put at the bottom of the jar; in two minutes it became dull, passed fæces, and soon fell; at six minutes it did not stir.

No. 138.—Five small caterpillars (*Papilio Brassicae*,) were put into a two-ounce phial, with one drop of acid: they immediately rolled and twisted about; in twenty-five seconds they were still, and did not afterwards move. In other experiments with this caterpillar I have found the same effect rather longer in taking place.

No. 139.—The larva of the common fly is much less easily affected than the perfect insect itself. A number were put into a jar, with ten minims of acid: they immediately became very active, as though suffering; after half an hour they were still, but lived for nearly three hours. The common fly is very easily affected; it is sufficient to hold one for five seconds over the mouth of a phial containing the acid; it becomes paralyzed, and generally does not stir; if put into a phial containing a small quantity, it is almost immediately powerless and still; if removed before dead, the wings or legs, or both, are rapidly moved. The common butterfly (*Papilio Brassicae*,) is as easily affected; so also are bees and wasps, and many other insects which I have tried.

No. 140.—Ten spiders (five long legged and five short,) were put into a similar phial, with two drops of acid: in from fifteen to thirty seconds they became incapable of crawling, and the short



legged did not stir after two minutes, but the long legs of some of the others continued to move for four hours. It is well known that the legs of this spider very easily become detached, and also that they are endowed with great tenacity of vitality, continuing to move for long after being detached from the body of the animal. If the spider is allowed to remain exposed for five minutes or so to the vapour of the acid, no motion is perceived; but if not for so long a time, then, though the body is perfectly still and insensible, the legs will continue to move for hours. Two of these spiders, after laying paralyzed for five hours, recovered sufficiently to crawl a few inches, some of the legs being still paralyzed. The next morning, fifteen hours after exposure to the acid, they appeared well and active, having the power to use all the legs.

It is a curious fact, that though the application of the acid to a detached leg will certainly induce an earlier cessation of motion, it appears to produce much less effect than when the limb remains attached to the entire creature. This, taken in connection with the fact of acid applied directly to the heart of a toad not inducing a cessation of action, as well as the condition of the heart, as shown in the post-mortem examination of other animals, would seem clearly to establish that it is upon the central nervous system the acid specifically acts.

No. 141.—Three cockroaches, (*Blatta orientalis*), with three slow-legged beetles, (*Blaps lethifera*), were put into a small jar, with two drops of acid. They tried to escape, but almost immediately became stationary and weak, particularly the active cockroaches, which in eighteen seconds were unable to run; the legs were moved with a quick convulsive motion, but these did not stir after one minute, nor the beetles after two. At five minutes they were removed from the jar and laid upon paper. After two hours I perceived a slight motion in one leg of one of the beetles, and placed it in a box; after six hours it could stir all the legs, but could not stand; in nine hours could just crawl upon its fore legs, the two hind being paralyzed; in twelve they were able to be moved a little; in fifteen it could crawl better, but seemed unable to direct its course; in twenty-four hours it had entirely recovered. On being placed in the same jar for three minutes it did not move afterwards.

It is curious to observe the effects of the acid upon these



insects. If a wasp be actively moving against the window, and an open bottle of the acid be held under it for four or five seconds, its motions almost immediately become less vigorous, its wings and legs gradually, but rapidly, become quiet, and for a moment it hangs to the glass by one or two feet, then drops dead.

I should venture to recommend the vapour of hydrocyanic acid to the entomologist, as a far better mode of destroying his specimens than any hitherto suggested. It acts more speedily, apparently occasions little or no suffering, does not affect the colour, and any position may be given to the insect.

The following experiment, though long, is very interesting. It shows most decisively that hydrocyanic acid is not cumulative, but on the contrary, that like many other poisons the system may by use be enabled to bear doses of it, which at first would have been destructive. It also shows that at times the effects of hydrocyanic acid *are very similar to those produced by opium*, far more so, indeed, than some writers upon medical jurisprudence would lead us to suppose.

No. 141\*.—*September 6th.*—Male cat, rather more than half-grown, placed in the jar with two minims of acid: in one minute he began to be convulsed, and was immediately taken out insensible, but with the reflex action good; four minutes, howled frequently; ten minutes, becoming sensible, nose plunged two or three times into cold water without much effect; thirty minutes, has lain perfectly still without stirring, but now, on being patted, he took notice, and in a few minutes walked; he repeatedly passed water, and was freely purged; he continued weak and indisposed to move, but in two hours and a-half was able to play with another cat.

Twenty-four hours, blood examined with the microscope; perfectly normal.

*September 7th.*—Twenty-four hours after, experiment repeated in the same manner. He evidently instantly recognised the smell of the acid, and made most desperate struggles to escape. At fifty seconds he managed to push off the heavy weight upon the jar, and got the head and fore legs over the edge of it, when he was instantaneously seized with a strong convulsion, and fixed across the jar: he was laid upon the floor, where he continued perfectly rigid for two minutes, and passed water and fæces very freely,



when he rose and crawled a little distance to a warm mat, where he laid down and remained still, and apparently in a comfortable doze for three quarters of an hour, at which time he appeared well again.

*September 8th.*—Twenty-four hours interval, has been active and cheerful all day. Experiment repeated: in forty-six seconds he became affected, fell, and was strongly convulsed; one minute, taken out; he lay perfectly paralyzed, with sensation and reflex action lost, up to twelve minutes, when a few drops of water were put into the ears, which occasioned a sudden moving of the head; and on a little being put into the mouth it was convulsively swallowed; a slight convulsive movement in the limbs now took place; this continued to increase, and the muscles to acquire more power, until twenty-five minutes, when all motion ceased and he was again paralyzed, being perfectly sensible, both seeing and hearing, but unable to stir a limb; forty minutes, has gradually improved; has been covered with cloths, which appear very grateful to him; now lies shivering, as though in an ague fit, placed in a warm corner near the fire; immediately he began to purr and seemed much pleased; two hours after he was much as usual, only weak; on a piece of meat being given, though he appeared very hungry, it was with great difficulty eaten; at the early part of the experiment the respiration was laboured and panting; at the latter, very rapid and feeble; both fæces and urine were passed.

*September 9th.*—Has been active and playful all day. Twenty-four hours after last experiment, blood examined and found to be perfectly natural. Experiment repeated: kept in the jar *three minutes* without any effect being produced, having set himself down and appeared quite at his ease; on being removed there was considerable straining to pass urine, with some protrusion of the penis and rectum. The jar was found to be rather moist, which might prevent the ready volatilization of the acid, and thus account for so little effect being produced.

*September 10th.*—Twenty-four hours interval. During the day has been perfectly well and active, with a good appetite. Experiment repeated: at one minute and three quarters made great exertions to escape up to two minutes and a-half, when he was violently convulsed; three minutes, taken out; he immediately shrieked loudly, became paralyzed and insensible, but with reflex action remaining he lay perfectly still for six minutes, when



some little convulsive movement took place; this increased, with loud howling, the respirations becoming very rapid; twelve minutes, there is some little sensation; forty minutes, for the last five minutes he has been busy licking his coat, and now seems nearly well again; the heart acts 125 per minute, with a feeble, tumultuous, and somewhat irregular beat; respiration about sixty per minute, with the murmur very loud; fæces, but not urine, were passed.

*September 11th.*—Twenty-four hours interval. Has been perfectly well all day: blood examined, quite natural. Experiment repeated, a trifle more acid being used: no effect until two minutes and a quarter, when he made very violent attempts to escape, and the respiration became hurried; three minutes, just began to be convulsed, the cover was removed, and he dashed forwards to spring out of the jar; at the moment he was seized with convulsion, and hung balanced across the edge of the jar for half a minute, then fell and lay paralyzed and insensible for a minute and a quarter, when on being taken hold of he howled loudly, roused up as from a deep sleep, and looked about as though frightened; in five minutes he was able to walk, but much preferred to sit crouched in a warm place, and on being noticed appears very pleased and purrs very loudly; urine, but not fæces, passed.

*September 12th.*—Well and active all day. At twenty-four hours interval experiment repeated; same quantity of acid used as last night: in one minute and a quarter affected; he became strongly convulsed with the mouth intensely red; three minutes, removed from the jar, having for the last minute lain perfectly quiet and only breathed twice; both urine and fæces passed in the jar; when removed he began to breathe quickly and convulsively; sensation and reflex action lost; fifteen minutes, has lain perfectly still and motionless; purged three times; muscles now show some little convulsive motion; twenty minutes, reflex action restored; twenty-five minutes, some little sensation; thirty minutes, now conscious, but without the least muscular power; respirations upwards of eighty per minute; thirty-nine minutes, some little muscular power; howls most horribly, especially if disturbed; put by the fire, as he appears to be very cold; two hours and a-half, for the last two hours has lain in a state very similar to that of a person who has taken a large dose of opium, appearing to be overpowered with sleep; can be rolled from side to side from one end of the



room to the other without rousing him or his making the least effort; but he howls as though not liking to be disturbed; both fæces and water freely passed.

*September 13th.*—Twelve hours after. During the night he had crawled into an adjoining room, and was found lying upon a piece of carpet; is perfectly sensible, but moves with the greatest difficulty; in attempting to walk his motions are most curious, he possesses hardly any control over the limbs, and stands with the hind legs widely apart, unable to stir. During the day he took some milk most greedily, and lay for some time with his nose at a piece of bread as though he wished to eat it, but could not; twenty-four hours, cannot move so well as in the morning; he has with great exertion managed to get out of a small box three or four times, when he falls down without being able to rise, but can push and drag himself upon his side by the carpet across the room; if his feet are pressed against he pushes with tolerable power, and, for the instant, will move the head suddenly, but he has a great disinclination to move, and lies as though in a sound sleep, breathing deeply and regularly; if caressed he immediately purrs. He has been several times purged, and the rectum and penis protrude. There appears rather to be a want of regularity and control over the nervous energy than any absolute loss of the power of contraction in the muscles. Some meat was given, and though he appeared most eager to eat, he made not the slightest effort to get it into the mouth; on examination I found the jaw firmly closed; the meat was cut up into small morsels and put into the mouth; if forced near to the fauces it was swallowed most voraciously, with every appearance of satisfaction. Blood natural.

*September 14th.*—Thirty-six hours after, much the same as last night, cannot stand, but has taken, with much difficulty, a little milk; forty-eight hours, limbs in the same state; offered some milk, with which he appeared pleased, but could only get up a few drops; about two ounces were put into the mouth by means of a teaspoon, this he eagerly swallowed; afterwards he could lap a little milk.

*September 15th.*—Sixty hours, improved, can now walk with only occasional falling head foremost; seventy-two hours, can get over the ground rather faster than in the morning, but falls and lies perfectly helpless for some time, then goes staggering about;



in whatever position the limbs may be placed there they remain for some minutes; if he be steadied by the skin of the back being taken hold of he can get on much better; meat and milk have to be put into the mouth, when they are voraciously swallowed. He appears not to be able to find the food even when placed close to his nose, perhaps from the sense of smell being injured.

*September 16th.*—Eighty-four hours, improved; can now walk without falling, unless touched; eats most voraciously, and begins to clean off the dirt which has remained upon him for some days.

*September 17th.*—One hundred and eight hours, is now nearly well, except being weak, but he can run, is more disposed to move, and if called to will come.

*September 18th.*—One hundred and thirty-two hours after last experiment being nearly well it was repeated: not affected for one minute and a-half, when he breathed rapidly; two minutes, convulsed; two minutes and a-half, paralyzed; three minutes, taken out insensible, but with reflex action; in three minutes more this was lost; he lay paralyzed, breathing rapidly up to ten minutes, when he gradually became more strongly convulsed, howling repeatedly; at twenty minutes he became sensible, and soon after tried to get up, but rolled over; twenty-five minutes, was able to crawl to the mat from which he had rolled; thirty minutes, quite sensible, but will not stir. Blood perfectly natural. He was purged and passed water repeatedly.

*September 19th.*—Has been, during the day, active and has eaten most voraciously when the food is put into the mouth, but is altogether incapable of finding it. Twenty-four hours interval experiment repeated with rather more acid. He showed not the least symptom of being affected for two minutes, and was not convulsed until two minutes and three quarters, and when taken out, at three minutes, was not altogether insensible; in three minutes after being removed could stand, and in five minutes he could walk a few steps; in half an hour he walked down stairs. Blood examined and compared with that of a strong healthy young cat; both were alike.

*September 20th.*—Twelve hours interval, can walk, and is able to jump off a table without falling, but does not like to move. Experiment repeated: in one minute was convulsed, but the convulsions showed much less power than before; three minutes, taken out of the jar perfectly paralyzed, insensible, and without reflex



action ; in four minutes the pupils became most intensely dilated, but two minutes afterwards they were not nearly so much so. The heart beat, feebly, upwards of one hundred per minute ; there was not *the least trace of pulsation in the carotid arteries*. I thought for some minutes he would die, but he soon rallied ; in fifteen minutes he was sensible, and in twenty-five minutes able to walk a few steps.

*September 20th, four p.m.*—Seven hours after last experiment it was repeated ; no effect for two minutes and a-half, when he was convulsed ; at three minutes, when taken out, he was unable to stand, but consciousness was not lost, and in five minutes, except weakness, he was recovered. The heart beat very feebly, and the pulsation of the arteries could not be felt, indeed, the circulation for many days has been very weak.

The following experiments upon plants were made by putting either a cutting or small root into an ounce and a-half phial filled with water, with which six minims of acid had been mixed, corresponding cuttings and roots being placed in similar phials filled with the same water, but without the acid. The phials were placed in two adjoining rooms, in order to completely prevent any effect from the evaporation of the acid upon those plants which were put into the water. The circumstances of air, temperature, and light, were exactly alike :—

NAME OF PLANT.	EFFECT IN ACID.	EFFECT IN WATER.
Cutting of black currant, ( <i>Ribes nigrum</i> .)	In five days leaves dry, shrivelled, and brown.	Leaves drooping, but not dead.
Sprig of jasmine, in flower, ( <i>Jasminum officinale</i> .)	In seven days drooping, much faded, but not quite dead.	Alive and green.
Cutting of common lilac, ( <i>Syringa vulgaris</i> .)	In seven days stalk, leaves, and buds dead and dry.	Leaves dead, but buds quite green.
Root of pansy, in flower, ( <i>Viola tricolor</i> .)	In seven days dead. This died sooner than in the water, but was not so decidedly affected as some others.	Seven days dead.
Small root of parsley, ( <i>Apium Petroselinum</i> .)	Ditto.	Ditto.
Small root of groundsel, ( <i>Senecio vulgaris</i> .)	In two days drooping and faded ; in five dead. Another root placed in a phial, with double the quantity of acid, (twelve minims,) was affected in five hours, and in twenty-four nearly dead.	In five days moderately green, but faded and drooping.
Root of the chickweed-leaved willow herb, in flower, ( <i>Epilobium alsinifolium</i> .)	Dead in two days. Another root in a phial, with twelve minims, was drooping in four hours, and soon died.	Dead in four days.
Shoot of London pride, ( <i>Saxifraga umbrosa</i> .)	In twenty-one days lower leaves brown and dead ; upper, green and vigorous.	Thirty days quite fresh and healthy.
Flower of the common dianthus, garden pink.	Dead in twelve hours.	



