is lying snugly in the bladder. Fix a safety-pin in the catheter, tie a piece of tape to each end of the pin, and carry these along the sides of the penis, and fix them there with strapping. This strapping should be just tight enough to control the tapes, and yet not so tight as to cause oedema of the prepuce. The tied-in catheter should be left draining into a bottle all the time so that the bladder never becomes distended—a most important point. The bladder can be irrigated with the oxycyanide of mercury solution (one drachm in one pint) twice a day. Be careful not to hold the irrigator higher than six inches above the level of the penis, so as not to force the bladder muscles; run in two ounces only of the lotion at a time, and then allow it to flow out again into a dish. Repeat this manoeuvre five or six times. If the urine is very purulent, and especially if it is alkaline, irrigate four times a day. If the urine is acid, give this mixture by the mouth six-hourly:

Hexamine	5 grains
Acid sodium phosphate	30 grains
Water	to 1 ounce

If the urine is alkaline give six-hourly:

Boric acid	15 grains
Ammonium benzoate	15 grains
Water	to 1 ounce.

Remove the catheter every fourth day, irrigate the urethra and tie in a fresh one. If this is not done the catheter may get blocked and the bladder stretched, and it may even give rise to perineal abscess.

By tying in the catheter several objects are gained:

1. Time is not wasted by passing a catheter frequently.
2. The urethra is not damaged by the constant passing of a catheter.
3. The bladder muscle is not overstretched, so that automatic bladder can be established in a few weeks' time.
4. It is easy to carry out lavage, the urine remains clean, and pyelitis and stone are prevented.

In any lesion of the spinal cord above the cauda equina, if the bladder muscle is not allowed to become overstretched, an "automatic bladder" becomes established in from three to six weeks' time, or occasionally in a little longer time. If "automatic bladder" has become established at the end of three or four weeks the catheter should be removed altogether, and simply introduced once or twice a day for lavage purposes. The hexamine mixture should be continued, and the patient's urination and urine watched.

The patient can learn to induce automatic flushing by tickling the skin of his abdomen, or by deep breathing ("spreading reflex"). When automatic bladder has become completely established, the catheter and lavage are entirely given up, but the mixture is continued indefinitely.

If surgeons would adopt this method they would be surprised to find how simple it is compared with such methods as suprapubic cystotomy or intermittent catheterization.

SUMMARY AND CONCLUSIONS.

I have tried to show that the subject of the treatment of the paralysed bladder after gunshot injuries of the spinal cord is ripe for discussion and needs further consideration.

My own feeling is that the methods of intermittent catheterization and of suprapubic cystotomy are inadvisable, and should be discarded. I think that in the hands of a careful worker the third method of mechanical expression of the bladder is likely to be the best method if it can be proved by end-results that it does not diminish the chances of automatic action. This method is likely to ensure a more or less clean bladder, but will it ensure an automatic bladder?

I feel that until this question is settled the method of the "tied-in" catheter is on the whole the best and most "fool-proof" method, and is likely to lead to the highest percentage of recoveries. By recovery I mean the establishment of a clean automatic bladder. If we can obtain a clean automatic bladder we give the patient a chance of living until he may reach the period of possible recovery from his paraplegia.

This paper has been written in the hope that it will induce other workers to bring forward the results of their cases, so that a comparison of the different methods may be attempted in the future.

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REMARKS ON CHEST WOUNDS.

FROM A PHYSICIAN'S NOTEBOOK.

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The following notes on gunshot wounds of the chest, which I have been asked to publish, were jotted down from time to time as the observations occurred. They represent experiences gained on the Western front at all stages, from the regimental aid post to the base hospital in England, mainly, however, at the casualty clearing station. If sometimes I may be adventuring opinions on matters surgical, I plead in extenuation that after working with Duval, Gask, J. Anderson, J. E. H. Roberts, and most particularly and intimately with Lockwood, my surgical colleague at No. 36 Casualty Clearing Station, I have seen thoracic surgery in the making.

The retreat of the Fifth Army (to which I was then consulting physician) in March, 1918, and the rapid advance of the Fourth Army from August 8th to November 11th, impressed upon me the results when military exigencies prevented the application of the surgical principles we had learnt previously. Duval's famous dictum, "the general rules of surgery must be applied to wounds of the lungs," came home at those times with additional force.

