LECTURES

ON THE

PRINCIPLES OF SURGICAL DIAGNOSIS:

ESPECIALLY IN RELATION TO SHOCK AND
VISCERAL LESIONS.*Delivered at the Royal College of Surgeons of England.*

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LECTURE VI (concluded).—LESIONS OF THE PELVIC VISCERA.

Fractures of the Pelvis and their Complications.—Rupture of Bladder; Is it always Fatal? Effects: considerations suggested thereby.—Rupture or Laceration of Urethra: Causes and Symptoms.—Traumatic Lesions of Rectum.—Shock in Pelvic Injuries, and in Certain Morbid Conditions of the Uterus.—Recapitulation.—Indications Premonitory of Dissolution or Convalescence.—Conclusion.

THE character of protection afforded by the pelvis to its contained viscera is more allied to that of the skull in relation to the brain, than to that of the abdomen or chest to the organs occupying, respectively, these regions. The arrangement of the rigid and irregular arch of bone which encloses and forms the walls of the pelvic cavity, is adapted to resist external violence by its sheer strength; whilst its large outlets permit the expansion and evacuation of its membranous contents. When these membranous and muscular organs rise, by their own distension, above the brim of the pelvis, they become obnoxious to injury, from which they are comparatively secure whilst within its protecting walls. Thus, in lesions of the urinary bladder, with rare exceptions, two conditions seem to be necessary, namely, distension and extrusion from the pelvis, which conjointly favour this result. The usual history of these cases is, that the patient has been indulging in free libations, neglecting the calls of nature, and then by some accident,—often a quarrel with a boon companion,—the abdomen is forcibly compressed, and rupture of the bladder is the result. It is somewhat remarkable that these injuries are not more frequent than they are; and this circumstance is a proof of the natural power of resistance of this membranous viscus. Accidents in which the pelvic bones are crushed, gun-shot wounds, and other still less frequent forms of injury, may involve the bladder. But ordinary fractures of the pelvis are very rarely complicated by this lesion; more frequently, though, in my experience, still rarely, its excretory duct, the urethra, is lacerated.

Fractures of the pelvis are met with in every variety, from the simplest to the most complex. They are always occasioned by great violence either of momentum or of weight, as in heavy falls, or in ponderous wheels passing across its walls. I have the records of numerous cases, some without displacement, others including dislocation of fragments of bone, or even of the pelvic symphysis, or of the sacro-iliac synchondrosis of one or both sides. In the detection of these fractures, the outline of the pelvis should be carefully scanned, including the often broken ischio-pubic ramus. Pressure, alternately with either hand, on the anterior spine of each ilium, will usually elicit any mobility which may result from loosening of this bone from its attachments. I would remark, however, that these fractures sometimes escape very careful examination; and I have long since learned the importance of assuming the possibility of pelvic fracture, where it is suggested by the nature of the injury and other circumstances, although it cannot be detected in the usual way. I could relate some remarkable instances of this class, if the time permitted; but no doubt the experience of other hospital surgeons is very much the same as my own. These obscure injuries of the pelvic bones not infrequently lead to unexpected consequences; especially where the body of the pubic bone is fractured, or the pubic symphysis is separated: such as sloughing of the areolar tissue between the bladder and bone, or burrowing abscess in the same position. It is remarkable to what an extent the pubic bones are sometimes divided in these cases, as is exemplified in the preparation I have on the table, which was taken from an old man, the subject of a contusion on the pubes, who survived the injury some weeks. I have a record of several instances, in which the separation varied from one to between two and three inches, the sacro-iliac junction being also torn apart on one or both sides. In some of these, the patients—often young—have died collapsed, without visceral lesion, and in some cases without serious hæmorrhage, or even laceration of any part of the peritoneum. The simpler forms of fracture of the pelvis usually admit easy repair. A

remarkable illustration of this was recently presented in one of my patients, a female, 84 years of age, in whom a loose fracture of the ilium was firmly united in six weeks.