In the following the strength of the acid was increased to ten minims in the ounce and a half of water:—

NAME OF PLANT.	EFFECT IN ACID.	EFFECT IN WATER.
A cutting of heliotrope, ( <i>Heliotropium Peruvianum</i> .)	In four hours the scent was nearly lost; in thirty-six drooping and faded; in forty-eight quite dead.	In three days still some scent, but rather faded; seven days dead, and brown in colour.
Stalk and flower of African marigold, ( <i>Tagetes erecta</i> .)	In three days petals curled up and shrunk; seven days dead and mouldy.	In three days quite fresh; seven days lower petals dead, others fresh; nine days all dead.
A small branch of stock, in flower, ( <i>Cheiranthus incanus</i> .)	In forty hours dull; three days whole flower drooping, and the separate petals, particularly of the lower flowers, shrivelled up, lost their colour, and dead; seven days mouldy.	In three days quite fresh; seven days flowers faded and nearly dead, but the stalk and leaves fresh and green.
A branch of common scarlet geranium, in flower.	In forty hours faded, leaves and flowers drooping; three days flowers shut up, and petals falling off; seven days dropping to pieces.	In three days quite fresh; seven drooping, but colour clear and bright; ten days all dead.
A branch of common tansey, in flower, ( <i>Tanacetum vulgare</i> .)	In forty hours drooping, with lessened scent, but leaves quite green; three days leaves withered, flowers dirty-looking, with scarcely any scent; seven days leaves and stalk brown and shrivelled up.	In three days perfectly fresh; seven days flowers faded, but the leaves and stalk fresh; ten days these much faded.
A cutting of common garden rose.	In forty hours dull, but the leaves green and moderately upright; three days leaves faded, drooping, and many of them covered with brown spots; seven days nearly the whole surface of the leaves and stalk dry and brown.	In seven days perfectly vigorous; ten days green, but drooping.
A cutting of musk plant, ( <i>Mimulus moschatus</i> .)	In four hours scent nearly lost; forty, nearly, but not altogether, faded; three days beginning to rot.	In three days perfectly fresh and has grown; seven days quite fresh and green, but not in so full flower; ten days quite alive.
Small branch of marsh mallow, in flower, ( <i>Althæa officinalis</i> .)	In three days much faded and very drooping; seven days shrivelled and dried up.	In three days flowers a little faded, otherwise perfectly fresh; seven days flowers dead, but stalk and leaves green and fresh; ten days ditto.
Slip of garden verbena, in flower.	In forty hours somewhat faded; three days leaves curled up, flowers dropping off, and the plant altogether shrivelled up.	In three days some of the flowers dropping off, otherwise perfectly fresh; seven days flowers gone, leaves and stalk fresh; ten days ditto.
Flower of a petunia.	In forty hours quite dead; three days beginning to rot.	In three days quite fresh; five days dead.
Slip of heath, in flower, ( <i>Erica cinerea</i> .)	In forty hours not much affected; three days quite dried and crisp.	In seven days flowers dead, but leaves and stalk green and living; ten days ditto.
Flower of Indian nasturtium, ( <i>Tropæolum majus</i> .)	In four hours brighter than that in water; in twenty-four hours quite withered.	In twenty-four hours withered, but not so much as that in the acid.

The following were put into a phial with thirty minims of acid:—

NAME OF PLANT.	EFFECT IN ACID.	EFFECT IN WATER.
Nasturtium.	In four hours faded; twenty-four dead.	
Verbena.	{ In forty hours very drooping, but not dead; three days withered.	
Chickweed-leaved willow herb.		
Flower of a petunia.	In forty hours dead.	

\*.\* In seven days the four were all mouldy.



The following plants were placed in a glass jar (pint and a-half,) into which ten minims of acid had been put, the top of the jar being closely covered over; corresponding plants were put into a similar jar without the acid:—

NAME OF PLANT.	WITH ACID.		WITHOUT ACID.
	IN TWENTY-FOUR HOURS.	IN THIRTY-SIX HOURS.	IN THIRTY-SIX HOURS.
Flower of nasturtium.	Much shrivelled.	Dead, but colour retained.	Nearly as fresh as when gathered.
Cutting of rose.	Leaves dull and rather brown.	Sap exuding from stalk; the leaves all dry, and of rusty brown colour.	Rather dry, but otherwise perfectly fresh.
Cutting of lilac.	Dry and faded.	Leaves dry and shrivelled up; dirty brown in colour, with small white spots upon them.	Leaves rather dry, and somewhat shrivelled up, colour good.
Cutting of black currant.	Dull and faded.	Shrivelled, dry, and brown.	As when cut from the tree.
Pansy in flower.	Not very much affected.	Colour of flower good, but the stalk and leaves perfectly faded and powerless.	Nearly as when gathered.
Cutting of ivy.	Not much changed; rather dull.	Faded and shrunk; perfectly powerless.	Fresh as when cut.
A piece of mignonette, in flower.	Faded, dull, and colour changed.	Perfectly shrunk, powerless, and of a brown-yellow colour; no scent.	Green, fresh, and with scent.
A sprig of jasmine, in flower.	Ditto.	Ditto, but not to quite the same degree.	Ditto.
A piece of groundsel, in flower.	Soft, dull, and faded.	Perfectly shrunk, brownish-green in colour, and wet.	Rather faded, but no other change.

\*.\* The above had so shrunk, and lost all erectibility and vigour, that at thirty-six hours they did not occupy half the space in the jar they did at first, and by a little pressure not one-fourth.

The above experiments will probably be regarded as sufficiently numerous to show that hydrocyanic acid affects vegetables generally. Though these cannot be considered as equally with animals susceptible to its influence, still it is evident it acts as a deadly poison. The most remarkable effect of the acid, whether the plant be exposed to the influence of the vapour, or be put into a weak solution, so that it may be absorbed within the tissues, is the complete prostration of all the power of the plant; it becomes shrunk, feeble, and dry; or if it be a succulent plant, moist, often with the sap exuding from the stem. The condition of the plants strongly resembles that of animals when in a state of paralyzation from a dose of the acid, or the extreme flaccidity immediately after death, before the commencement of rigidity. The acid soon disappears, being either decomposed or absorbed; for after a few hours, in all the experiments no smell of it was perceptible.\*

\* These experiments, it will be seen, confirm those made by Marcet, Christison, and Turner, and others, as to the action of different poisons upon plants being very



## POST-MORTEM EXAMINATIONS.

Four dogs were placed upon the boarded floor of a closet, under the roof of a large room; the weather was hot and dry, and from being just under the roof, they were exposed to the action of the sun. Two were examined on the sixth day, and two on the seventh day, after death. In all, putrefaction had very far advanced; indeed, they were perfectly putrid and horridly offensive. The contents of the stomachs were collected and distilled; the stomachs were also cut up and placed with distilled water in another retort. There was not the least trace of acid in the liquid from either retort.

Examination of five dogs forty-three hours after death.—To two of them iron had been given, (No. 51 and 52;) one had been placed under the douche, (No. 37;) one had had the acid by the mouth, having on the previous day had it by the vagina, but not sufficient to destroy it, no antidote or remedy having on either occasion been used, (No. 12 and 40;) and the other had been destroyed by having had the acid introduced into the rectum, (No. 22.) The quantity of acid which had been given was, No. 51, ten minims; No. 52, ten minims; No. 37, five minims, a smaller dog than either 51 or 52; No. 12 and 40, having had before death seventeen minims of acid, viz., twelve minims by the mouth, and the day before about five by the vagina, also less than these two, but larger than No. 37; and No. 22, six minims by the anus, of the same size as No. 40, but not so old a dog. The smell was beginning to be offensive, though all were very stiff and rigid. The muscles were natural in colour and appearance. In No. 51 and 52, where the iron had been given, there was the greatest change; the least, in No. 22 and 37; indeed, in these, especially No. 37, there could hardly be said to be any disagreeable smell. In all, the liver was soft; there was no alteration in the gall-bladder; the spleen natural; the stomach much contracted, and the mucous membrane red; the lungs were

similar to those upon animals. Dr. Lindley, in his *Introduction to Botany*, p. 295, has referred to some experiments made by M. Macaire, on the effect of poisons upon plants, and amongst them of hydrocyanic acid; but the poison having been used in a comparatively concentrated condition, so good an opportunity for judging of its effects was not, in my opinion, afforded as in those above related.



not engorged, but appeared *shrunk and contracted*; heart distended on both sides; blood in it equally dark in all the cavities: in one dog, fluid; in the others, loosely coagulated. The stomachs of No. 51 and 52 contained plenty of iron; the stomachs of these two were cut up, washed with distilled water, and with the contents distilled in separate retorts. There was not the least trace of hydrocyanic acid, neither was there among the contents any appearance of Prussian blue. The stomachs of No. 12 and 37 were also cut up, washed, and, with their contents, distilled. The distilled fluid yielded a very faint odour of hydrocyanic acid; and the nitrate of silver, as well as sulphate of iron tests, showed slight, but still decided traces of it.

As it appeared desirable to ascertain the condition of the head and spinal marrow at or soon after death, I made the three following examinations:—

No. 23.—Bull terrier examined nine hours after death. Blood fluid and dark; muscles excessively rigid; no unusual injection of the spinal cord or its membranes, nor of the brain.

No. 79.—Where death had been delayed after the first dose. Examined immediately the heart had ceased to beat. Brain natural, not injected; some *little* clear serum upon the surface and in the ventricles; sinuses quite full of dark blood. The pia mater congested, as was the theca of the spinal marrow, though it was rather the vertebral sinuses which were full of dark fluid blood than the marrow itself or its investing pia mater. I thought I could detect a very faint odour of the acid in the brain, but I was not perfectly sure of it.

No. 14.—Death speedy. Brain and spinal marrow, with membranes, natural; not particularly injected.

In all the dogs that I examined the stomach was found to be very much contracted, the mucous membrane excessively corrugated, and of a brownish reddish colour.

These examinations having furnished so little information of a positive character, I determined to open the bodies of many animals destroyed under various circumstances, and examined at different periods after the acid had been given. For the result, in by far the greater number of instances, I must refer to the accounts of the experiments themselves, to which I have added them; in order to save space and to avoid, as far as possible,



unnecessary repetition, I here place the details of only a few of the examinations.

No. 86.—Rabbit: poisoned in two minutes and a-half, by respiring the vapour of hydrocyanic acid. Examined five minutes after it had ceased to breathe. Heart: some little clear serum in the pericardium, also in the cavities of the pleuræ. This was evidently just being effused, as on the pericardium being opened and the serum wiped away, the surface of the heart was soon again moistened by the exuding fluid. The left ventricle contracted and firm, the right ventricle filled, but not distended, with blood; the two auricles excessively distended, as were the coronary veins, the three venæ cavæ (the rabbit has two descending cavæ,) and the pulmonary arteries and veins; the aorta and its branches were empty; the lungs were reddish in colour from the blood they contained; the two auricles and right ventricle contracted rapidly, but, apparently, without the power to propel their contents. Blood uniform in colour, darker than natural and muddy in appearance. Brain not in the least injected, indeed, it might be called pale in colour; neither its membranes nor sinuses were filled; spinal marrow itself natural, not injected, nor was the spinal pia mater, but the vertebral sinuses, from top to bottom, were enormously distended with almost black fluid blood. During the time the brain and spinal marrow were examined the heart continued to pulsate. I cut through the cervical portion without effect, then cut out the whole dorsal and part of the cervical without effect, then cut away the whole brain and remaining part of the cervical spinal marrow, the heart still pulsating, and not being in the least influenced by the interference with the cerebro-spinal axis. The pulsation of the heart had not entirely ceased until an hour and a-half after the animal had been placed in the vapour, eighty minutes after the heart had been exposed, and sixty minutes after the brain and spinal marrow had been removed; first the left auricle ceased, then the right ventricle, and lastly the right auricle.

The examination of the kitten presented analogous appearances. There was serum effused into the pericardium and pleuræ; the lungs were reddish from the blood they contained; the right ventricle and the two auricles, with the coronary veins, were distended, but not to the same extent as in the rabbit, and the left



ventricle contained some little blood ; it, as well as the three other cavities, continued to contract, or rather to move ; the aorta was not perfectly empty. Brain and its membranes not injected ; in fact, the substance of the brain was white ; spinal marrow natural ; the dorsal sinuses, through the whole extent of the vertebral canal, filled with dark fluid blood, but not to the same extent as in the rabbit ; entire brain and spinal marrow removed in the same manner as in the rabbit, with the same want of effect upon the action of the heart. It was not until at least six hours had elapsed after the whole cerebro-spinal axis had been taken away, and more than six hours and a half after it had breathed, that all the cavities of the heart ceased to move. This they did in the usual order, the left ventricle soon being empty, contracted and quiescent, the right auricle continuing to move the longest.

Though the heart in pulsating does not appear to propel the blood, yet the cavities gradually become less, the blood probably being forced out by the tonic rigidity which supervenes ; so that although its motions become more feeble, until some extraneous stimulus, as a sharp prick, is required to excite them, by the time they have altogether ceased the heart is generally empty, very small in size, and hard from its contracted state. This is a condition which I have observed in nearly every animal examined while the heart has been acting.

No. 87.—Rabbit : died from the inhalation of the vapour of the acid and of sulphuric æther. Opened three minutes after it ceased to breathe. Heart, acting strongly ; appearance of heart, blood vessels, and lungs, exactly as in the preceding rabbit, with the same effusion of serum going on. Head and vertebral column not disturbed, in order to compare the heart's action with the preceding. Heart ceased to act in less than three hours ; the ventricles, at least, an hour and a-half before the auricles ; these continued nearly filled with blood, which on the following morning was found to be partially coagulated. The ventricles also contained a small quantity of blood ; altogether the heart was not contracted so firmly or completely as in the preceding case, or as is usually found.