In the early stages of chest wounds the physician's first work is to help the surgeon to select cases which require, and are fit for, immediate operation or resuscitation. He has to decide at once with the surgeon and radiographer (1) whether the patient needs immediate operation. If so, why? (2) Can the patient stand immediate operation? If not, why not?

Indications for Immediate Operation.

These are by now pretty well agreed upon. Briefly, they are as follows:

1. Haemorrhage.
2. Injuries of the diaphragm.
3. Open pneumothorax (traumatopnoea).
4. "Stove-in" chest.
5. Retained missiles, bone, and clothing.
6. Early acute infection.

If one or more of these reasons for operation exist, a prolonged physical examination of the chest is unnecessary and inadvisable, unless there is doubt whether the patient will stand an operation.

Cause of Unfitness for Operation.

The patient may be unfit for operation owing to

- Intrathoracic injuries.
- Severity of the external or complicating wounds.
- Loss of blood.
- Collapse or shock due to cold and transport.

It is the physician's province to decide as to the intrathoracic injuries, and he must form a definite opinion on the following points:

Is there a sufficient degree of

- Pneumothorax,
- Haemothorax,
- Collapse of lung,
- Laceration or haematoma of lung,
- Injury of heart, pericardium, or great vessels,
- Injury of diaphragm,
- Injury of vertebrae or spinal cord,

to account for the severity of the symptoms? Radioscopy and radiography are almost indispensable in order to reach a correct conclusion on these points, but it will sometimes happen that a patient's condition will not permit of immediate x-ray examination. When this is so, the question is rendered easier rather than harder. The patient is unfit for any immediate operation save one of the following:

- Immediate and rapid operation for the arrest of visible haemorrhage from the chest wall or thorax.
- Arrest of haemorrhage from coexisting wounds.
- Aspiration for relief of pneumothorax (usually valve pneumothorax).
- Aspiration for relief of haemothorax.
- Temporary closure of open pneumothorax.

Apart from one of these procedures, there remains nothing else to be done than to resort to measures for resuscitation of the patient.

As a rule, it will be found injudicious to aspirate immediately for pneumothorax or haemothorax. It is very rarely possible to decide at first sight that one or both of these conditions exists in sufficient degree to account for the severity of the symptoms. Occasionally it may be obvious from the urgency of the dyspnoea that relief by immediate aspiration is indicated.

More usually this becomes evident after resuscitation has been tried without success, or with only partial success. The patient recovers partially from his shock or collapse, and as he recovers, the dyspnoea, which is often absent while the respirations are very feeble and shallow, begins to show itself. Urgent dyspnoea with cyanosis seems more marked in cases of extensive collapse or deflation of the lung without much haemothorax or pneumothorax than in cases with these latter conditions unaccompanied by collapse of the (relatively) uninjured lung.

In order to decide whether a patient requires immediate operation the extent of the thoracic injury must be estimated. The mere presence of a thoracic wound is not sufficient evidence that the symptoms are due to thoracic injury. Broadly speaking, although a penetrating wound of the chest which produces collapse of one lung with or without haemothorax or pneumothorax will cause immediately grave shock to the patient, nevertheless recovery is fairly rapid provided the other lung remains undamaged. Experience at advanced dressing stations shows that although there is immediate and profound distress, such a patient will rally and become fairly comfortable within an hour or two if kept at rest. He will then bear the journey to the casualty clearing station, and should arrive there in good condition if the transport has not involved much jolting.

A patient with a simple through-and-through wound of the lung, or with a small missile retained, should not on arrival at the casualty clearing station be profoundly collapsed or in great respiratory distress. If he is, the following possible causes should be considered:

Haemorrhage.

This may have been very large in amount, and there may still be active bleeding. As a rule with closed thorax the amount of intrathoracic haemorrhage will not be enough to produce of itself severe shock. When there is an "open thorax" the estimated size of the haemothorax is no guide to the quantity of blood lost, as the greater part of the bleeding may have been external. In such a case physical examination is of little assistance beyond determining that there is an "open thorax" and that the patient is suffering from loss of blood. If the missile has been retained, it is of the greatest importance to localize it accurately by *x* rays. An operation is necessary to close the chest; the lung will have to be examined to discover, and if possible repair, the laceration, and to arrest the bleeding if it is continuing. It is essential to remove the missile, if accessible, to avoid infection.