I have never met with, or perhaps I should say more correctly I have never verified, an instance of recovery after rupture of the bladder. The structure and function of the organ are such as to make any reparative effort very difficult; and the qualities of the urine are of a character to render this fluid very obnoxious to the parts amongst which it is extravasated. Yet I must admit that I have, on several occasions, been surprised that the symptoms attending this lesion have not been more positive. Hæmorrhage, sickness, painful or impossible micturition, abdominal pain and tenderness not necessarily acute, are the chief symptoms in these cases, but are not, even in the aggregate, pathognomonic of the lesion. It is true that the suspicion that the bladder is ruptured may be fortified by the history of the accident and the condition of the patient at the time of its occurrence: but many instances are recorded, and some I have seen, where no certainty could be entertained as to the actual presence of this lesion, or where it has not even been suspected;—circumstances which induce me to doubt whether the generally received impression respecting the irritating quality of the urine in relation to the peritoneum may not be overestimated. The symptoms to which I have referred, accompanied with scanty urine and constipated bowels, have suggested uræmic poisoning, or even intestinal obstruction or strangulation: but the condition of the urine in the one instance, and the absence of fecal vomiting and painful peristalsis in the other, are diagnostic distinctions which are aided by the history of the case. I will place, side by side, the leading features in two cases exemplifying the above remarks.

A man was admitted under my care, over whom an omnibus wheel had passed, taking a direction from the right groin upwards and outwards. The abdomen was severely contused, and he was in a state of collapse. Bloody urine was drawn off. On the following day he had severe pain in the belly and back: fresh blood was mingled with the urine; and there was a noticeable variation in the temperature of the stream: constant sickness was present. On the third day, urine flowed through the catheter slowly, but free from blood, and was not accelerated by pressure on the abdomen. On the fifth day there was constant abdominal pain: pressure excited vomiting; and the abdomen was distended: he was delirious at night. On the seventh day it was evident that the distension was partly due to effusion: he said his belly felt like a furnace. During the succeeding week he varied, but on the whole his symptoms somewhat abated: the urine was more abundant and clear. On the twentieth day the fluctuation in the distended abdomen was more distinct, and he suffered from frequent sharp pain: the urine was albuminous; the tension of the abdomen diminishing. On the thirty-first day there was a sensation communicated to the hand, as of some solid body in the lower part of the abdomen gliding away under pressure: the tenderness had ceased. In six weeks he was well.

The other case is that of a young veterinary surgeon who, when intoxicated and riding, suddenly curbed his horse sharply, which reared and fell backwards on him. When admitted, he was semiconscious and restless, but not much collapsed, and not sick. I drew off six or eight ounces of bloody urine, without clot. He complained of constant desire to micturate, without ability to do so. On the following day there was general tenderness over the abdomen, especially on the left side: a pint of bloody urine was drawn off twice with relief. The desire to micturate continued, and he was sick for the first time after taking some tea. The temperature was 96 deg. On the third day the urine was only slightly discoloured, and he appeared better: but on the fourth the pain and tenderness in the belly became very severe, though there was no abdominal distension: he suffered from bilious vomiting, and perspired profusely: his pulse was rapid, and the temperature of the surface varied from 96 deg. to 99 deg. On the sixth day he again rallied, and passed urine freely himself, slightly tinged with blood. On the seventh day he continued to pass his urine: but the pain extended, though the sickness had ceased. He sank gradually, and died at midnight, his intellect remaining unimpaired to the last. The *post mortem* examination revealed a lacerated wound in the back of the bladder, about an inch in length. The bladder itself was contracted and almost empty. Its outer surface and the edges of the torn opening were cemented to the adjacent rectum and peritoneal folds by a considerable exudation of plastic lymph; and the intestines were attached to each other, to the omentum, and to the parietal peritoneum, by recent adhesions. The pelvis contained a pint of turbid brownish fluid; and a catheter, passed along the urethra, found its way, through the rent in the bladder, into this space.