Kitten : death induced as the last. Chest opened four minutes after it had ceased to breathe ; the appearances were exactly as in the preceding kitten. Head and back not disturbed ; the heart



continued to contract for upwards of three hours, the auricles being very active; contrary to what I have almost uniformly seen, the left continued to act vigorously, probably from its containing blood. The following morning they still contained blood, alike in colour and fluidity, while the ventricles, especially the left, contained hardly any.

No. 89.\*—Chest opened in four minutes after acid had been given. Heart beating; all the cavities contain blood, as do the venæ cavæ, all the pulmonary vessels, and the aorta, but none of them are much distended; the left cavities are much less so than the right, and the aorta than the pulmonary vessels; the blood is of a *bright florid* colour; the lungs are collapsed and of a pink colour; the whole extent of brain and spinal marrow laid completely bare in sixteen minutes; entire mass of brain removed at seventeen minutes; heart pulsating as before; whole spinal marrow removed at eighteen minutes; heart continued to beat, but not quite so vigorously, as when the chest was first opened; the left ventricle has ceased to contract and has become nearly empty, while the distention of the right has somewhat increased; the left auricle has lessened, the right is of much the same size; the auricles do not contract together, the left contracting twice to the right once, then being perfectly still, while the right auricle and ventricle continued to contract, but in no regular order, sometimes the auricle two or three times without the ventricle, then this two or three times without the auricle; forty-seven minutes, the heart is now still, but on pricking it, the left ventricle and the right ventricle and auricle show the slightest motion; there is also some little motion in the intestines; fifty minutes, all motion of the heart has ceased; the left ventricle is firmly contracted and empty, the auricle nearly so, but not quite; the right auricle is full, but not distended, the ventricle not quite so full as before, and perfectly flaccid; twenty-four hours, the heart is firm, small, and pale, *all* the cavities being perfectly empty.

No. 89.\*\*—Chest opened in twenty-three minutes after the acid had been given. Blood rather darker than in the preceding case. Condition of the heart similar, except that the right cavities are more distended, the left ventricle more contracted, and the aorta empty. Lungs pink in colour, contain frothy mucus, and are not quite so much collapsed as in the last. Fifty minutes, even on



irritating the left side of the heart, neither the auricle nor ventricle contract, but both the right, especially the ventricle, continue to contract rapidly, though feebly; one hour and a-half, on irritating, both still show very slight movement; four hours and a-half, about the same amount of motion; ten hours, on pricking suddenly, the ventricle shows the merest movement possible.

No. 142.—Half-grown kitten. Attempted to give thirty minims of acid, so as to destroy it, if possible, instantly: not nearly the whole got into the mouth, and but little of that swallowed; held in the hand by the four legs; struggled, but not violently, for nearly a minute; cried out, passed water, but not fæces, then motionless. Heart exposed in less than two minutes, beating; left auricle and ventricle contracted and empty; the right ventricle and auricle contained some little blood, but were by no means distended; pulsation did not expel any portion of it; aorta empty; the venæ cavæ tolerably full, but not distended; lungs collapsed and white, not in the least engorged; the ventricles soon ceased to contract, but the auricles, more particularly the right, continued to contract for nearly half an hour; the right ventricle was now nearly empty and quite flaccid; the left ventricle became quite dense and rigidly contracted, even while the right was perfectly soft and loose; this, however, gradually contracted, but was not perfectly so until the expiration of nearly three hours. Twenty-four hours after, the heart quite firmly contracted and dense; on cutting open the cavities, about two drops of blood were found in the right auricle; the other cavities perfectly empty; indeed, from the contraction, there were no cavities.

No. 143. Kitten, fellow to the preceding. Gave thirty minims of acid; the whole swallowed: convulsed, cried out feebly, passed a little urine; insensible in fifteen seconds. Chest opened in forty-five seconds. Blood natural in colour. Lungs white, and instantly much collapsed; the large blood vessels not much distended. Heart, feebly pulsating. Left ventricle and auricle empty and contracted, but not very firmly; right auricle and ventricle contained some blood, but not distended. The left side of the heart soon became motionless; the right ventricle showed some fluttering for five minutes, and the right auricle continued in motion for twenty-three minutes; the motion, however, was of such a character as not to propel the contained blood. During this time the right cavities gradually became fuller, and were now distended, but not



excessively so; the venæ cavæ were also rather full. It was not until nearly an hour had elapsed before the left ventricle had become completely contracted; the blood in the right side separated into two portions, a colourless and coloured, but still was not coagulated. Thirteen hours after, the right side of heart is rather less than it was, but still contains blood, and is flaccid; the superior cava opened, the blood in coloured and colourless portions immediately escaped, emptying the heart, the motion of the blood rendering it of one uniform colour.

*Blood.*—The condition of the blood would naturally excite considerable attention; an attentive examination of it, however, does not yield any very positive results. The appearance of the blood to the naked eye is often materially changed, not only in colour, but it looks muddy and broken down, while its important property of coagulation is so interfered with that it seems to be the generally received opinion, that after death from hydrocyanic acid the blood is almost invariably found in a fluid state: yet this is by no means the case; and unless other observers shall be more successful than myself, the examination of the blood will throw but very little light upon the subject. If, however, any inference is to be drawn, it will tend to confirm the opinion that the action of the acid is upon the central nervous mass, the blood being only secondarily involved. Though the blood to the naked eye is often materially changed in appearance, yet when examined under the microscope no decided difference is seen between the globules of blood drawn from an animal before the administration of the acid and that taken immediately after death has ensued from it, whether the acid has been given by the stomach, or through the lungs by inhalation.\* Experiment 141 *bis* shows that even the almost daily

\* I would here recommend any experimenter upon the effects of substances upon the blood, first to examine the healthy blood of either the same or a corresponding animal, or he may be led into a mistake similar to the one I was nearly committing. I first examined the blood of a kitten poisoned by the acid, in which the globules were seen of the most irregular shapes, or, rather, regular in irregularity, for the greater number approached a hexahedral or octahedral form, with a few larger flattened circular discs among them. This would have been supposed an effect of the acid had we not examined the healthy blood, which was found to present exactly the same appearances. The addition of a minute portion of water, or hydrocyanic acid, instantly converted the irregular granules into circular globules. The irregularity in the shape of the globules of the young kitten has not, I think, been mentioned by



saturation of the system for the space of fourteen days with the acid does not change the character of the globules; and that the acid has, in reality, no peculiar action upon the globules is shown by the fact that when it is added to healthy blood just drawn, on examination it is found not to produce so great an effect as a similar quantity of water does; indeed, the globules remain tolerably perfect and in motion for a considerable period, the appearance of the clear central nucleus gradually becoming more distinct. It might, therefore, be supposed that the action of the acid was limited to the fibrine, yet it is extremely doubtful if there be any decided change in even the fibrine, for the foregoing observations by no means confirm the idea of the fluidity of the blood after death from hydrocyanic acid; on the contrary, in by far the great majority of cases the blood is found to coagulate, though by no means invariably so; possibly coagulation is somewhat delayed, and certainly in many instances the coagulum is found less dense than in blood abstracted from the body. But it must be borne in mind that after death from almost any cause, the coagulation of the blood in the vessels is hardly ever complete, and often very imperfect, as compared with that which possibly has been abstracted from the same body only a few hours before death. In order more certainly to test the effect of the acid upon the fibrine as the blood was flowing from the arm of a woman, bled on account of an inflamed leg, into one cup I had six minims of acid added while the blood was flowing: the only difference observed between this cup of blood and a corresponding one without the acid, was that it was thought the blood in the cup which contained the acid coagulated somewhat more slowly, but that the coagulation after a short time was more complete, and the clot more dense than in the other.

So, also, though the colour of the blood is very frequently darker than natural it is not always, as several of the experiments show. Thus in No. 112, where out of four toads which were destroyed in a similar manner, in two the blood was florid, while in only one was it very dark; and in the cats, Nos. 89 and 98, the blood was of the brightest, most florid, hue I ever saw any arterial blood,

microscopists as greater than in other young animals. I am indebted to my friend, Mr. W. S. Ward, for the use of his microscope in these experiments, and also in some of the examinations of the blood for his personal assistance.



and the blood which flowed from the jugular vein of the dogs, experiments 80 and 81, was certainly not darker than usual.

These experiments sufficiently prove that in whatever way hydrocyanic acid acts it affects the whole animal kingdom (if not the vegetable also,) in a similar manner.\* Some animals, it is true, are more obnoxious to its influence than others, but even in this respect the difference is not nearly so greatly so great as has been supposed. Those who have imagined that reptiles, amphibia, and the cold-blooded animals generally, enjoy an almost perfect immunity from its deadly properties, have been deceived. True it is that these creatures do require a larger quantity than warm-blooded animals to affect them, but the difference in the time required for the development of the symptoms is far greater than that of the quantity, it being often several minutes before any symptom whatever is manifested. Experiment 107 will show that considerable power may be retained for a long period, and, in one instance, I saw a frog, which subsequently died, leap a foot in length at least half an hour after the acid had been given. Whether the larger quantity which may be taken and the longer time required for its manifestation bears any ratio to the slowness of the circulation, or the different condition of the nervous system, it is difficult to say positively. Those who suppose the acid to act by being absorbed into the blood would incline to the former opinion, and, perhaps, consider the question proved by the well established fact of the absorption of the acid, for not only may its presence in the blood be detected chemically, but it is exhaled from the lungs in respiration within a short time after it has been swallowed, or, even, as in experiment 22, after it has been placed within the rectum. Those, again, who lean to the supposition of the difference being dependent upon the condition of the cerebro-spinal axis and the nerves, would point to the curious fact of the acid, whether it be introduced into the blood by absorption from within the living body, or merely by adding to it when abstracted, producing no greater effect if so great in its physiological properties than a

\* If the effects of hydrocyanic acid upon plants be, as the experiments seem to show, similar to its effects upon animals, it would prove either that plants possess a structure analogous to the nervous of animals, or that in these the acid does not primarily act upon the nerves, or so acting that its specific and essential action is proximately upon some parts whose structure and functions are common to plants and animals.



similar quantity of water does, and also to the fact of some warm-blooded animals, where there is no corresponding difference in the condition of the circulation, being more obnoxious to the poison than others; thus the rabbit and the mouse (perhaps all rodents,) are more susceptible to its action than is the cat, and the young animal of the same species than the old, while in these the tenacity of life and the powers of the nervous system are more equable and enduring than in the young.

When the effects produced by a dose of hydrocyanic acid are not too rapid to be observed, the earliest appear to be giddiness, with a loss of muscular power and control over the combined action of the muscles; the head droops, the mouth is open, the tongue protrudes, there is apparently a sense of distress and constriction in the fauces, and the respiration is hurried and panting; but I doubt whether this condition of breathing is not dependent upon the state of the muscles. It would seem they are unable to expand the chest deeply, gradually, and efficiently. The muscles of the pharynx and larynx are very soon affected, and, indeed, it might almost be supposed that these are peculiarly susceptible to the action of hydrocyanic acid. There are many persons who are unable to detect the presence of the acid by the sense of smell, yet who are at once cognizant of it by a peculiar feeling of dryness, and the sensation of constriction, in the throat; and even those persons who detect it readily enough by the nose are also conscious of this feeling. When any one has been exposed for some time to the vapour of the acid, even when not very concentrated, this feeling in the throat continues for some hours. Thus in the case of Mr. A——, which is reported in the *Provincial Medical and Surgical Journal* for July 23rd and 30th, 1845, with whom I remained upwards of half an hour before he died, and shortly afterwards made an examination of the body, I did not altogether lose the feeling until the next day. The true explanation, however, of this is probably, not that these parts are really more susceptible to the action of the acid than the others, but that in the act of respiration it is brought immediately into contact with them.

This unsteadiness and loss of power is speedily succeeded by spasm,—frequently of the most intense kind. This may be either tonic or clonic, according to the strength of the dose of acid and the



susceptibility of the animal. The stronger the dose usually the more violent and continuous is the spasm. If the spasm be tonic, not only do the voluntary muscles continue rigid, but the heart is, at least, to the same extent, affected. It ceases to pulsate, the diastolic action is suspended, and consequently the circulation is at once arrested, while the respiration is also equally, and at the same instant, prevented by spasm of all the muscles by which the function is performed.\* Hence, the lividity and bloatedness of the face; the protrusion of the eyes; and the excessive congestion of the veins. In this condition of these two all-important functions is to be seen one of the causes of the almost instantaneous death which takes place in some instances.

When, however, the dose of the acid is less, or the susceptibility of the animal not so great, the rigidity of the muscles soon abates and gives way, and is followed by paralysis more or less complete; when the respiration either becomes excessively rapid, the chest being but little expanded, or it is very slowly performed, being then deep and sighing. The heart now beats most rapidly and feebly.

This state of paralysis may continue, the weakness gradually increasing until the animal dies, or, as more generally occurs, the creature is convulsed and paralyzed at intervals, the heart continuing to beat very feebly for two or even three minutes after all indication of sensation and other motion have ceased; though by no means unfrequently a strong convulsion immediately precedes death. In some instances I have observed respiration continue quite as long as the heart could be felt to pulsate. If the animal recovers it will often lie in the most complete state of paralysis possible; after a time some little convulsive movement in the limbs, or some spasmodic action in respiration may be observed. These gradually become stronger, until the convulsions often become very powerful. It now howls loudly, reflex action returns,

\* It is in these cases that the foaming of the mouth, which has been much dwelt upon as a symptom of poisoning by hydrocyanic acid, most occurs. It is, however, by no means an invariable symptom; when the trismus is considerable, the foaming is seen; not otherwise. When the tongue protrudes, it often appears to possess a sort of vermicular motion, which, on closely observing, is seen to arise from a very rapid series of contractions and relaxations of its muscular fasciculi. On laying the hand upon the trunk or limbs of the animal, the same quivering is felt to pervade all the muscles.



and, after a time, sensation. The utter powerlessness of the creature gradually becomes less, and sensibility is evinced. It will now sit or lie as though in a comfortable sleep, and, after a varying period, will either wake up and appear surprised and walk slowly away, or it will continue very feeble, but little disposed to move, and with very little command over its muscles.