Severe Parietal and External Injuries.

Comminuted fractures of ribs, scapula, or sternum produce the gravest symptoms even in the absence of severe intrathoracic injuries. It is of the utmost importance in such cases to determine the extent of the intrathoracic or pulmonary injury. Physical examination by auscultation and percussion is difficult to perform and more difficult to interpret. It will give little information beyond establishing the presence or absence of haemothorax or pneumothorax. But it is essential for the surgeon to know beforehand whether his operation should be limited to the parietes or should extend to the interior of the thorax. As a general rule, if the entrance wound is small, clean, and has not comminuted any bone, whilst the extensive bony injury is confined to the exit wound, there will be no in-driven fragments, and the operation may be limited to the parietes. But if the entrance wound is large, if there are in-driven fragments of bone, or pieces of clothing, and especially if there is a large missile retained, the operation must extend to the interior of the chest.

Associated Injuries.

Careful attention has always to be paid to injuries other than purely thoracic which may have been caused by the missile or missiles which have struck the chest,

particularly injuries of the diaphragm and abdominal viscera.

A prompt decision must be arrived at as to whether there is sufficient thoracic injury to produce the symptoms, or whether the intrathoracic injury may be ignored and a further explanation looked for below the diaphragm.

To the surgeon a definite and reliable opinion expressed by the physician to the effect that the intrathoracic injury is negligible is of great assistance.

In order to form a definite opinion in such a case, physical examination of the chest becomes more important than in the class of case previously considered. If the heart is not displaced; if there is no great degree of surgical emphysema; if there is no large amount of air or fluid in the chest; but, above all, if there is a fair degree of air entry* into the lungs, it may be assumed that, although the missile has entered the chest, the grave lesion exists elsewhere.

In a through-and-through wound the track of the missile may be enough to furnish an explanation; failing this, *x* rays will be required, unless the presence of an abdominal injury is made clear by other signs and symptoms. Abdominal rigidity and immobility are not, by themselves, clear indications of abdominal injury; these signs are often present in pure chest injuries.

Increased dullness in the spleen area, haematuria, the presence of dullness in the flanks, localized tenderness and pain in the abdomen, the peculiar "catchy" breathing suggestive of diaphragmatic injury, and hiccough are signs which should be noted and interpreted as indicating injuries below the diaphragm.

Spinal Injuries.

These demand recognition, and not merely those which involve the spinal cord itself. Injuries to the body or processes of vertebrae may cause the gravest symptoms and present very puzzling features. Excessive pain, radiating very irregularly, is constantly met with in injuries of the vertebral bodies, and resembles the intense and erratic pain due to erosion of the vertebrae by aneurysm. Profound collapse which resists all efforts at resuscitation is often met with in spinal injuries, even when the cord is undamaged.

Multiple Wounds.

Apart from the associated injuries which the missile entering the chest may have produced, there may be other wounds which make it difficult to decide whether the patient's serious condition is attributable mainly to the chest wound or not. Here, again, if there is fair air entry into the lungs the intrathoracic injury may be put on one side. A patient with one lung expanding well should not be greatly distressed even though the other lung is completely out of action, provided some hours have elapsed to allow him to adjust himself to his new conditions, and provided he has been kept at rest.

Intrathoracic Injuries.

We may now pass to a consideration of the intrathoracic injuries pure and simple.

The distress caused by an open thorax is usually very great, and until the opening has been closed it is difficult to estimate the extent to which the symptoms are due to injury of the thoracic contents.

Auscultation and percussion will add little or nothing to the information obtained by seeing the hole in the chest wall.

Active haemorrhage may be visible externally and be recognizable by the colour of the blood, which continues bright and arterial. The leakage of a haemothorax which is not increasing from fresh haemorrhage is usually darker and resembles venous bleeding; moreover, the blood does not clot outside the body.

With closed thorax the examination of the chest resolves itself into a combination of the ordinary methods (inspection, palpation, percussion, and auscultation) with radioscopy and radiography.

Inspection.