The foregoing representative cases are suggestive of many interesting considerations. The nature of the lesion in the former instance is necessarily conjectural; but for some days the symptoms were such as to induce me to suspect injury to the bladder; and the nature of the acci-

dent rendered it not improbable that such was the fact. Indeed, the favourable issue of the case alone points to an opposite conclusion. But, is that conclusion of necessity justified by the result? I do not feel sure that it is. Assuming, as I have stated I am disposed to believe, that we overestimate the irritating effects of urine on the peritoneum, by knowing how destructive it is when diffused through other tissues, I see no insuperable obstacle to the obliteration of a small rent in the bladder, if favourably placed for such result, by plastic effusion and adhesion to neighbouring textures,—a condition which was exemplified in the second and fatal case, where the connective lymph was broken down in a large rent, by the passage of the catheter after death. And this conjecture is confirmed by the retentive and expulsive power of the bladder in the fatal case, towards its close. But what becomes of the extravasated urine, that which finds its way into the peritoneal cavity? Probably it becomes absorbed. Indeed, I know not how else to account for the absence of urine, which is a not infrequent occurrence in fatal cases; and I am not aware of any insuperable obstacle to this event. There is sufficient analogy between the secretion of a serous membrane (especially when surcharged with saline ingredients in inflammation,) and the urine, to permit the absorption of the latter by the peritoneum, even including, I apprehend, the special ingredients of urea and uric acid. But, whether this speculative opinion be correct or erroneous, still the fact remains, that in some, I may say many instances, the quantity of urine discharged is very scanty: and that, although catheterism may relieve the pelvic cavity of urine which accumulates in it, a cautious use of the instrument may give the patient a better chance, by not disturbing the process of repair, if any such effort be made.

In many cases, no doubt, the history of the accident, the general condition of the patient, and the introduction of the catheter with little or no result, point to the nature of the lesion. The constant desire to micturate and evacuate the bowels, accompanied by the disability to perform these acts, are very suspicious symptoms; and such, likewise, is the continued presence, though in diminishing quantity, of blood in the urine; for, I believe, the bladder rarely bleeds except it be rent or rendered hyperemic from irritation. Restlessness, an anxious countenance, lumbar pain, a rapid pulse and low temperature, are usually present in this injury. Yet, on the contrary, I have known some instances in which the urine has been voided spontaneously, and some where it has become quite clear and free from blood before death. Tympanites or abdominal effusion is frequent, but not constant, in ruptured bladder, and the *post mortem* signs of peritonitis vary exceedingly. The patient from whom this bladder was removed had very little urine in his bladder after the accident, but much blood, and the secretion continued very scanty during the five days that he survived, though it became quite clear, and he was able to pass it spontaneously on the third day: yet there was a large, rugged laceration, through which a hen's egg might be thrust, in the posterior part of its fundus. The man had been thrown violently in wrestling whilst his bladder was distended; and although he survived the injury for five days, the abdomen shewed no signs of peritonitis, except the presence of four pints of straw-coloured fluid, and a small patch of lymph on the bladder. Mr. Drake, of Stratford, who kindly sent me this preparation, asks, "What became of the urine that was in the bladder at the time of the accident, and how was it possible for a bladder with such a rent in it to empty itself? which it did most assuredly, and the urine was quite natural for two days before his death. Moreover, there were scarcely any signs, *post mortem*, of peritonitis." The answer to some of these inquiries may be found in the remarks which I just now made.

When rupture of the bladder is consequent on fracture of the pelvis, the injury is usually very quickly fatal. The shock is greater, and the urine finds its way beyond the peritoneal cavity. Indeed, it would appear that patients die rather from the effects of shock perpetuated and renewed in ruptured bladder, from whatever cause, than from peritonitis.

The position of the urethra, as it emerges from the pelvis, renders it especially obnoxious to laceration either from fracture or from external contusion; but separation of the pubic symphysis is not necessarily, nor indeed usually, accompanied by any lesion of this canal. Persistent hæmorrhage from the urethra after injury characterises laceration of its walls; when the blood does not find a ready exit by this channel, it will accumulate, in the form of ecchymosis, in the perinæum, but not otherwise. Occasionally the urethra is completely severed from the bladder—a fatal injury in my experience. Even simple laceration of this duct often produces collapse; but it is of a transient nature. The lodgment of a calculus in the urethra is a well-known source of obstruction and of retention of urine. It rarely occurs that it is allowed to remain so long intact as to attain such a magnitude as this phosphatic stone, which I cut from a man's urethra, immediately in front of the scrotum, where it had been lodged for three or four years, until, by increment, it occa-

sioned complete retention, and inflammatory swelling of the scrotum and penis: it is an inch and a quarter long, and three-quarters of an inch in diameter.