I do not agree in the opinion which has been expressed by some,\* that the heart only ceases to beat because of the suspension of respiration, and its consequently containing only dark blood. It rather appears to me that the cause of death is altogether different from what occurs in asphyxia from occlusion of the air passages, the heart being primarily, and to, at least, an equal extent, affected as respiration.† This is not merely a theoretical question, but a most important practical one, as it must materially influence the treatment. If the heart's action only ceases on account of the want of respiration, and the consequent engorgement of its cavities with dark blood, venæsection would be one of the remedies to which we should first have recourse, and from which we should expect the most decided benefit; while, on the contrary, if the state of things be as I suppose,—not only that the blood itself is changed by the introduction of the poison, but that the heart is primarily affected, our reasons for having recourse to venæsection would be much less powerful; neither should we expect the same amount of benefit from its employment. The results of experiments 79, 80, and 81 do not justify the expectation of any very marked benefit from the abstraction of blood, for though there is experiment 54, in which the dog recovered after having had an emetic and being bled, I do not attribute this to the abstraction of blood, but rather to the small dose of acid in proportion to the size, age, and breed of the dog; I am inclined to think the result would have been the same had blood not been taken. Besides this, it was an artery which I opened; this would, of course, relieve the left side of the heart, and consequently could have little influence in inducing a continuance of its action, according to the theory of those who think the heart only ceases to act on account of the

\* Dr. Lonsdale; *Edinburgh Medical and Surgical Journal*, vol. 51, p. 56.

† The appearance of the heart is altogether different from what occurs in asphyxia from drowning, as shown in the heart of a frog, a toad, and two kittens, which were examined immediately after death, by immersion, at the time these experiments were being made.



distention of its cavities from impediment to the passage of the blood through the lungs. If this were so, it would be the right side of the heart, not the left, which would principally be engorged, and which should be relieved by venæsection. If the bleeding in this case were really useful, it would tend to support the view I have above taken of the condition of the heart.

It must not be understood that I am arguing against the abstraction of blood in every case, or denying that congestion does occur. Under all circumstances when the respiration and circulation are feeble, and more especially in similar cases to those under consideration, where there is also spasm, congestion is apt to take place. Venæsection may, therefore, in some few cases, where the dose of acid has been small, be proper and advisable enough, when practiced with the understanding of why we employ it, and too much blood be not abstracted,\* but as there is great loss of power as well as spasm at the time, and where recovery takes place considerable weakness and depression are for a while manifested, the taking away a large quantity of blood, in my opinion, is likely to be rather injurious than beneficial. The condition of the heart, at least at first, is one of contraction, not of dilatation. There is a persistence of contraction, not a diminution of contractibility, so long as the spasm continues, and of the left cavities for long after. The cavities, it is true, may possibly occasionally afterwards become engorged, but this is only when the heart, like the general muscular system, becomes paralyzed, and certainly is not supported by the condition of things as revealed by the post-mortem examinations above recorded.

Though the sensorium is soon affected, as shown by the vertigo, which is one of the earliest symptoms, it is not that portion of the cerebro-spinal axis which appears to be most affected by hydrocyanic acid. At the time I was with Mr. A——— I could not divest myself of the feeling that he retained some degree of consciousness, and was to some extent cognizant, at least in part, of what was going on about him (and even at first, when I shouted in his ear, that he recognized my voice,) at a time when he was

\* Of this, in most cases, there is little danger, as the blood will not flow. Indeed, I am not sure the distress in respiration is not in a great measure caused by the want of blood passing through the lungs. It appears very probable that but very little blood is passed forward by the heart.



unable to give much indication of sensibility. From what I have since seen in many of the animals I have experimented upon, I have little doubt they retain some consciousness and sensibility when, from the powerlessness of the muscles, they are unable to indicate it. Of course when the powerlessness is complete it cannot be proved that either, in any feeble degree, is retained; but it may fairly be inferred from what is witnessed in such cases as Nos. 11, 23, 28, 33, 36, 39, 88, 90, 91, and others, that the acid acts more upon the nerves of motion than upon those of sensation. To what extent consciousness is retained it is difficult to say; I am, however, inclined to think it is preserved to a longer period than many are even now disposed to allow. The many cases which have been reported where parties have swallowed large doses of hydrocyanic acid, and yet retained consciousness for some time, proves that it may be retained longer than was formerly supposed to be possible; but, even in these, consciousness is thought to be retained only so long as the power of voluntary motion continues; it, however, appears probable in some cases, where either the dose has not been sufficiently large to prove suddenly fatal, or the susceptibility of the animal to its action but little, that some degree of consciousness may be retained, after all power of voluntary motion is lost, and even when there is but little sensibility remaining; at least, some of the foregoing experiments seem to indicate this. If this be correct, it would prove that the sensorium is not that part of the nervous system which is most affected by hydrocyanic acid, so also the violent spasmodic action, occurring alternately with paralysis, independent of volition, would point rather to the spinal marrow than to the brain as being most obnoxious to the action of the poison.

Whatever may be thought of this opinion, there are few persons, I apprehend, who will be inclined to dispute that upon one most important practical question these experiments are quite decisive, and fully confirm the reports which have been made of the length of time which not only consciousness, but perfect volition and entire control over voluntary motion, may be retained after a dose of hydrocyanic acid, sufficiently large to prove fatal within a few minutes, has been taken. In some few instances, as Nos. 8, 9, 15, 18, 27, and 36, the action of the poison was so expeditious as to prevent almost the slightest exhibition of voluntary motion;



but in the majority of dogs and other warm-blooded animals, about twenty seconds elapsed before any symptoms were manifested; and this space of time in a man would allow of several actions being done, as the corking of a bottle and placing it in the pocket, or upon a shelf, the possibility of which has been much doubted. In several of the dogs a much larger interval intervened, during which they gave no indication of having had hydrocyanic acid; thus the time which elapsed before any decided symptoms of poisoning were shown in Nos. 4, 6, 13, 14, 70, was fully sufficient to have permitted a man to have performed many voluntary actions, and to have not only put away anything which would have revealed the nature of what he had taken, or how he had taken it, but also to have passed to a considerable distance from the place where he had swallowed the poison: while a still more remarkable retention of consciousness and power was seen in 24, which went down three or four steps of some stairs, saw the door at the bottom was closed, and came back again; in 56, which went down, came up, and then went down again, the whole flight a steep winding staircase; and in 38, which retained sufficient vigour to jump over one of the dogs, and then actually leaped completely across the open top of the staircase. In No. 22, to which the acid was given by the rectum, fully two minutes elapsed before symptoms set in, and it was not until a further period that voluntary motion was lost, yet the animal died in thirty-seven minutes; while in a few, but only a few instances, as No. 60, where the effect was almost immediate, yet the dose was not sufficient to destroy life.

Reflex action is that which is last destroyed and first returns. This continues for some time after all voluntary motion and sensation have ceased. Touching the cornea will induce winking of the eye-lids when there is nothing to indicate the retention of volition or sensation, and irritating the nostrils of a frog will cause depression of the eye.

When the dose of acid has been sufficient speedily to destroy life, none but an ignorant or careless person would confound the effects with those produced by opium; but if the animal survives for some time it is very different. The deep, quiet sleep, with the great indisposition to be roused from it, so closely resemble those from opium, while the condition of the pupil is so variable, being



often in this stage by no means dilated, that not only is there great liability for the effects produced by the acid to be confounded with those of opium, but I have very strong suspicions that in, at least, one recent case where death was supposed to have been induced by opium, it, in reality, was caused by hydrocyanic acid. Experiments 56, 88, 90, 91, and 141 *bis*, will show the symptoms which most resemble those seen after opium.

The acid acts locally as well as generally. This is seen not merely by its producing vascular congestion, but also by the decided effects upon the nerves of the part. Thus when it is dropped in one eye of an animal, the pupil of the eye is sooner, and to a greater extent, dilated than that of the other; and when the acid is administered by the rectum or the vagina, both hind legs are sooner affected than the anterior portion of the body. (See experiments 19, 22, and 23.) But that the acid does not directly paralyze muscular fibres, when locally applied, is shown in the experiment upon the frog, No. 108, where a drop of acid, applied upon the heart itself, acted as a stimulant, inducing a quickened action; possibly any other fluid would have done the same; had, however, the acid been a direct sedative, such an effect would not have continued for so long a time, and, perhaps, more decidedly still in the cat, No. 96, where three drops were put upon the heart without arresting its motion.

Post-mortem examinations, whether made immediately after life has ceased, or not until some time afterwards, do not throw any very decided light upon the cause of death; indeed, until I had examined the state of the heart immediately the acid had produced insensibility, I had, like other observers, considered the evidence as altogether of a negative character; for the reports of the appearances found in examinations made some time after death of the bodies of men and animals who had died from the effects of hydrocyanic acid are too contradictory to be at all conclusive. Such, also, I found to be the case with the animals I examined a day or two after death; but, if the body be opened while the heart is pulsating, this contradiction in the reported condition of the heart and great vessels is in a great degree explained. If death has been long delayed, or the dose of acid very small, the blood is usually dark in colour, alike on both sides of the heart, and all the cavities of the viscus may contain more or less blood, especially



the right, which is often much distended; while, on the contrary, if the death has been sudden, in almost every case the left side of the heart, and especially the ventricle, is found to be perfectly empty and rigidly contracted, while the right side of the heart contains blood, being in some cases, though by no means always, much distended. That this different condition of the two sides of the heart does not depend merely upon obstruction to the flow of the blood through the lungs is shown by many of the post-mortem examinations, but I would refer particularly to those of the two rabbits and two kittens, Nos. 86 and 87, where not only the right side of the heart, *venæ cavæ*, and the pulmonary arteries were filled, but also the pulmonary veins and left auricle, while the left ventricle and aorta were contracted and empty. This, when taken in conjunction with the appearances found in the two kittens so suddenly destroyed and immediately opened, Nos. 142 and 143, where not only the left ventricle was empty and the auricle on the same side also, but the lungs were white and collapsed, their blood vessels not filled, and the right cavities by no means distended with blood, proves, beyond a doubt, that this condition of the heart is dependent upon causes acting upon itself, and that it does not merely depend upon any change in the respiratory function.\* In nearly every instance the aorta and its large branches were, like the left ventricle, found empty. That the large arteries are, after death from most causes, found to contain but little blood I am aware, but I do not think there is ordinarily such a bloodless and contracted condition.† It would seem as though not only the left ventricle propelled the whole of its blood, and continued in

\* It must not be forgotten that we know hardly anything of what is or would be the condition of the heart and great vessels, if examined so immediately after death has occurred in a healthy animal from any other equally sudden cause.

† This condition of the heart and great vessels sufficiently explains, what has given rise to much surprise, why it is that with the venous system so much congested, so little blood should flow on a vein being opened. It is obvious that it cannot. The circulation is positively suspended; though there be motion of the heart, the blood is not propelled; there is no *vis a tergo*. For as the left ventricle will not open to receive the blood from behind, so it cannot give the onward impetus: hence, should the blood in some degree flow, or afterwards continue to drain away, this will merely depend upon the circumstance of the aperture being in the most depending position, when, if the blood continues fluid, some of it will find an exit, as any other fluid does from an opening below its level, a mode of escape altogether different from that in ordinary free venæsection.



persistent contraction, but that if the contractile power of the great arteries be not absolutely increased, by the diminution of opposing force, it is relatively so. I am not, however, convinced (but, on the contrary, rather incline to the opinion,) that if the contractile power of the involuntary muscles be not increased, at least the persistence of it may yet be. The movements of the alimentary canal, throughout its entire extent, are not only most decided, but long continued, and afford by far the best opportunities I have had of observing the peristaltic action of the intestines, and the important use of the mesentery in preventing entanglement and intussusception of the gut. So strong are the motions of the different portions of intestine, that the attached mesentery is put fully upon the stretch. The passing of urine and fæces so often witnessed during the action of the poison, would not of itself be regarded as of much importance in this argument, as it might arise from paralysis of the sphincters, but when it is considered that it usually takes place during the time of rigidity, and that not unfrequently there is considerable straining to pass both fæces and urine, with protrusion of the rectum and, at times, of the penis, in connection with other circumstances, it is worth bearing in mind.

The curious fact of the independent action of the different cavities, and even of different portions of the same cavity, of the heart, as well as the curious order in which their contractibility disappears, the right auricle apparently possessing the greatest persistence of action, so frequently alluded to in the post-mortem examinations, and especially the property which experiment 88 and others, upon the rabbit and kittens, fully prove the heart to possess of continuing for long to contract after the brain and spinal marrow are entirely removed, even in warm-blooded animals, also supports this view. I would venture here merely to refer the reader to the detail of these experiments: the facts could not be passed over in this account of the action of hydrocyanic acid without being alluded to, but to follow them out would lead us too far away from the subject immediately under consideration, and their physiological bearing is far too important not to demand a full investigation, the result of which I must elsewhere relate. I may, however, state that while I do not consider them as proving the truth of the Hallerian hypothesis of the independence of muscular contractility



of the brain and spinal marrow, (for the determination of which a far more extended series of experiments must be made,) they are, at least to my mind, fully sufficient to disprove the opinion of Flourens as to the dependence of the heart's action solely upon respiration, inasmuch as in these experiments, and many others, the whole anterior thoracic parietes had been removed, and, consequently, no respiratory movement could take place. They not only appear decisive as to the incorrectness of the statements of Le Gallois, for the entire mass of the brain and spinal marrow was removed, but they also strongly tend to show, that whatever countenance may be given by them to the conclusions of Wilson Phillip, they at any rate prove that the sudden taking away of the brain and spinal marrow does not, as he supposed, at least under all the circumstances, arrest the action of the heart; and further, if it be admitted that these parts are under the dominion of the sympathetic nerve, not possessing an independent inherent power of contractility, the experiments would, at any rate, prove, first, that the office of the sympathetic nerve is not merely to bring those parts to which it is distributed under the influence of the motor power of the cerebro-spinal axis, but that it in reality is an independent nervous system, being only connected with the spinal marrow, and not derived from it; secondly, that as its functions are different, so is it differently affected by the same means, for while the power of the cerebro-spinal system is utterly destroyed by the action of hydrocyanic acid, that of the sympathetic is scarcely or not at all affected by it.