The presence of surgical emphysema almost always means the presence of either partial or complete pneumo-

* It is surprising to find how little attention is paid to the amount of expansion or air entry into the lungs in examining gunshot wounds of the chest. Yet this is of vital importance to the patient.

thorax. If the heart's apex beat is visible, an alteration in its position may depend on the heart being pushed over by air or fluid, or on its being pulled over by collapsed lung.

Visible distension of one side of the chest may depend on air or fluid. An over-distended chest will generally be immobile. The degree of movement in a chest is not, however, always proportionate to the intrathoracic injury. On the one hand there may be, for instance, a considerable amplitude of respiratory movement with a large haemothorax if the lung remains partly expanded; and on the other hand, a chest which has been struck without material intrathoracic damage may remain immobile for two or three days, even though the lung is not collapsed, and even in the absence of haemothorax or pneumothorax. Cases of this kind are seen in which the injured side remains resonant, slightly retracted, without inspiratory or expiratory sounds, but with normal vocal fremitus and normal *x-ray* appearances.

In cases of collapsed lung (without haemothorax or pneumothorax) the side may appear greatly retracted, with indrawing of the interspaces on inspiration.

Palpation.

Surgical emphysema is the first sign to be felt for. If extensive, it obliterates or distorts every other physical sign except the position of the heart. Displacement of the heart may be determined by palpation.

Exocardial friction fremitus may be felt. It does not always indicate haemo-pneumopericardium or pericarditis. Substernal surgical emphysema may cause a similar friction fremitus.

Fractured ribs, or a missile lying under the skin, may be discovered by palpation. An ecchymosis on the chest wall should be carefully palpated, as it is often due to a missile which has penetrated as far as the skin without making its exit.

Tactile vocal fremitus is not always diminished and is occasionally increased over haemothorax. It is not even invariably lost over pneumothorax.

Percussion.

Percussion is apt to be misleading when the chest has been injured. The resonance of the normal chest depends to some extent on the tension of the chest wall, in the same way as the resonance of a drum depends on the tension of the drum-head. If the chest wall becomes abnormally laxer (as when ribs are extensively smashed) the resonance and the pitch of the percussion note are thereby altered. Surgical emphysema will yield a resonant note even over a large haemothorax. Resonance may be impaired over a collapsed lung even if there is no haemothorax. Alteration in the position of the mediastinum may be detected by percussing out the anterior limits of resonance of the uninjured lung.

The position or size of the cardiac dullness may be found changed.

The liver dullness or stomach resonance is sometimes found to rise unduly high in chest wounds owing to relaxation or paralysis of an apparently uninjured diaphragm. This may mean that the diaphragm is paralysed, or that the lung above it is collapsed.

Particular attention should be paid to percussion of the base of the opposite (and apparently uninjured) lung. Abnormal dullness of this base may be due to an abnormally high diaphragm, to consolidation, collapse, or compression of the lung or to a haemothorax. A missile may have passed through both lungs. The diaphragm may be pushed up by subphrenic injuries or by tympanites and cause abnormal dullness at the pulmonary base or bases.

Auscultation.

The positive sign of good air entry with normal vesicular breathing is the most valuable of auscultatory sounds. It is evidence that the lung in that area is expanding. Absent and altered breath sounds are less reliable. Breath sounds may be diminished or totally absent in haemothorax and pneumothorax; they may be equally absent in any case where the lung is not expanding—for example, when a bronchus is blocked, or when the respiratory movements are too feeble (as in shock) to produce any audible sound.

Altered breath sounds do not follow the same general rules in injuries as in disease of the lungs. Bronchial breathing is not uncommon over haemothorax, whilst it may be absent in haematoma of the lung if the haematoma is superficial and wide in extent. Bronchial or amphoric breathing is frequently heard over pneumothorax even when closed. The coin sound is sometimes absent even in large pneumothorax.

Mucous and Crepitant Rales.

It is very difficult to assign particular values to mucous rales and crepitations, in the same way as has hitherto been customary in disease. When it is remembered that, in the majority of cases where the lung has been struck, three changes almost invariably occur which are capable of producing mucous or crepitant rales, the difficulties of exactly interpreting these physical signs will be appreciated.