The source of hæmaturia in cases of abdominal injury is often very obscure, and especially so when the blood is mixed with the urine, and we are thus deprived of the advantage of examining the form of the clot. In such cases the blood may find its way rapidly from the kidney, without coagulation, presenting even a fresh and florid appearance, as I have seen where the symptoms unequivocally pointed to the kidney as its source. In other instances, the reddish-brown opaque fluid which is drawn from the bladder, with gradually diminishing depth of colour, suggests the presence of a large clot there, which is undergoing gradual solution—a condition which may be occasionally verified at an early period, by the impediment which it offers to the abstraction of the urine through the catheter. In some cases of injury, I believe, the blood is derived from the distended veins of the prostate in elderly persons; and I cannot see the objection which I know to be entertained by many surgeons to this interpretation of the class of cases to which I allude; viz., that the blood cannot retrograde, and thus find its way into the bladder: the fact I believe to be, that enlarged prostatic veins may bleed directly into the bladder. Hæmorrhage from the urethra, where the prostate is enlarged, may be accompanied by blood in the urine; and this I have known to occur persistently for some time after an injury. If the blood—and the same remark applies to pus—precede clear urine, there can be no doubt that its source is urethral or prostatic, as exemplified in rupture of the urethra, or where a prostatic abscess is burst in attempting to pass a catheter.

Superficial injuries of the rectum, in the neighbourhood of the anus, are of not infrequent occurrence, and are readily recognised and usually manageable; but deeper lesions from external violence are, in my experience, rare, and are difficult of diagnosis, and beyond the reach of active treatment.

A severe injury of this class, of which I have a record, was produced in a singular way. A young man was brought to the Hospital, who had been crushed between the buffers of two railway carriages which he was uncoupling. He was suffering from shock; and the only external injury was a laceration of the skin, extending backwards from the anus two-and-a-half inches, and forwards into the perinæum. On further examination, the rectum was found almost severed from its attachments, and retracted, being held at one point only by a small strip of the mucous membrane. There was an extensive space behind containing clots, and here the sacrum and coccyx were denuded. No fracture of the pelvis could be detected: the urethra was uninjured, and the urine was clear. He did not rally, though some reactionary hæmorrhage took place after the lapse of a few hours. On the third day, air was extravasated, emphysema extending round the pelvis, and as high as the scapula on the left side: ecchymosis was co-extensive on the right side. The collapse continued: he did not suffer much, but became restless and wandering, and died on the fourth day. In addition to the injuries described, the skin was found separated over the sacral, lumbar, and gluteal regions. The pelvic bones and the other viscera escaped; and even the rectum was only detached as described, and was not lacerated.

A more extensive and complicated injury occurred, but in a different way, to one of my patients, which was speedily fatal. In this case the rectum was ruptured, and feces were extravasated into the pelvis. The bladder was likewise ruptured, presenting a long rent, extending from its upper part to the prostate gland in front. A similar laceration, but shorter, was found in the front of the bladder; and the urethra was completely torn from the prostate gland. There were also several fractures of the pelvis, involving the acetabulum, as well as separation of the sacro-iliac synchondrosis, on each side, and of the pubic symphysis to the extent of four inches.

Lacerations of the vagina and female perinæum from external violence are occasionally met with, but offer no particular point for comment in relation to their diagnosis, which is usually simple.