An appearance which I have almost invariably found present is the congested condition of the membrane upon which the acid is applied: thus the stomach is found when empty to be much contracted, and the mucous membrane of a brick-red colour. The same appearance of congestion is seen in the vagina, the rectum, and conjunctiva, when death has followed the application of the acid to these parts. I have thought the lungs were found to present a collapsed condition when the poison has been swallowed, but when inhaled the lungs are frequently, though not invariably, much congested, scarlet in colour, and in an emphysematous condition from distention of the air-cells. The examinations will show that we may in vain look for any decided change in the substance of the brain and spinal marrow. At first, when



the examinations had been limited to dogs, and those principally which had been dead some short time, I was inclined to think the little congestion of their membranes was a post-mortem effect, depending upon the position of the animal and the fluidity of the blood. I had not then observed that in nearly every instance the vertebral sinuses are remarkably engorged. On finding this in almost every case, even on immediately opening the canal, for some time I thought this was to be regarded as something positive and explaining, or, at least, connected with, the state of the spinal marrow and the excessive convulsions, but more numerous examinations lead me to doubt if the distended condition of the vertebral sinuses arises from anything more than the general distention of the veins throughout most of the body, for I have observed the two exist in the same degree in the same cases. If the convulsion have been tonic, the vertebral sinuses and veins generally are much distended; on the contrary, if the convulsion be less, there is less venous distention, though it is never altogether absent. It at first seems singular that the vertebral sinuses should be almost uniformly so much engorged, while the cerebral are not; but this, perhaps, admits of explanation by the fact of the vertebral sinuses being rather the receptacle for the blood which has circulated in the surrounding parts, than in the medulla itself, while with the cerebral sinuses it is just the reverse. Hence, probably, the circulation in the spinal marrow is in reality not more disturbed than it is in the brain, for if it were, we should find the congestion in the veins accompanying the spinal arteries, instead of in the vertebral sinuses, which we do not. We must, therefore, conclude that the symptoms exhibited depend upon some functional perversion in the action of the nervous system, or upon some physical change, which either disappears with life, or is of so slight and subtle a character as hitherto to have escaped detection, being confined to the more minute organization; or, on the other hand, we must consider the persistent contraction of the left ventricle of the heart as a primary effect of the acid, the suspension and perversion of the cerebral and spinal functions being secondary and dependent on the want of a due supply of arterial blood, and, possibly, on the congested condition of their veins.

In the case in the *Provincial Medical and Surgical Journal* before referred to, it is stated that the acid was easily detected in the



contents of the stomach twenty-three days after death, although no pains had been taken to preserve it. This appeared to be in direct contradiction to the general opinion as to the speedy disappearance of the acid. From what I have since seen I do not now doubt that the preservation of the acid for so long a period was owing to the contents of the stomach having been removed from the viscus, and to their being strongly imbued with gastric juice, the antiseptic properties of which were sufficient to preserve the whole mass from decomposition. The examination of the animals now reported does not confirm the supposition that, under ordinary circumstances, hydrocyanic acid can be found many days after death, even when the body has not been disturbed.\* If decomposition is not accelerated, it is certainly not delayed; and when this has advanced to any extent, it is probable the acid will have participated in the change. I am inclined to think the rigidity after death from hydrocyanic acid is greater than after death from some other causes. I may also mention that animals poisoned by the acid may be eaten by others. The trout, killed by six minims of acid, was eaten the same night by a cat without any ill effects; so also were some of the rabbits, and others were blown by flies, the maggots of which feasted most luxuriantly upon them.

There is no fixed quantity of acid which will invariably destroy life. The boundary between the dose which is hazardous, or even will destroy life, and that which may be taken with impunity, is very slight and indefinite,—dependant upon individual, and, probably, varying circumstances. The same creature is, I apprehend, liable to be seriously affected by a dose which at another time would produce but little effect. This, indeed, appears to be fully proved by the varying effects produced upon the cat, No. 141 *bis*, by exactly the same doses of acid. The more vigorous the animal *cæteris paribus*, the larger is the quantity which may be taken. The stomach being full of food lessens the effect of the acid, probably by its mixing with the acid, and thus preventing the poison coming into such ready contact with the mucous membrane. At this period there is also more vigour in the system, whereas an empty stomach allows the immediate contact of all the acid at once, and a hungry animal possesses less power of resistance. It was owing to the stomach being nearly filled with food recently

\* In scarcely a single case could I detect the smell of hydrocyanic acid in the brain.



taken at breakfast, that, I think, may fairly, at least in part, be attributed the long continuance of life after the swallowing of so large a quantity of hydrocyanic acid as there is every reason to suppose was taken by the person whose case is reported in the *Provincial Medical and Surgical Journal* for July 23, 1845. The age of the animal, I am quite satisfied, makes a material difference.\* The foregoing experiments, I think, fully prove that a much smaller dose of the acid is fatal in young animals than in old; and that almost in direct proportion to the youth of the creature is it speedily and fatally brought under the influence of a smaller dose of the acid. Several of the experiments would, however, show, as Nos. 87,\* 87,\*\* 90, and 91, that this must be taken with some limitation, for it would appear that the *very* young animal is actually less susceptible, and requires a larger dose of the acid to destroy it, than does one of the same species a little older. This is so curious a fact, that were there not sufficient evidence to support it, we should feel much inclined to doubt it. Is it to be regarded as another proof of the approximation of the young of the higher species to the adult of the lower?

The degree of concentration of the acid has no very material influence over its action. The dogs to whom a diluted acid was given were quite as speedily and violently affected as those to whom acid of Scheele's strength was administered. Indeed, I am inclined to think, from observing the action of the concentrated acid, containing twenty-five per cent. of real acid, that a moderate degree of dilution renders the action of the acid more speedy, probably from bringing it at the same instant into contact with a larger surface. Certainly the foregoing experiments shew that dilution to a considerable extent does not weaken the action, if it does not rather accelerate it. The contrast between experiments 11 and 35 would by many seem to prove greater effect and rapidity in the very dilute acid; it must, however, be borne in mind that No. 11 was an adult dog, while No. 35 was a young one.

\* It will be observed that I have for the most part mentioned the breed and age of the dog. The old can certainly bear much more than the young, the strong and active than the feeble, and some animals, when every circumstance appears to be as nearly as possible the same, have a greater power of resistance than others. I am not quite certain that the weather does not make some difference in the power of resisting the acid: in very hot weather I suspect it is somewhat less; probably on account of the debilitating effect it has upon the creature.



The action of the acid is not proportionably speedy to the quantity taken. The difference between the rapidity in the effects of a large dose of the acid and of one which is so small as to be barely sufficient to destroy life, is certainly well marked; but this is not the case between two doses each of which is capable of destroying life with moderate rapidity;—as for instance, suppose forty minims of Scheele's acid will kill a dog within four minutes, it does not follow that eighty minims or two drachms would do so in two minutes, or in one. Hence, when called to a person poisoned by hydrocyanic acid, we cannot, merely from the length of time he has survived, or the violence of the symptoms, determine anything with certainty as to the degree of concentration or dilution of the acid, nor, except within wide limits, much as to the absolute quantity taken.

In determining whether hydrocyanic acid possesses an accumulative power or not, it is necessary first to determine what we understand by this. The foregoing experiments clearly show that where one dose has not been sufficient to destroy life, a second smaller one, which, by itself, would not have been sufficient to kill, if given before the effects of the first have passed away, immediately induces more violent symptoms, and that death speedily ensues. Thus, within certain limits, hydrocyanic acid may be said to be accumulative, but in this sense almost every medicinal preparation is the same. But if it be meant by those who imagine that the acid is accumulative, that doses of it given on different days may be so small as singly to produce no injurious effects, and might otherwise be continued with impunity for an indefinite period, yet that these distinct quantities may remain in the system unchanged until the whole aggregate quantity shall suddenly produce the effect of a larger quantity given at once, I must in toto dissent from the opinion; indeed, I think we may fairly consider the result of experiment 141 *bis* fully sufficient to prove that hydrocyanic acid does not possess this power; on the contrary, many would, and I believe correctly, regard it as proving the contrary,—that the system becomes habituated to it, and by repetition will endure a dose which, if given at first, would have been destructive.\*

\* I wished to try the effect of repeated doses of the acid by the mouth, but I found its action so capricious and unmanageable that it is almost impossible to do so. When administered by inhalation, it is far more manageable, as we can withdraw the animal at any moment from the impregnated air.



Whether or not hydrocyanic acid be decomposed in the system I am not prepared to say, but it is certain that it is readily absorbed, and also that it passes off with the respired air by the lungs, for the breath of poisoned animals, both warm and cold blooded, strongly exhales the odour in a short space of time, and I have no doubt the whole is quickly passed off. It does not, however, necessarily follow that the effects of it as speedily pass away; indeed, several of these experiments show that they do not, particularly experiments 39, 56, and 141 *bis*. It is the same with alcoholic drinks, yet no one attributes to them an accumulative property. Hence, a dose which may with impunity be given two or three times a day, because there is time not only for the acid to be given off, but for the effects upon the system to subside, cannot, I think, prudently be repeated every hour or so; for though it is possible the acid may have been given off, I do not think the system would have had time to recover from the depressing influences of it. It was curious to observe that however helpless and paralyzed a dog might be lying, if another dose were given, the first and *immediate* effect of it was to rouse it, and often to produce violent motion.

The poison acts with almost, if not absolutely, equal rapidity and certainty when applied upon a mucous membrane, as the conjunctiva, the rectum, or the vagina, as when swallowed. (See experiments 20, 21, 22, 23, 24, 25, 98, and others.) A knowledge of this fact may be of the utmost importance in a medico-legal examination, as it would not be difficult either by force or cunning to introduce into the vagina, or rectum, or put upon the eye, a sufficient quantity of the acid to quickly destroy life—a mode of administering the poison which a murderer, who had sufficient acquaintance with its properties, is not unlikely hereafter to adopt. Experiments 86, 87, 88, 89, 101, 103, 112, and others, will prove that the action of the acid upon the lungs when air impregnated with it is breathed, is not only rapid, but certain in its effects, and forms one of the easiest methods of exhibiting it—one which it would be very easy to employ, but most difficult after a few hours to detect, as the odour being so diffusible is very soon dissipated.

It is probable that the acid applied to an ulcerated surface would speedily induce death; but of this I have hitherto not had any opportunity of ascertaining the truth by experiment: it would, however, appear, if we may form an opinion from a single experi-



ment (No. 23,) that this is not the case with a recent wound.\* I did not repeat the experiment, being averse to inflict the wound for the purpose, as there is not much probability, even if the acid would act freely when so applied, of it being thus used with a criminal intention. I do not think there is reason to suppose the acid readily acts through the epidermis. I have put it within the external auditory meatus, and upon the surface of the body, with little effect; if applied largely it might penetrate and thus act, or its evaporation will act through the respiration.

Much has been said on some recent trials as to the death shriek, as it was then termed, in persons who are suffering under a poisonous dose of hydrocyanic acid. Though it is now generally admitted that the shriek does not uniformly occur in man, it does not appear to be so generally known that this is also the case with animals. The foregoing experiments will, however, show that so far from the shrieking being characteristic of death by hydrocyanic acid in dogs, (and I may also add in other animals, as rabbits, mice, cats,) it occurs in only half the number of cases, and in not more than one-third, if quite so many, very loudly; but when it does occur, the cry is of so peculiar a kind, and so indicative of severe distress, as to give the idea of consciousness on the part of the animal of impending death,—as though it felt that its condition was such as to render all assistance unavailing: it is different from anything I have heard in any other condition of dogs or other creatures, and is, I think, when present, characteristic of the poison.

In, perhaps, a tenth of the cases the fæces alone are passed; in another tenth, both fæces and urine; and in a far larger number, the urine alone: but it so frequently happens, probably as often as in two-fifths of the whole number of cases, that neither fæces nor urine are passed, that we cannot rely much upon these as symptoms. In neither of the two cases I have seen in man were either passed. Their expulsion appears to be owing to the violent spasmodic action of the voluntary muscles assisting the contraction of the involuntary,

\* This is opposed by the statement of Sobernheim, of the apothecary who died from the application of the acid to a recent wound of the hand, occasioned by the breaking of a glass vessel in which the acid was contained. It is, however, probable the quantity of acid was large, and not at all unlikely the effect might in reality have been produced by the acid being diffused through the air, and thus acting upon the lungs by respiration, a mode by which, as the foregoing experiments fully prove, hydrocyanic acid acts with considerable rapidity and power.



as the rectum is usually unloaded and the water passed during a strong rigor—often during the violent one, which not uncommonly immediately precedes death. If, instead of a mere unloading of the rectum, there is purging or tenesmus, it may be regarded as a favourable sign, as it was observed in nearly all the dogs, and in several of the cats, that recovered. Vomiting is, of all the symptoms, the most favourable, not only, I apprehend, from the unloading of the stomach, getting rid of part of the poison, but also as indicating that the system is not fully under the influence of it. Vomiting does not occur in recovery after inhalation.

I know of no antidote to hydrocyanic acid.

Chlorine has been much spoken of by many persons, but it is probable these parties have advanced the claims of chlorine rather on theoretical and chemical grounds than from any experience of its utility. It will be seen from experiments 56, 57, and 58, that little good is likely to result from it. In these dogs it was administered much earlier than it is ever likely to be in the human subject, and yet they died quite as soon as those dogs to whom a like dose of the acid had been given, and where nothing was done. We should, therefore, I think, not be justified in placing much reliance upon its efficacy as an antidote. Some persons may consider the quantity of chlorine given not sufficient, but the extreme difficulty, often impossibility, of getting anything swallowed after hydrocyanic acid has been taken, must be borne in mind, and I apprehend chlorine can only be given in solution, and not as a gas, by inhalation.

It appeared not improbable that if an insoluble cyanide of silver could be formed, by administering a solution of the nitrate soon after the acid had been taken, good might possibly result; but this is fallacious. It will be seen from experiments 42, 43, 44, and 45, that the cyanide of silver itself acts as a poison, in a weaker degree, it is true, than hydrocyanic acid, but in a similar manner; and the termination in those dogs (Nos. 46, 47, and 48,) and in the cat (No. 83,) to whom a solution of nitrate of silver was given immediately after the acid had been administered, by no means holds out much hope of any great advantage from this preparation.

Alkalies have been suggested, as readily combining with the acid,



it being thought the compound would be less deadly than the acid. There appears not much value in the suggestion, and experiment 49 shows that potass is not likely to be of any avail.

The preparations of iron I thought worthy of a trial. It seemed not impossible that we might, if these were given sufficiently early, so far convert the acid into an inert prussiate of iron as to render it innocuous. Accordingly I gave iron in different forms,—the red oxide, the fresh precipitated green oxide, and the sulphate, alone and in combination with alkalis, (see experiments 50, 51, 52, 53, and 54,) but in all equally without such effect as to lead us to expect any advantage as likely to result from administering them as antidotes.

If the class of antidotes give us little hope of counteracting the poison by changing its composition, the expectation of relief from remedies against its effects is not much more cheering.