The three constant changes are: collapse of air vesicles, haemorrhage into the alveoli and bronchioles, haematoma of the lung. Whatever other accidents may have occurred these three may be confidently assumed to be present when a missile has struck the chest with sufficient force to penetrate its wall.

Mucous rales will give practically no information of diagnostic value.

Crepitations are occasionally useful, particularly in two conditions. In collapse of the lung (either homolateral or contralateral) widespread, coarse, dry crackling is a valuable physical sign. In compression of the opposite lung by a large haemothorax or pneumothorax on the injured side fine crepitations are often heard over the base of the compressed lung.

On the second or third day (and at any later time) the appearance of crepitations, where none were previously heard, may indicate the occurrence of pneumonia or bronchopneumonia, or that extremely rare condition gas gangrene of the pulmonary tissue.

Friction Sounds.

Pleural friction must be carefully watched for. It is often the first sign of intrathoracic infection. But a small haemothorax almost always at an early stage produces friction which is of no great moment. Pericardial friction is not uncommon, but pericarditis is not necessarily a fatal or even a serious complication of gunshot wounds of the chest.

A heart beating in surgical emphysema of the substernal tissues may give rise to a friction sound indistinguishable from pericarditis, or to a remarkable churning sound mistakable for haemo-pneumopericardium. An adjacent pneumothorax will give to the normal heart sounds an exaggerated resonance or reverberation, and if friction is present either from pericarditis, or from surgical emphysema, or from haemo-pneumopericardium, the noises which may result are astonishing, although with experience they become unmistakable.

As a rule the exocardial friction sounds which appear immediately after wounding are due to surgical emphysema, and are very loud and coarse. True pericarditic friction usually comes on later and insidiously. It begins faintly over a limited area and spreads gradually with increasing loudness. Hernia of the stomach or intestines may cause gurgling sounds to be heard in the chest, but this sound is not diagnostic of a lacerated diaphragm. Intestinal gurgling is sometimes transmitted very distinctly through a pneumothorax with the diaphragm intact, and it is also heard when the diaphragm is raised abnormally high. It is very difficult to interpret correctly changes in the heart sounds and rhythm. Bruits which are mistaken for endocardial murmurs are produced by displacement of the mediastinum with dislocation or torsion of the heart and great vessels. Irregularities in rhythm may be similarly caused. Speaking generally, a heart which has been hit, with or without penetration, takes on a rapid and irregular action, especially if struck on the posterior aspect or near the auriculo-ventricular junction. I have, however, seen a case with a shrapnel ball lodged in the ventricular muscle near the apex, and another with a fistulous opening through the chest wall into the right auricle, yet in neither case was there any interference with the heart's action. But as a rule true delirium cordis indicates that the heart has been struck by the missile.

Succession Splash.

It may be possible to elicit this sign in haemo-pneumo-thorax. It is never justifiable to attempt to do so in the early stages, and with *x* rays at hand it is never necessary.

Metallic tinkling: I do not remember that I have ever met with this sign in gunshot wounds of the chest.

Voice Sounds.

Modifications of vocal resonance are apt to be misleading. The most constant and reliable sign is aegophony, which I have not met with except when there was fluid in the chest. It is usually best heard at or near the upper level of the fluid, and may be localized to a very restricted area there.

Diminished vocal resonance does not always accompany even a large haemothorax; it may be considerably increased. Occasionally the vocal resonance is increased without any obvious intrathoracic change, even on *x*-ray examination. I do not know what is the explanation of this sign occurring in a chest which has been hit or penetrated. I have met with it frequently in the first few hours, and have not been able to attach any importance or diagnostic significance to it. Possibly it is due to a partial deflation of the lung insufficient to produce the physical signs of collapse.

In pneumothorax the voice sounds and the cough may acquire a characteristic metallic ring. This metallic ring is also sometimes heard with the inspiratory soufflé in a closed pneumothorax, and indicates that a large opening communicates with the pneumothorax from the bronchus.

Auscultation is made very difficult when surgical emphysema is present. If the surgical emphysema is considerable and obvious, it will be recognized at once that auscultation can be of little assistance. Often, however, the emphysema is not evident, and the auscultatory sounds become very puzzling, particularly when the surgical emphysema is mediastinal, substernal, or subpleural, and does not extend to the subcutaneous tissues.