In connection with the subject of shock accompanying abdominal injuries, I may be permitted to refer to some interesting facts to which my friend and colleague, Dr. Barnes, has directed my attention. In a clinical lecture on the subject, published some time since, he points out that the prolapse of a large polypus from the interior of the womb

may entail severe shock, which he attributes to the sudden violence done to the structures connected with the uterus; and observes that this form of uterine hernia is analogous in its effect, in some respect, to the twisting of an ovarian tumour on its axis. The same accurate observer records some interesting cases, in which the decomposing and purulent contents of the uterus, having found their way along the Fallopian tubes into the peritoneal space, produced sudden and fatal collapse, precisely identical, in its phenomena and fatal results, to perforation or rupture of intestine, by the intruding poisonous matter coming into contact with the peritoneum. This condition may follow abortion, where the decomposing remains of the ovum are not cleared out speedily; but it may occur in the unimpregnated uterus, when the products of inflammation are retained within its cavity, and find an exit either by the open orifice of the Fallopian tube, or by an ulcerated aperture in its wall.

Is not this a probable explanation, in some instances, of the rapidly fatal peritonitis which occurs in the puerperal state? Sudden collapse may also occur from rupture in early tubal gestation, or in rapidly formed pelvic hæmatocele. The bursting of an ovarian abscess or cyst may produce the same result; but not necessarily so, as I once had the opportunity of witnessing in a patient to whom this accident happened in St. Thomas's Hospital, by the sudden descent of a lift in which she was being lowered: in this instance the sudden rupture of the cyst was followed by a permanent cure.

In one instance only has it occurred to me to have the opportunity of performing the Cæsarean section at the full time of gestation: in this instance the shock, consequent on exposure of the abdominal cavity and section of the uterus, did not appear to be great.

I trust, Sir, that the alliance of these remarks with the subject which I have been discussing may be my apology for thus travelling off the surgical groove of my discourse.

In reviewing the preceding observations in relation to visceral lesions involving the large serous membrane of the abdomen, I feel myself committed to the following opinions.

1. The fatality of the injuries in question is chiefly due to the prolonged collapse, dependent upon the impression made on the cyclo-ganglionic nerve-centres, and terminating in death.

2. This fatal impression is due usually to the extravasation of the intestinal contents, and only exceptionally so to the actual lesion, *per se*, of the bowel; and rupture high up in the intestinal canal is, other things being equal, more rapidly fatal than lower down.

3. Lesions of the solid viscera in the abdomen are rarely succeeded by general peritonitis; and these lesions, unless extensive or complicated, and attended by the operation of other depressing causes, are repairable, and are not usually fatal.

4. When fatal, hæmorrhage is the most usual cause of death, in injuries of the solid viscera; but rupture of an excretory duct, as the hepatic duct or ureter, is a most serious, if not necessarily mortal, complication.

5. Rupture of the bladder, with extravasation of urine into the peritoneum, is not usually accompanied by collapse so profound as that which marks rupture of the intestine and the escape of its contents: in some instances the presence of urine seems to be tolerated almost passively by the serous membranes; and, as a rule, it is not resented so actively as is the presence of feculent matter from the bowel.

6. The period of survival, after rupture of the bladder, usually exceeds that of rupture of the stomach or small intestine; and the pelvic peritoneum, being far removed from the great ganglia and nerveplexus of the abdomen, is thereby less susceptible to the consequences of inflammation.

7. It seems not improbable that urine may be absorbed by the peritoneum.

Lastly, I would remark, in relation to traumatic peritonitis, that this form of hypervascular action is most variable in its presence, intensity, general features, and consequences, as well as in the signs by which it may be recognised. The fickleness of its occurrence seems to defy any general classification, but is to be explained by peculiarities, both intrinsic and operating from without, in each particular case. Those extraneous causes which will excite intense vascular activity in one instance, arouse scarcely any in another. A few patches of lymph, or the presence of some turbid fluid, may, in one case, indicate, *post mortem*, that such action existed; whereas, in another, the abundant production of plastic matter, agglutinating together all parts in contact, and floating, in its redundancy, in a sero-purulent menstruum, testify to the active peritonitis which, perhaps, a trifling cause may have sufficed to light up.