I had formed some anticipation of relief from electricity or galvanism, but the result of experiments 26, 27, 28, 29, and 30, appears to destroy every expectation of benefit from its employment. In experiment 28 the dog recovered after the first dose of acid, but this I believe it would have done had nothing been tried, the dose being small in proportion to the size and strength of the creature. It is true some muscular action is continued longer when galvanism is used than when nothing is done. This, however, appears not to be anything more than the motion which may be induced by galvanism in the limbs of any recently dead animal. Indeed, on comparing experiments 26 and 29 it would appear as if the galvanism, by its continued excitement, sooner exhausted muscular irritability, or nervous energy, for it will be seen that though muscular action continued much longer in No. 26, where galvanism was applied, than in No. 29 where nothing was done, yet that at the end of twenty minutes, when action could no longer be excited in No. 26 it was freely excited in No. 29.

Experiments 33 to 41 show the effects of cold water. This remedy has been very much relied upon from its apparently good effect in some cases, but probably much more from the symptoms appearing to require some such rousing of the system as cold affusion produces. Though the effects of it in these experiments are not such as to confirm the very high expectation which some practitioners have held out of its value, nor to lead to the conclusion that where



a large dose of the acid has been taken much good will be effected by the use of it, yet, I think, we may fairly consider that when the dose has been of barely sufficient strength to destroy life, cold affusion possesses some power for good, and hence it is one of the means to which we should without any loss of time have recourse. In one or two of the cases, I am inclined to think, the plunging was rather injurious than not, and I must take the liberty of warning gentlemen against the supposition that if the moderate dashing of water is useful, a more continued and general application of it would be still more so. This is most decidedly not the case. When the whole of the body was placed in water for more than a very short time, or the douche was repeated too often, or the water allowed to fall with too great a force, the dog appeared to suffer, and harm was done. A moderate quantity of water suddenly dashed a few times upon the face, or the head just plunged in water, produced better effects than placing the whole body in it. This produced depression and shivering. The contrast between experiments 56, 60 and 39, and 35 and 37, will shew this. It must be borne in mind that those dogs and cats which recovered were weak and depressed, and some were paralyzed for many hours, or even days, as Nos. 39, 56, 88, 90, 91, and 141 *bis*, and all appeared to feel the cold and to suffer from it, while warmth appeared to be very grateful to them. I would, therefore, venture to recommend that cold water should be merely dashed upon the head and face, and not, as some have advised, that the whole body should be put into cold water.

The effect of a good shaking ought not to be overlooked. In some of the animals the effects of the poison appeared to be delayed by this, and in several of those which recovered the return of sensibility and motion was, I thought, decidedly accelerated by it; indeed, from its effects upon animals, I am inclined to estimate its value as high as that of anything I have tried.

It is not necessary here to repeat what I have already said of bleeding. It has been stated that in most of the dogs which recovered vomiting took place. This also occurred in the man Jackson, who recovered after taking so considerable a dose of the acid.\* It might, therefore, be presumed that the use of emetics would be beneficial. I tried the effect of three preparations—

\* *Provincial Medical and Surgical Journal*, August 13, 1845.



sulphate of copper, sulphate of zinc, and tartarized antimony; experiments 59 to 71 will show the result. It will be observed, that if the dose of the acid were small and vomiting were induced, the creature recovered; but, on the contrary, if large, the stomach became insensible to the action of the emetic, even though the dose of this were considerable and administered immediately after the poison. We may, therefore, conclude that where the quantity of acid swallowed has been so small as to be of doubtful effect, or the condition of the stomach such, from the quantity of food which it contains, or, perhaps, spirits, (Jackson had been drinking to some extent before taking the acid, and took this in gin; though we do not know what influence this condition of the stomach and system may exercise, the fact is worth bearing in mind,) as to prevent or delay the speedy action of the poison, the administration of an emetic is proper, and ought to be practised, yet that the experiments hold out not the least hope of advantage from emetics where the quantity of acid has been considerable, even though immediately at hand to be instantly given. But little difference in the action of the three different substances was observed, but of course it would be well to select that substance which acts most promptly.

Whatever may be the value of some stimulants, experiments 87, 87,\* 87,\*\* and will show that little advantage is likely to result from sulphuric æther. In these cases it was given in a way likely to test its properties in a more favourable manner than it is probable it ever could be in any ordinary case of poisoning by the acid, and yet, so far from any benefit resulting from it, if any effects were produced by it, the action of the acid was increased in power and rapidity.

It is, however, upon diffusible stimulants that great reliance is placed; and as of these ammonia is the one to which most value is attached, statements having been published which, if corroborated by experience, would show that at least one tolerably active remedy against the effects of the poison was in our possession, I was anxious to ascertain if those favourable opinions were founded in fact. Accordingly, a greater number of experiments with this stimulant were made than with any other supposed remedy or antidote; and they are so varied that it may not, perhaps, be thought presumptive to suppose they will enable us to estimate the true value which should be attached to ammonia. Experiments 73, 74, and 75 will



show the effect of ammonia given internally within a very short time after hydrocyanic acid had been administered by the mouth; No. 100, the effect when given mixed with the acid; Nos. 76, 77, and 78, of it freely applied externally shortly after the acid had been swallowed; No. 97, of the effect of the vapour of it after the acid had been given by the mouth; No. 98, after the acid had been put within the eyelids; Nos. 88, 91, 94, and 99, illustrate the effects of the vapour of ammonia when mixed with the vapour of hydrocyanic acid, both being inhaled together; No. 95, of the vapour inhaled shortly after the inhalation of the vapour of hydrocyanic acid; and No. 96, of the vapour when inhaled previously to the giving of a dose of the acid by the mouth. This latter experiment was made in order to ascertain how far it was possible to prevent the development of the action of the poison by having the system well saturated with the supposed antidote. The liquor ammoniæ was as strong as possible, and in all cases the quantities given were larger than *cæteris paribus* are likely to be administered to man; we may, therefore, consider the test as fairly applied. The conclusion to be drawn from these is, that though on the whole, under some circumstances, ammonia may possibly possess some virtue as a remedy, it by no means merits the praise which has been bestowed upon it, nor are we justified in placing much dependance upon it when the dose of acid has been at all considerable. The external application (and it was freely applied,) did not appear to be of the least value; nor was the administration of it by the mouth much more encouraging, either given shortly after the acid had been swallowed or when mixed with it. The dog No. 75 rallied, it is true, after the ammonia had been given; but when the smallness of the dose of the poison, and the mode of its administration is considered, this case affords very little ground for attributing any other good effect to the ammonia than the inducing of vomiting, which cannot be regarded as the proper action of it, nor for the production of which it would be given. Neither was the vapour of ammonia, when used immediately after the system was affected from the internal administration or the external application of the acid, more successful, while the vapour of the acid appeared to be wholly uncontrolled by the presence of that of ammonia when this was added one minute after the animal had been subjected to it. If those experiments in which the vapour of both the acid and



ammonia were inhaled at the same time be compared with the corresponding experiments where only the vapour of the acid was inhaled, (Nos. 86, 89, 90, 92, and 93, with Nos. 88, 91, 94, and 99,) it must, I think, be admitted that though in some, as Nos. 88 and 89, the difference in the effects was too slight to be regarded; yet, on the whole, those animals which breathed the mixed vapour were less affected than the others. The smell of the mixed vapour is somewhat peculiar, whether merely resulting from the mixture of the two, or from some new compound, I am unable to say, probably only the former; if from the latter it also is poisonous, for it must be observed the effects were the same in kind, being only less violent in degree, and, therefore, as in practice, the poison and the remedy could by no possibility be so used, I think all that can be fairly deduced in favour of ammonia is, that as it may be beneficial we ought to have recourse to it, not with the expectation of deriving benefit from it in severe cases, but that in those cases where the dose has been so small as to render it uncertain which way the balance will turn it may assist it to incline on the side of life. Experiment 95, where the vapour of ammonia was administered, when the animal had only been exposed for the space of one minute to that of not a strong dose of the acid, and experiment 96, where the whole system was, as far as can be, saturated with the ammonia *before* the acid was given, will warn us against the expectation, in ordinary cases of poisoning in man by hydrocyanic acid, of deriving any very marked assistance from its use.

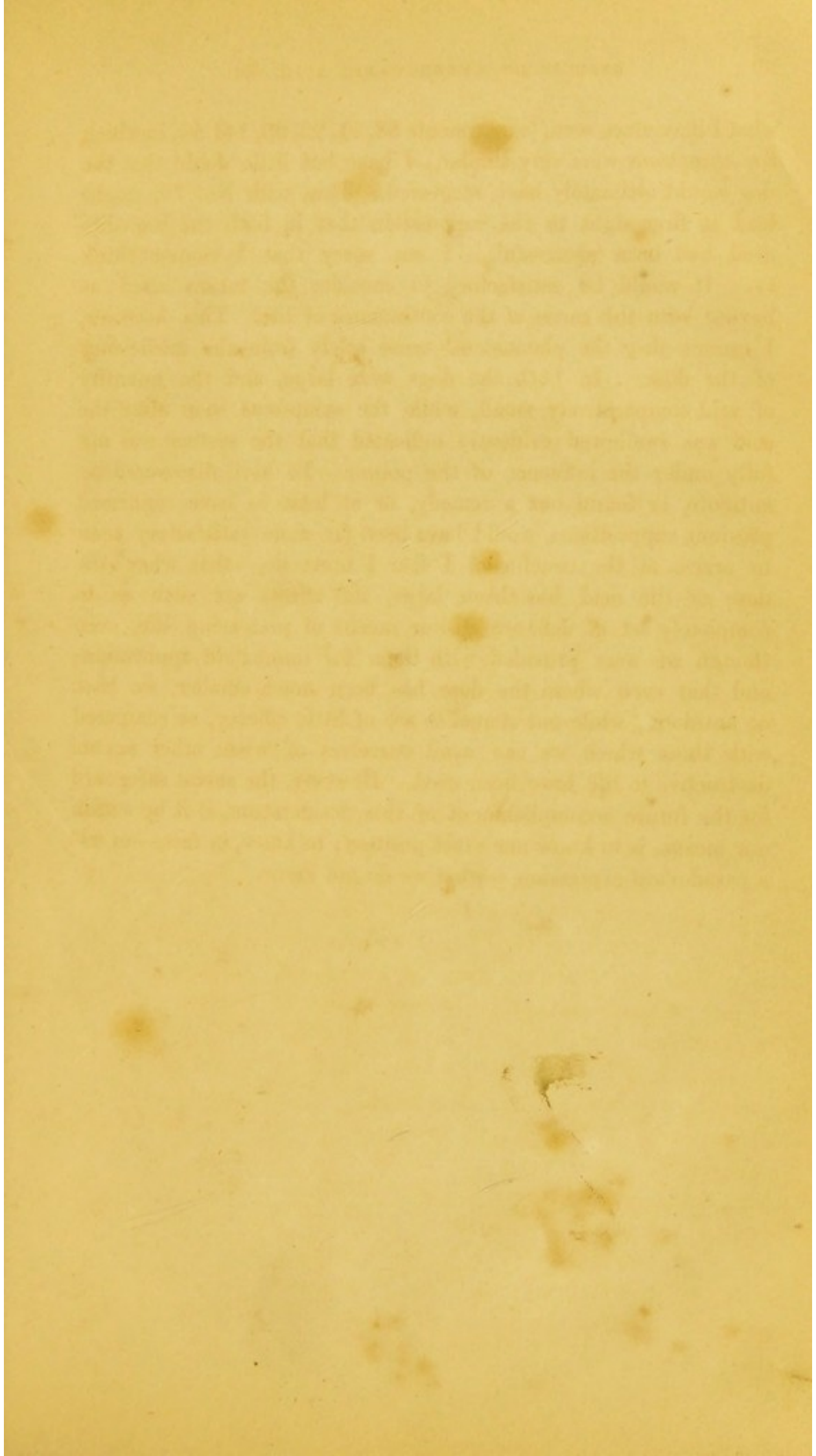
I have not as yet referred to the experiments where more than one antidote or remedy were used, as I have been wishful to ascertain, if possible, the degree of value each one possessed. In practice, however, it may be perfectly proper to combine two or more. No. 59 will show the effects of emetics and abstraction of blood; No. 33, of the douche and ammonia; No. 74, of ammonia and the douche; No. 79, of ammonia, bleeding, and cold affusion; No. 56, of ammonia and chlorine; Nos. 20 and 47, of nitrate of silver and ammonia, given under the most favourable circumstances, yet without much effect; and others of other combinations. No. 56 is one of the most remarkable experiments I have witnessed in the singular effects of hydrocyanic acid upon the dog. That the case should not have proceeded to a more legitimate termination mortified me greatly at the time, but from