Under all circumstances auscultation should reveal the approximate position of the heart, and this is a point which requires determining in every case of gunshot wound of the chest.

X rays.

It is impossible to treat chest wounds adequately without *x* rays. From the time a case comes within reach of surgical assistance to the time he is finally discharged as cured, and even long after if untoward sequelae are suspected, *x* rays are constantly required. At the outset it is only with *x* rays that the probable track of a missile and its position, if retained, can be ascertained. The position of the heart and diaphragm, their movements, damage to the lung, collapse of the lung, haemothorax, and pneumothorax can only be accurately determined by *x* rays interpreted in conjunction with physical signs.

Radiography alone is insufficient; the cases must also be radioscopically examined and the parts be seen in movement with fluoroscopic screen, in a sitting-up position if possible.

It must be remembered that pieces of clothing can never, and fragments of bone only rarely, be seen with *x* rays.

General Considerations from the Physician's Standpoint.

The first consideration is to save life; the second is to restore function as completely and as quickly as possible.

All wounds of the parietes and thoracic contents should receive the surgical attention they require at the earliest possible moment.

Haemorrhage must be arrested and every possible step taken to early avert infection.

No fluid, whether blood, serum, or pus, must be allowed to collect in the chest. Early and frequent aspiration must be resorted to whether thoracotomy has been performed or not.

Any fluid in the chest is dangerous from two points of view: (a) It is a nidus for sepsis. (b) It interferes with the expansion, not only of the injured, but also of the uninjured lung, setting up conditions favourable to the development and spread of bronchitis, bronchopneumonia, and lobar pneumonia.

Foreign bodies, metal, clothing, and bone, should be removed whenever possible. They are dangerous, not only

from the point of view of immediate sepsis, but from that of subsequent interstitial fibrosis.

Resection and open drainage as formerly practised for empyema is an unsatisfactory operation, and is shown by experience in this war to be rarely necessary if the early treatment, according to modern methods, is not neglected.

REFERENCE.

¹ Duval: *War Wounds of the Lung*, Preface.

RESUSCITATION WORK IN A CASUALTY CLEARING STATION.

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This report deals with work amongst wounded men (stretcher cases only) received in a tented casualty clearing station during three weeks of activity on a sector of the Western front (September 27th to October 15th, 1918). Until October 4th there were eight surgical teams working, but subsequently only six.

TABLE I.

Period.	Admissions (wounded).	Operations.	Percentage.
Attack on the Canal du Nord: Eight days—Sept. 27 to Oct. 4, 1918...	1,713	479	28
Quiet period: Four days—Oct. 5 to Oct. 8, 1918 ...	275	71	26
Fighting on the Escaut Canal north of Cambrai: Seven days—Oct. 9 to Oct. 15, 1918...	835	353	42

TABLE II.—Classification of Operations.

	First Period.	Second Period.	Third Period.
Abdominal	31	1	9
Chest-abdomen	12	1	1
Chest	15	4	12
Fractured femur	23	2	15
Fractured femur with multiple wounds	6	4	3
Large flesh wounds	40	—	26
Knee-joints	33	3	13
Multiple wounds: Amputations, fractured tibia, humerus, forearm, etc.	314	56	274

It will be noticed that during the third period proportionately far fewer abdominal cases could be operated upon. This was largely due to the increase in distance of the unit from the front line during a time of rapid advance. Most of the cases arrived more than twenty hours after being wounded, and a large number died soon after admission from advanced peritonitis. The earlier abdominal cases, too, on the whole responded badly to resuscitation methods, and intravenous methods of treatment in such cases were not often successful, even if they were not obviously contraindicated.

A large number of cases of chest wounds, mostly with other complicating wounds, were admitted, and there were opportunities for keeping cases until better fitted for evacuation.

Total chest wounds	194
Aspirations	93
Operations on chests or chest wall	31

Of 21 deaths recorded in the chest wards one-half could clearly be ascribed mainly to causes other than the chest wound. In 33 cases the haemothorax fluid was proved bacteriologically to be infected, streptococcus being found in 79 per cent., anaërobe bacilli in 57 per cent., and staphylococcus in 50 per cent.