But one remarkable feature is, that not only may general chronic peritonitis run its course unsuspected, when excited, for example, by a growing ovarian cyst, but, even in the acute form, the signs and symptoms during life are by no means uniformly commensurate with the re-

sults which are witnessed after death. It is true that this circumstance may be, and no doubt in many cases is, accounted for by the depression of shock from injury under which the patient is labouring; and this is often no bar to increased local vascular action: yet, in many instances, I have no hesitation in affirming that traumatic peritonitis may be present in an active degree, with scarcely any of the characteristic signs by which it is usually described as recognisable. I say traumatic, because it is with this form of serous inflammation that I have been dealing in the preceding remarks;—a condition which, under these circumstances at least, I cannot regard as a disease, but purely as an effort, perhaps misguided and uncontrolled, in the direction of repair. Whether the so-called idiopathic form of peritonitis has, in practice, that constant type, and is uniformly characterised by those active signs which are usually ascribed to it, I must leave to more competent judges than myself to decide.

The symptoms and signs which indicate convalescence, or are premonitory of dissolution, are naturally watched for with deep interest in visceral lesions, as in other cases of doubtful issue. Many circumstances to which, separately, not much importance would be attached, assume, in concert, a significance which scarcely admits of doubtful interpretation. Such are, a rapid and feeble action of the heart; depressed or abnormally elevated temperature; a parched tongue; hurried respiration; tympanites; muscular spasm; aggravated or arrested pain; the colour and expression of the face; even the earthy odour of the skin; the raving of delirium, or the wandering of inanition,—these and many other well known signs possess, in more or less complete or varied combination, a significance which cannot be ignored.

The information derived from varying temperature is not unimportant, and will, no doubt, assume more value as our study of the facts connected with this subject becomes more accurate and extended. In acute sthenic diseases, the temperature continues to rise usually till the time of death; and it is higher, as I had occasion to remark in a former lecture, in inflammatory action following brain-injury, than in other cases, according to the record in our surgical wards. The highest death-temperature registered is 106°, in a case of traumatic abscess of the brain which I narrated last year; the lowest is 89°, in a case of fracture of the base.

In cases which belong to the category which I have recently been considering, sudden transitions in the general phase of the symptoms, the result of accidental or unforeseen causes, often baffle the calculations and anticipations of the medical attendant. But the onward march—the progressive development—of such signs as an increasingly rapid pulse and falling temperature, with a dry and glazed tongue and a tympanitic belly, is alarming; and, when the stomach rejects, not only what it receives, but its own secretions and those of the upper bowel, there is not much hope for the patient, though the cerebro-spinal functions may manifest but little sympathy with these evidences of fast-failing power and of ebbing life. The appeal is to and through the cyclo-ganglionic centres of organic life; and, till the pitcher and the wheel are broken, the silver cord and golden bowl may retain their integrity.

Among the signs of recovery, I have more confidence in a moist tongue and a tractable and willing stomach, than in any other indication or combination of signs; and herein especially is the agency of the judicious practitioner witnessed, in that he does his utmost to humour this susceptible and fickle organ, whilst he avails himself to the utmost of its capabilities for good.

In my present course of lectures, I have experienced, even more sensibly than in my last, the difficulty of compressing within a given area even a digest of the materials which an extended hospital experience has placed at my command. I have, indeed, felt painfully conscious of the obscurity which is necessarily associated with a condensed style in lecturing; and I have been as frequently embarrassed by the abundance of illustrative matter, as by the alternative of selection or entire omission. I therefore feel the more beholden to you, Sir, and to other members of the Council and professional friends, for your indulgent attention to my discourses.

The materials which I had collected, for the purpose of illustrating the extended and important subject of intestinal obstructions from various forms of strangulation and other causes, I have been reluctantly compelled to omit from my course. But it became evident to me, as I advanced, that some such sacrifice must be made, unless I were willing to permit my lectures to degenerate into little more than a series of surgical aphorisms.

Yet it has been neither my intention nor ambition to furnish a systematic treatise on the subject I have undertaken, but rather to throw into a suggestive form what I have observed, and the conclusions which I have drawn from my observation. It is in this reading of Nature from

various stand-points, and in the interpretation of her language by different minds, that our store of knowledge is extended; and he who works in an honest spirit, even though he fail to read her lessons aright, may still have done some service in helping forward the cause of Truth.

ADDENDUM.