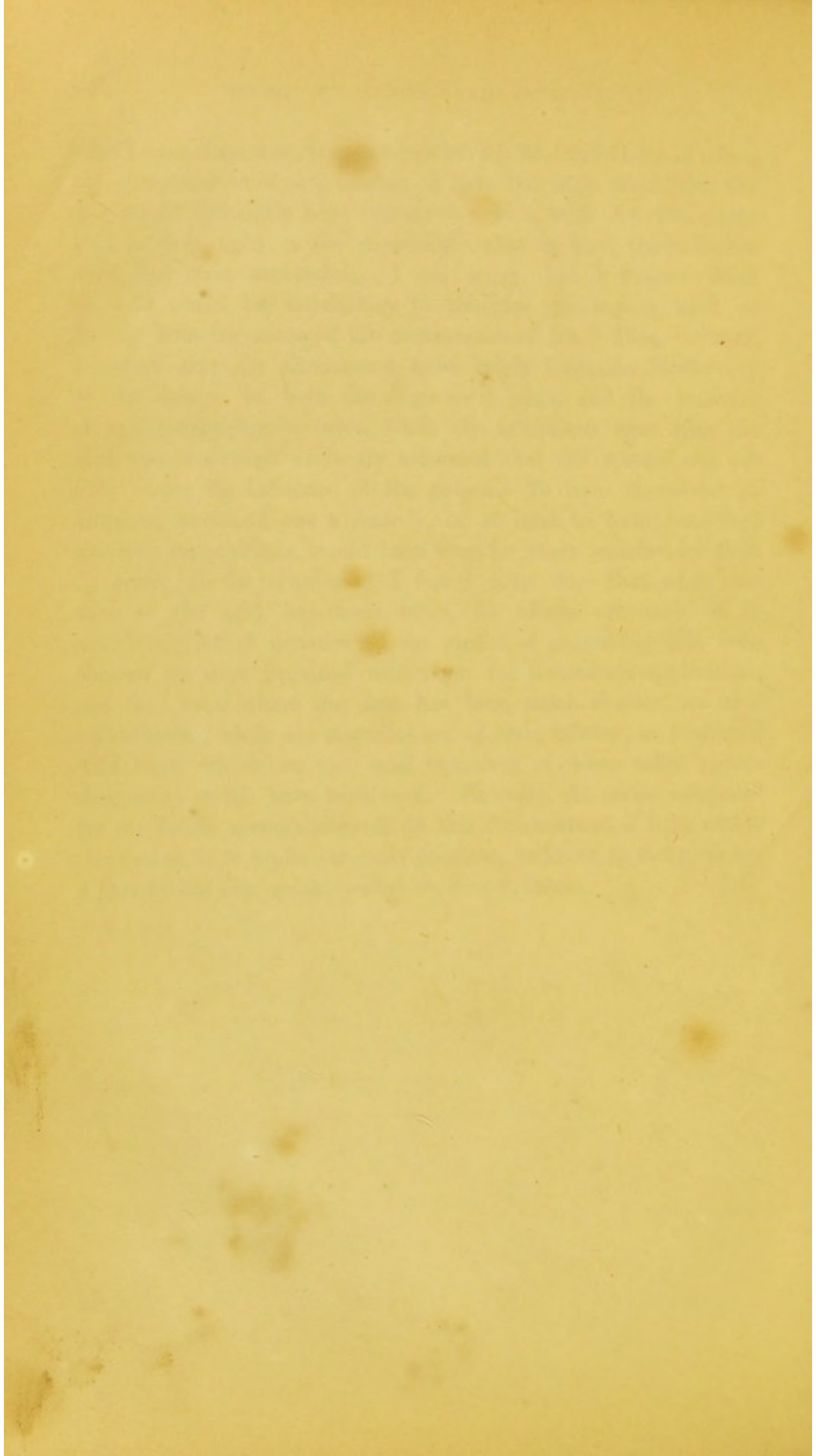
what I have since seen, (experiments 88, 91, 92, 99, 141 *bis*, in which the symptoms were very similar,) I have but little doubt that the dog would ultimately have recovered. This, with No. 79, might lead at first sight to the supposition that in both the remedies used had been successful. I am sorry that I cannot think so. It would be satisfactory to consider the means used as having been the cause of the continuance of life. This, however, I cannot do; the phenomena arose solely from the inefficiency of the dose. In both the dogs were large, and the quantity of acid comparatively small, while the symptoms soon after the acid was swallowed evidently indicated that the system was not fully under the influence of the poison. To have discovered an antidote, or found out a remedy, or at least to have confirmed previous suppositions, would have been far more satisfactory than to arrive at the conclusion I fear I must do,—that when the dose of the acid has been large, its effects are such as to completely set at defiance all our means of preserving life, even though we were provided with them for immediate application; and that even where the dose has been much smaller, we have no antidotes, while our remedies are of little efficacy, as compared with those which we can avail ourselves of when other agents destructive to life have been used. However, the surest safeguard for the future accomplishment of this desideratum, if it be within our means, is to know our exact position; to know, in fact,—to use a paradoxical expression,—what we do not know.

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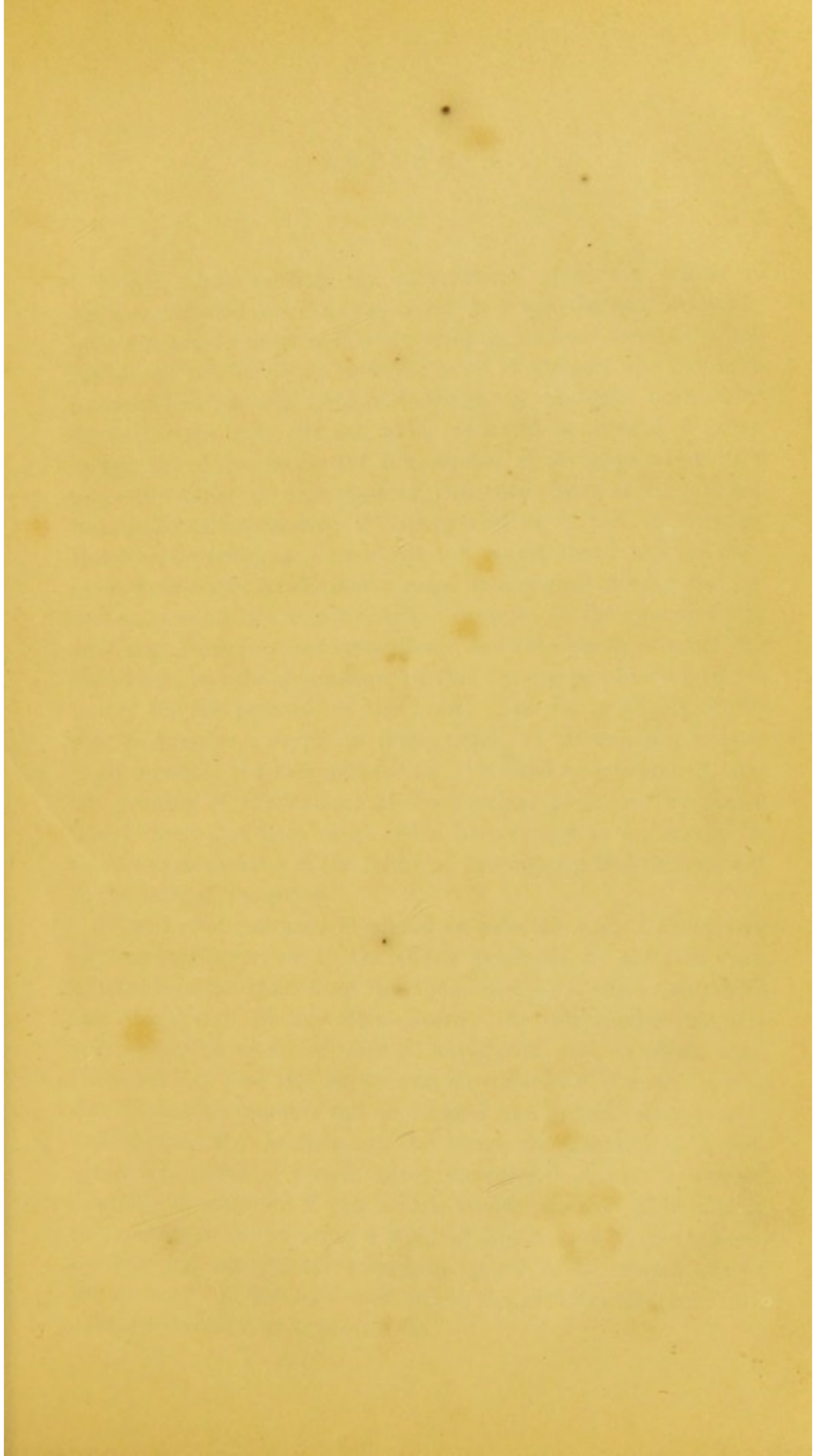




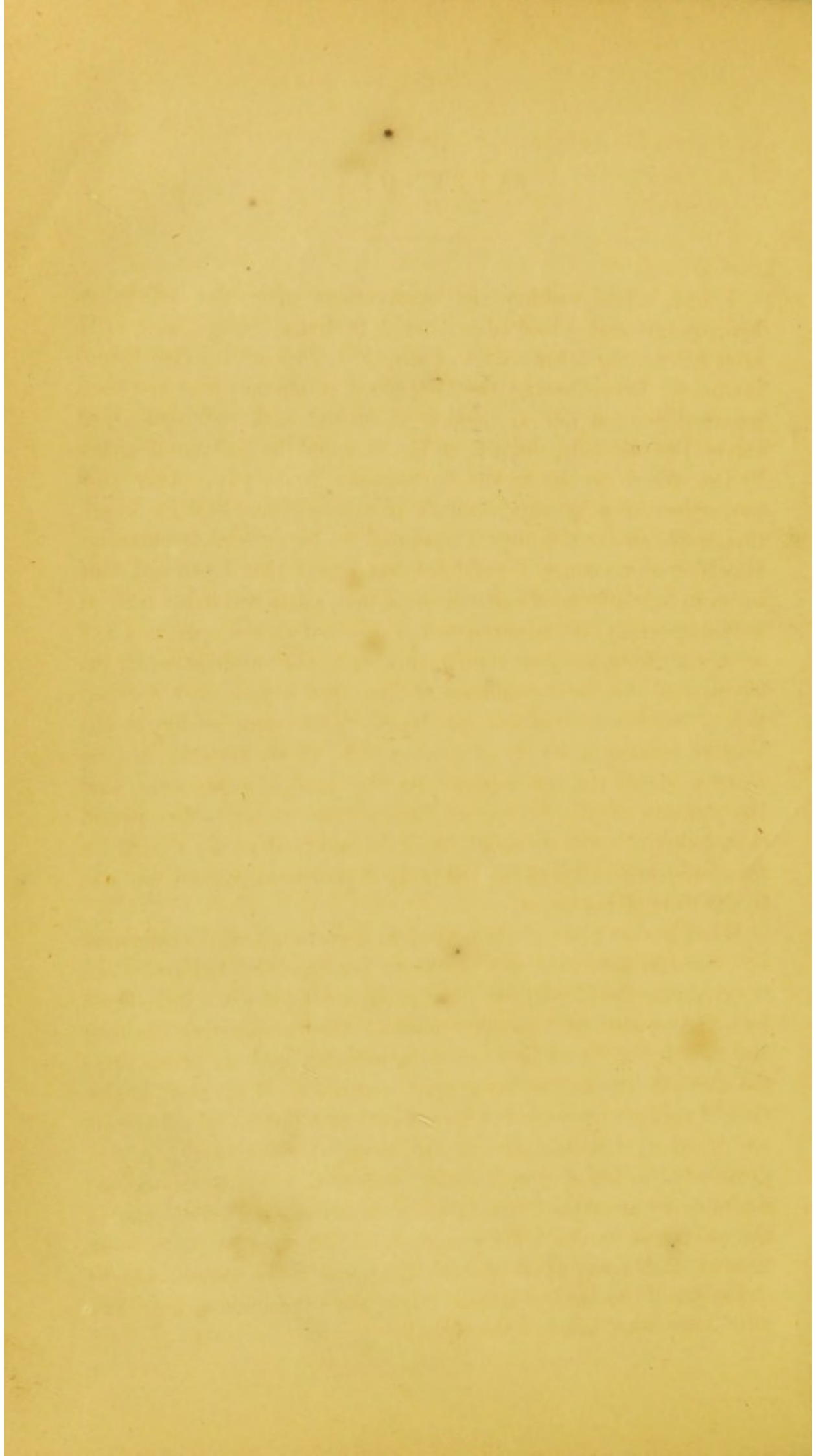














## APPENDIX.

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I had, while making the observations upon the effects of hydrocyanic acid when administered to living beings, originally intended, among other modes of giving it, to have injected it into the blood; but on seeing that the blood of animals who had been poisoned by it, as well as blood to which the acid had been added external to the body, did not, so far as could be judged of either by the naked eye or by the microscope, in its physical or vital properties differ in any essential particular from healthy blood, this mode of introducing it appeared to be of less importance. However, on reflection I could not but regret that I had not done so, as by it might be elucidated more than one interesting fact, as well as, possibly, the confirmation or disproof of the opinion I had arrived at, from previous experiments, as to the annihilation of the circulation, and the dependance of this upon a persistent contraction of the left ventricle of the heart. The being unable at the time to procure a supply of dogs, which, of all animals, are on many accounts the best adapted for this kind of experiment, and the printing of this volume of *Transactions* at an earlier period than hitherto has been usual, must be accepted as my excuse for the non-incorporation of the following experiments and observations in the body of the paper.

What I more particularly wished to ascertain was, if there were any essential difference in the effects produced by the acid when injected into the blood from those produced by it when introduced into the system by any other means; the comparative intensity and rapidity of its action when so introduced, and its effects upon the blood if it pass into the general circulation; if it enter, in how short a time its presence can be detected in a distant blood-vessel; and whether, if it be found in the blood, the quantity of it progressively, within a certain time, increases. Lastly, it seemed desirable to ascertain if the acid is readily carried off by any of the secretions, as the urine, a mode by which some of the mineral poisons, and many other materials, appear to be carried out of the system. As before, I shall relate the experiments, and then offer a few observations upon them.



No. 142.—A young, but full-grown, male cat. In order to ascertain the direct effect of the acid upon the circulation, I endeavoured to inject eight minims of acid with one drachm of water into the right femoral vein, without having first secured it by ligature. On the vein being opened it bled so freely that, with this and the violent struggling of the animal, I was by no means certain that the acid entered the vein, or did not pass into the cellular membrane along the course of it, especially as some force was required to make the injection pass: in one minute he became convulsed, and passed both fæces and urine, after which he lay paralyzed, with sensation and reflex action lost. As soon as the acid began to affect him the hæmorrhage ceased, and though the vein was not in any way secured no more blood escaped. One hour, has lain breathing feebly, but without any other motion; on the eye being now touched he became convulsed: one hour and a-half, has been many times convulsed, and there is now some reflex action, but no indication of sensation; laid in a warm place before the fire: two hours and a quarter, has gradually improved; the convulsions have continued, and in the intervals there is now some indication of sensation, also there is more power. Next morning he was found dead, lying in exactly the same place he had been left in; he had been freely purged. This cat, to all appearance, was quite as likely to recover when left for the night as several of those which did recover, nor did he at any time exhibit such an utter loss of power as some others did. On examining the limb the effusion of blood along the vein was so great that I could not find the opening, which was very small, in it. The length of time before he was affected, compared with the time in which the dogs were affected, when the large dose is considered, conjoined with other things, render it, I think, far more probable that the acid passed along the outside of the vein than that it entered it. This experiment may, therefore, be taken as an illustration of the effects of the poison when injected into the cellular tissue.

No. 143.—Small young mongrel dog, not more than ten or twelve months old. The neck having been shaved, and the left *external* jugular vein exposed, a ligature was placed round it to prevent any escape of blood, and immediately two minims of Scheele's hydrocyanic acid, mixed with thirty minims of tepid water, were, by means of a fine syringe (holding exactly this quantity,)



provided with a long fine nozzle, which was introduced into the vein through a small opening directly below the ligature, injected in the direction of the heart; the vein being immediately secured not a drop of blood was lost. In twelve seconds he became rigid, with hurried respiration; the eyes very prominent and the pupils intensely dilated; he fell and lay until two minutes, when he turned round and raised himself on his fore legs, upon which he supported himself: seven minutes, got up, walked steadily away, and passed the fæces with much voluntary effort, having done which he walked under the table to a corner, where he sat, appearing perfectly well, except weak and indisposed to move. When No. 144 was laid down, after having had the acid, he came and smelt at him, and in a few minutes ran briskly about the room, where he found a dry human sternum, which he immediately began to know most vigorously. This dog did not lose sensation, nor was he completely paralyzed.