THIS woodcut, from a drawing by Dr. Stewart, the Curator of the Museum at St. Thomas's Hospital, exemplifies the condition alluded to in a former Lecture, in which the primitive muscular fibres are found

ecchymosed, disintegrated, and ruptured, in tetanus. The specimen was taken from the patient referred to in the text, who died of acute traumatic tetanus; and is magnified 300 diameters.

ON THE USE OF PROTOXIDE OF NITROGEN GAS; AND ON A NEW MODE OF PRODUCING RAPID ANÆSTHESIA WITH BICHLORIDE OF METHYLENE.*

By RICHARD RENDLE, Esq.

It is my intention to place before you the results of my experience in the use of protoxide of nitrogen gas and the bichloride of methylene, which, I think, from the variety of cases in which these agents were used, and the varied modes in which they were administered, may prove interesting to you. Having had, since the last meeting of the Association, some opportunities of studying the use of anæsthetics in various departments of surgery, I have been often struck with many disadvantages in the use of chloroform; such as the length of time in the production of anæsthesia, the occurrence of vomiting and muscular excitement, and the tardy recovery which in some cases attended its use.

With the idea of lessening, if not of remedying these evils, I began to administer the bichloride of methylene with a modification of Dr. Junker's apparatus, which is here before you. I gave it in this way in forty cases taken indiscriminately—19 males and 21 females, from 14 months to 76 years of age. In 32 of the cases, the time required to produce anæsthesia was—over 20 minutes in 3; over 10 minutes in 4; over 5 minutes in 9; over 3 minutes in 6; over 2 minutes in 2; and over 1 minute in 8. In eight cases, all over 20 years of age, after continuing the administration for 3, 5, 10, 11, 14, 15, 16, and 17 minutes respectively, using from 30 minims to 4½ drachms, chloroform was substituted, and in 5 of the 8 produced anæsthesia in 1 minute; in 1 in 2 minutes where the methylene had been used 14 minutes; in 1 in 3 minutes where the methylene had been used 15 minutes; in 1 in 9 minutes where the methylene had been used 16 minutes; in this last case, complete muscular relaxation was required and produced. Of the 32 cases, in 1 anæsthesia was kept up for 45 minutes (ovariotomy); in 2, for 10 minutes; in 9, for 5 minutes; in 15, for 2 minutes; in 5, for 1 minute. On an average, three or four fluid-drachms were used. It was given for iridectomy in 11 cases; for strabismus in 11; for extraction of cataract, needle-operation for cataract, excision of eyeball, applying nitric acid, setting fractures, reducing dislocations, ovariotomy, and various other operations, in 18. Vomiting occurred in 8 cases—that is, 1 in 5. Thus, in the majority of the cases, it took longer to induce anæsthesia, required more of the anæsthetic, and was consequently much more expensive (bichloride of methylene being at present more than three times as costly as chloroform). Vomiting occurred as often as with chloroform; and the only advantage which I noticed the bichloride of methylene, administered in this manner, to possess over chloroform, though a very important one, was, that there was scarcely any muscular excitement.

I next gave the protoxide of nitrogen gas in 74 cases. The details of manufacture and of administration having been published in the *Odon-tological Society's Transactions*, and in papers read by Mr. Fox and Mr. Clover at Oxford last year, I shall proceed at once to mention the modes in which I have given it, and the observations I have made. Its mode of action, I believe, is similar to that of all other anæsthetics; viz., that the blood supplied to the nerve-organs is not duly oxygenated,

or is not able to interchange its oxygen for carbonic acid sufficiently for the due performance of their duties. Anæsthesia is a consequence of the air supplied not producing the necessary changes in the nerve-organs, and not of a deprivation of respirable air, as has been stated.

At first, I obtained the gas compressed in iron bottles from Mr. Barth, and gave it in the manner recommended by Mr. Coleman, which consists in causing the gas, when expired, to pass through a chamber of slaked lime (as shown in this diagram). This economises the gas very much, about three gallons being sufficient for each patient for almost any length of time, but the apparatus required is rather complicated; moreover, there must be some arrangement for getting rid of the air already in the lungs, instead of allowing it to return into the bag. This is effected by a valve near the mouth-piece, which opens on expiration, and after the first three expirations can be closed. Here are two made for this purpose. After this the gas, when expired, returns to the bag over the slaked lime, by which any carbonic acid is removed, and the gas is rebreathed. It was given in this way in 24 cases, 13 males and 11 females, from 3 to 73 years old: for strabismus, in 7 cases; for iridectomy, in 6; for operations on the eyelids, in 8; removal of opaque lens capsule, in 1; extraction of teeth, in 2. The shortest period in which anæsthesia was produced was 60 seconds; the longest, 150 seconds; average, 93 seconds. Anæsthesia was maintained 13 minutes in 1 case; 6 minutes in 5; 4 minutes in 5; 2 minutes in 12; and 1 minute in 1. Intervals of air were allowed in all but one. The gas was given until deep anæsthesia was produced, air being then admitted until the natural colour returned, when the gas was again turned on, and so on alternately as long as desired. The gas was required for a shorter period at each successive time. The period during which air was admitted varied very much, and it would require a much larger experience to state whether it had any relation to the time of each inhalation of gas or to the whole period of anæsthesia. In the earlier cases, before I succeeded in getting well-fitting mouth-pieces, some failures occurred from the admission of air with the gas; yet I noticed that, if the quantity of air admitted were small, anæsthesia was produced, though less rapidly, and the blueness was less marked. One of these patients laughed uproariously on recovery, and had lost all idea of the time. One, a woman, aged 48, on whom iridectomy was performed in both eyes, was under the influence in 60 seconds. The gas was continued five minutes longer without any admission of air; at the end of this time she was most unusually blue; the respiration and pulse very slow and failing. The gas was removed; the patient was turned slowly over on her left side (a proceeding, I believe, peculiar to the ophthalmic department at Guy's, and which has never failed to restore cases manifesting unpleasant symptoms from anæsthetics). She gradually recovered completely, and walked away in five minutes more. I next had a small gasometer made, a modification of one made by Mr. Barth (seen in section in this diagram); it has a core to diminish the quantity of water, and on the top of this is a tray containing slaked lime; a pipe passes in from beneath for the passage of the gas in and out; the upper part is exactly counterbalanced, and, as the gas is breathed out and in, this falls and rises. The expired gas is thus exposed to the slaked lime before being again inspired. Of course the same arrangement has to be made in the mouth-piece for getting rid of the air in the lungs, by the first three expirations being allowed to escape instead of being expired into the gasometer, but all other valves are done away with. This is a very suitable apparatus for an operating-room, but is not portable. This was used in 15 cases—7 males and 8 females, from 4 to 70 years of age; for strabismus, in 3; for needle operation for cataract, in 1; for operations on the nasal duct, extraction of teeth, removal of toe-nails, and various others, in 11. The shortest period in which anæsthesia was produced was 30 seconds; the longest, 85 seconds; average, 64 seconds. Anæsthesia was maintained half a minute in one case; 1 minute in 8; 2 minutes in 3; 4 minutes in 1; 6 minutes in 1; and 8 minutes in 1. One of these cases, a man, aged 30, short-necked, plethoric, who began to inhale it for the extraction of a tooth, pushed away the inhaler and refused to continue. He complained of very unpleasant sensations in his head for some hours after, but this eventually passed off. One woman complained of headache afterwards.

Having now a store of gas at my command, economy was not studied, and it was given in the ordinary way from a large bag, with a mouth-piece having an inspiratory and expiratory valve; in this way a much larger quantity of gas was used, about five gallons for each minute's inhalation. Thirty-four inhaled it in this way—22 males and 12 females, from 3 to 58 years of age; for strabismus, 3; enlarging lacrymal duct, 2; fistula in ano, 6; opening of abscess, 4; extracting teeth, 8; removal of nails, reducing paraphimosis, removal of small cysts, attempt to reduce a dislocation, 5. The shortest period in which anæsthesia came on was 40 seconds; the longest, 100 seconds; the average, 61 seconds. Anæsthesia was maintained 1 minute in 23; 2 minutes in 6; 3 minutes

* Read in the Surgical Section before the Annual Meeting of the British Medical Association in Leeds, July 1869.