No. 144.—A full-grown, rather small, mongrel terrier, (very dull and sulky.) Five minims of acid, with thirty minims of tepid water, were injected into the right *external* jugular vein in the same manner as in the last dog. In twelve seconds he became affected, breathing hard; he fell and howled loudly: in one minute he passed water *very* copiously: five minutes, has raised his head and looked about him, but is unable to sit: seven minutes, set upon his legs in a very awkward position, in which he stood without making the least effort to alter it: thirty minutes, able to walk to a wall, against which he supported himself, but on being taken from it he was able to run about briskly and steadily.

No. 145.—Full-grown, active, strong, rough-haired terrier, with a cross of bull dog. Eight minims of acid, with thirty minims of tepid water, were injected into the right *external* jugular vein, in the same manner as in the other dogs: in ten seconds the breathing became affected, and in twenty seconds he passed urine, howled, and on being released fell: seven minutes, passed fæces; heart now beating eighty per minute, very irregularly, but with tolerable power: eight minutes, made great efforts to get up, but was unable to do so: at nine minutes he licked his foot, which had been wetted, then got up and walked very staggeringly away: seventeen minutes, has been repeatedly purged, and now walks about wagging the tail, and desires to be noticed: thirty minutes,



seems as well as ever, looking about for something to eat. These dogs were all evidently sooner affected than when corresponding doses had been given in any other way. The symptoms were not very intense; neither the rigidity nor convulsions were very great; the paralysis was not complete; the respiration was not so much affected as it often is, nor was the heart's action so much disturbed; neither sensation nor reflex action were lost, and all these dogs recovered completely in a shorter space of time than I have usually seen.

No. 146.—Same little dog as No. 143, four days after last experiment, having been since perfectly well. Gave two minims of the same acid by the mouth: forty-five seconds, fell convulsed; up to this time he had been running actively about the room, raising himself upon his hind legs for the purpose of being patted by the lookers on; lay until four minutes, when he raised himself upon the fore-legs, but immediately fell: twenty-five minutes, has gradually improved, and is now busily employed in licking from the floor bits of grease, which had dropped from a candle: thirty minutes, perfectly well; urine, but not fæces, was passed; sensation was nearly, but not altogether, lost; neither the convulsions nor paralysis were extreme. This dog's stomach was very full of pieces of sheep's lungs, (given him unknown to me not very long before;) these he vomited soon after the acid had been given, and his first object as he recovered was to eat the whole again. It did not appear to produce any effect; indeed, I doubt whether, when only two minims of acid are given, if any of it reaches the stomach.

No. 147.—Same dog as No. 144, four days having elapsed: he has continued as he was before the first experiment, very dull and stupid, and has eaten but very little. Two minims of acid, with thirty minims of tepid water, were injected, in the same manner as before, into the left *internal* jugular vein: in fifteen seconds breathing became hurried, and he fell: one minute, passed both fæces and urine: four minutes, has laid perfectly still, sensation and voluntary motion being lost, but reflex action continues; the urine must be secreted rapidly, as he has again passed an enormous quantity: twelve minutes, appears perfectly sensible, noticing what is going on, but he is unable to rise: fifteen minutes, is now able to walk away. This dog did not stir while the vein



was being opened, nor was there the slightest motion when the acid was injected.

Two ounces of urine, passed at three minutes and a-half after the acid had been injected, was collected; by the nitrate of silver test it showed faint traces of the acid.

These experiments were made with the remainder of a little of the acid employed in some of the previous experiments; as it appeared from the effects very probable it had lost part of its strength, from having been repeatedly opened, the following were made from a fresh bottle of Allen and Co.'s acid:—

Twenty-four hours after (with the fresh acid) I made the same experiments upon the two dogs, only reversing the dogs; that to which the acid had last night been given by the mouth, had it to night injected into the vein, and that which had it by injection last night, had it by the mouth on this occasion.

No. 148.—The young dog, (Nos. 143 and 146.) Two minims of acid, with thirty of water, were injected into the right *external*, jugular vein: it almost immediately became affected and fell convulsed, but lost neither motion nor sensation, and in four minutes had nearly recovered, when two minims of acid were put into the mouth: in one minute afterwards it became very rigid and vomited, then was perfectly paralyzed, and in four minutes was dead.

No. 149.—Same as Nos. 144 and 147. Gave two minims of acid by the mouth. It was affected in a similar manner as last night, after the acid had been injected into the vein, (and the acid used then contained less of the anhydrous acid,) but in a decidedly less degree; it was soon well again.

No. 150.—Same dog as last, (No. 149,) seven days after the last experiment: he has remained very dull and stupid, but has eaten rather more; (he was, before the first experiment, in the same mood, and made many determined attempts to escape;) had given to him ten minims of acid by the mouth, for the purpose of ascertaining if the acid could be traced in the urine: he was affected in the usual manner, and was dead in six minutes. He passed the water in three minutes after the acid had been given, but not nearly so copiously as on the two previous occasions. The urine was received as it flowed into a small jar, and immediately examined by Mr. West; but neither the iron or nitrate of silver test, before nor after distillation, revealed the least trace of hydrocyanic acid.



No. 151.—Same dog as No. 145, five days after last experiment, the dog having remained since that time perfectly well. The left *internal* jugular vein having been tied, four minims of acid, with thirty minims of tepid water, were injected into it immediately below the ligature, and the vessel secured below the opening, not a drop of blood being lost. The vein was now opened *above the first* ligature: in fifteen seconds six drachms of blood were received into a small jar; again in thirty seconds; and in one minute, other six drachms in a third jar; this flowed very slowly, and no more could be obtained *above* the ligature. Both ligatures were now removed, and at two minutes, and again at three minutes, other portions, each about an ounce and a-half, were received in separate jars. The circulation had become so arrested, although the heart could be felt beating, that in order to procure the latter quantities it was necessary to enlarge the wound considerably, even down to the junction of the jugular with the subclavian vein, and to favour the escape of the blood by a depending position. A portion of glass moistened with a minute quantity of pure solution of nitrate of silver, was placed over each jar: in a few minutes each glass, but especially the last taken portion, showed a ring of the white cyanide of silver, which, on being subjected to the blow-pipe, left upon the glass a coating of metallic silver.

The heart ceased to move in about five minutes, after which ten ounces of blood were taken from the large vessels and given to Mr. West, who intended to have distilled a portion; but, in consequence of the mouth of the retort becoming obstructed by the coagulated blood, nothing came of the attempt.

Though I had intended to take all the portions of blood from above the ligature, where necessarily only that which had passed through the lungs and general circulation could escape, and fully believe that the blood received in the three first jars did flow exclusively from above the upper ligature, yet as some might entertain doubts, and incline to suppose that even these specimens might contain a portion of blood which had regurgitated, I made the following experiment, where no such supposition could by possibility be entertained.

No. 152.—An active, rather large, full-grown terrier dog had injected into the *left external* jugular vein six minims of acid with thirty minims of tepid water: he was affected in ten seconds, and



the heart ceased to beat in six minutes. Six drachms of blood were taken in separate jars from the *right external* jugular vein at the following times after the acid had been injected:—at thirty-five seconds, at one minute, at one minute and a-half, at two minutes and a-half, at four minutes, at six minutes, at ten minutes, at eighteen minutes, and at thirty minutes. The first three portions escaped freely, the three next, especially those at four minutes and a-half and six minutes, more slowly, and the time named is the medium time, as the six drachms occupied some space on each side that noted. Those at ten minutes and eighteen minutes passed rather more freely, and at thirty minutes no more could be collected. The body was now opened, and the inferior cava and internal iliac veins were divided, (at thirty-five minutes after the acid had been injected,) and about an ounce and a-half collected; and, lastly, at forty minutes from the *right* ventricle and auricle, which were moderately distended, nearly another ounce and a-half were taken.

No urine was passed by this dog; the bladder contained at least an ounce and a half. This viscus was opened at thirty minutes after the acid had been injected, and the urine taken out.

This experiment was made thus:—the external jugular vein of each side was exposed, the opening on the right side being somewhat higher in the neck than that on the left, in order to avoid the possibility of direct communication by anastomosis, a single ligature was placed under that on the right side, two were put under the left vein, the upper of which was tightened, the vein opened, the injection made towards the heart, and the lower ligature immediately tied, not a drop of blood having escaped. The ligature on the right vein was now tied, and an opening made in the vein above it, the opening being closed from time to time by the finger.

The urine was immediately examined by Mr. West, but did not yield with the nitrate of silver nor the sulphate of iron, the least trace of hydrocyanic acid.

The different jars containing blood had each placed over them a piece of glass moistened with a small quantity of pure solution of nitrate of silver. In a short time all except the first (that taken at thirty-five seconds after the acid had been injected,) showed a ring of the white opaque cyanide of silver; the third



(that drawn at one minute and a-half,) more decided than that taken at one minute; the others presented nearly the same appearances, except the two larger quantities, (that from the inferior cava and that from the right side of the heart,) which showed a more decided and thicker film than the others. Twelve hours after; in all the film was greater and more decided, and even No. 1 presented a very thin white circle, which I believe was the cyanide, but it was not sufficiently decided to speak in very positive terms about.

The deposits were exposed to a flame and blow-pipe; in each, except No. 1, a white shining metallic looking substance was the result. A cyanide of silver was made by holding a drop of the same solution of nitrate of silver over a weak solution of hydrocyanic acid; it was then exposed to the blow-pipe flame. The only difference between this and those was, that this was somewhat denser, as, indeed, from the greater quantity of cyanide, was to be expected. At Mr. West's suggestion, a small quantity of the solution of nitrate of silver was dried, and subjected to the blow-pipe flame. As before, a firm coating was left on the glass, but which differed from that left by the cyanide in not being quite so shining, and was of a darker colour, having brown spots in it. I am not sufficiently versed in the use of the blow-pipe to be able to give any opinion as to the probability of these being distinctive marks between the cyanide and nitrate of silver when subjected to the influence of heat. If it should turn out to be so, the fact will be a very useful one, (and the suggestion belongs to Mr. West,) for such very minute portions of the cyanide as were here subjected to its action it would be almost impossible to analyse in any other method; at least, I must confess to know of none. It may, perhaps, be proper to mention that the nitrate of silver is a test of far greater delicacy for hydrocyanic acid than the sulphate of iron. I have seen, in two portions of the same fluid, the nitrate of silver throw down the cyanide, while no indication was afforded by the sulphate of iron. This is especially the case should the fluid happen to possess (as urine,) a yellow tinge, which appears to mask in some degree, a feeble blue tint.

These experiments sufficiently prove, I think, that hydrocyanic acid does not produce any other effect when injected into the blood than when administered in any other way, the only difference



being a somewhat speedier effect, and also, I think, somewhat more decided, so that probably a rather smaller quantity would destroy life by injection than when applied upon a membrane, though when all circumstances are taken into consideration I doubt whether absolutely the same quantity coming into *actual* contact, over an equally large surface, upon a mucous membrane, whether alimentary, respiratory, or even the conjunctiva, would not produce, if not as speedy, at least as decisive effects as when injected into the blood. They also confirm what has been stated at pages 67 and 68, as to the acid not acting upon the structure of the blood, for here not any difference could be seen in the characters of the blood; its colour and coagulation was as usual.

That the acid is rapidly carried throughout the vascular system is decidedly shown by the last experiment; for though we might, to avoid the possibility of dispute as to the blood having actually passed the circuit of the lesser and greater circulations, not rely upon experiment 151, where the blood was taken from the same vein, though I have no doubt of the correctness of it, experiment 152 is conclusive upon the question. Here we have positive proof of the presence of the acid in the opposite jugular in one minute after its injection, if not in fifty-five seconds, as those who witnessed these experiments fully believe; and short as the time appears, it is long when compared with what Hering states he found in his experiments to be required for detecting the presence of ferrocyanate of potass in the jugular vein of a horse after it had been injected into that on the opposite side, which he states to be from twenty to thirty seconds.\* Now the heart of the horse does not in health pulsate more rapidly than from thirty-six to forty times per minute, while that of the dog beats about ninety-five times; so that, supposing other things be equal, the blood in the latter ought to circulate with at least double the rapidity which it does in the former.

I was anxious to ascertain if the successive portions of blood contained a progressively increasing quantity of the acid, and also if the blood flowed more rapidly, or even continued to flow as

\* *Müller's Physiology*, by Baly, vol. i., p. 186. I confess to entertaining some suspicion of error in the experiments of Hering, as the rapidity he gives is too great to be easily reconciled with the size of the heart's cavities, the quantity of blood, and the frequency of the pulse.



rapidly as on the first opening of the vein; because if this were so, it would tend to disprove the correctness of the opinion I have given at pages 72, 76, and 77, as to the condition of the heart, especially of the left ventricle, and the suspension of the circulation. However, these experiments fully confirm the deductions which I had drawn from the previous experiments and *post-mortem* examinations. Experiments 151 and 152 show that, even with such large veins as the internal jugular in No. 151, and the external in No. 152, opened in convulsed and struggling dogs, in the space of a minute, and a minute and a-half, the blood almost ceased to flow. So also in the cat, No. 143, where I am doubtful as to the acid being injected into the vein; in him, the blood was escaping very freely from the femoral vein until symptoms of the acid taking effect were shown, when all hæmorrhage immediately ceased, which, I apprehend, could only have occurred from the pressure of the approaching column of blood (*vis a tergo*,) being destroyed, from the left ventricle ceasing to propel any into the aorta.

The evidence is against the presence of hydrocyanic acid in the urine, for though there appeared to be faint traces of the acid in the urine in No. 147, yet no traces were detected afterwards in the urine of the same dog, No. 150, voided three minutes after a full dose of the acid had been given by the mouth, nor in No. 152, where the urine was taken from the bladder thirty minutes after the acid had been injected into the blood, and the presence of which was proved in the blood which had circulated through the body. I should rather rely upon these two experiments, which were carefully made, and conclude that what was supposed to be a faint trace in No. 147 arose from some other cause than hydrocyanic acid, possibly ammonia.

