been impossible to keep them from returning when reduced. The size of the ring precluded its obliteration by any method, flap or otherwise. Further, if drainage had been decided on it would have been necessary to drain the pleural cavity or sac (regarding these as identical in this case) as well as the abdomen. That the patient suffered from gall stones, of which there were a large number, added to the complexity of the case. The history suggests that the first event was incarceration of the hernia. The patient had pain four days before admission to hospital with some vomiting and constipation; these symptoms, on the other hand, may have been due to the gall stones. The very acute pain coming on fourteen hours before being seen would correspond to the perforation of the gastric ulcer. It was impossible from the *post-mortem* appearances to say what had been the start of the terminal illness, but they pointed strongly to incarceration and commencing strangulation of the hernia as being the first factor.

When the multiplicity of the pathological findings are considered, it seems extraordinary that the patient should have been able to carry on the active life he had for the previous six months. As a burgher he was constantly in

the saddle. The case further emphasizes the fact that patients with congenital diaphragmatic hernia either die in early infancy or live well on towards old age.

As regards the treatment of hernia in this region, it has been found that in cases of strangulation no attempt should be made to repair the opening through the diaphragm, relief of the strangulated gut being all that is justified. The mortality is high.

The position of the opening in congenital diaphragmatic hernia is almost always behind the liver through that portion of the muscle which in the fetus corresponds with the pleuro-peritoneal canal in the posterior part of the diaphragm near the vertebral column. Most frequently the hernia is on the left side, but on whatever side it is situated, if well posterior to the central tendon of the muscle, an embryological explanation can be given, whereas in the case described the position of the ring does not fall into line with what we know of the development of the diaphragm.

The present case, owing to the position of the opening in the diaphragm, and apart from its clinical interest, appears to be an extremely rare abnormality.

INJURIES AND DESTRUCTIVE EFFECTS OF AEROPLANE BOMBS:

WITH SUGGESTIONS ON THE PRECAUTIONS TO BE
TAKEN DURING HOSTILE AËRIAL RAIDS.

BY

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[The following observations refer only to bombs dropped from aeroplanes. They were made during a period of five months in various parts of France and Belgium antecedent to February, 1915, but their publication at that time was not deemed advisable.]

TYPES OF BOMBS.

The bombs the effects of which were observed were of two kinds:

(a) *High Explosive Percussion Bombs.*

The high explosive bombs weigh from 10 to 20 lb., and consist of a metal case $\frac{1}{4}$ in. thick, filled with high explosive only. It is presumed that no shrapnel bullets are contained in them, as we have never been able to demonstrate such either in the wounds or in the wreckage of property produced. By visiting the spots immediately after the explosions we have been able to secure various pieces of the bombs—for example, the handle, the base, and pieces of the casing of various size, as shown in Fig. 1.

The destructive effect is due to the high explosive and to the metal case being broken up into fragments of various sizes, which are propelled in all directions at tremendous velocity.

The bombs may be released from the aeroplane by hand, either over the side of the machine or through a hole in the floor of the fuselage, or by a special bomb-dropping device, by means of which the bombs are released by hand levers or foot pedals.

As the bomb leaves the aeroplane a pin is withdrawn, which allows a small metal propeller to unscrew itself; this sets the internal mechanism ready for explosion on

contact. As a precautionary measure the mechanism is not set ready for detonation until the bomb has fallen about 200 ft. Fixed steel vanes keep the bombs steady on their downward flight. Sometimes these bombs fail to explode on percussion, and have been found intact.

(b) *Incendiary Bombs.*

The incendiary bombs used to set fire to collections of stores, etc., consist of a thin metal casing containing a medium soaked in some highly inflammable substance, such as petrol. A percussion device in the bomb ignites the inflammable contents.

FLIGHT OF BOMB.

Bombs are dropped from aeroplanes usually at a height varying from 4,000 to 7,000 feet. Below this the machine comes well within the danger zone from anti-aircraft guns.

The forward speed of the aeroplane determines the first part of the bomb's flight, which will be in a forward direction until gravity asserts itself, and then the course will be directed downwards. But from our experience we venture to make the statement that there is a certain amount of forward deflection, perhaps small, in the whole course of the bomb's flight. Lateral deflection in the bomb's flight may also occur, and this may be due to one of two causes. First, if the wind is across the aeroplane's path some lateral deflection of the bomb's flight must be

expected, depending on the wind velocity and the height of the aeroplane from the ground. Secondly, if a bomb is released as the machine is being banked centrifugal action comes into play and will cause some lateral deflection.

A bomb was dropped from an aeroplane at about 6,000 ft. A cross wind was blowing and the bomb fell, as estimated by competent observers, at a spot 200 yards lateral to the aeroplane path.

A bomb was dropped from a height of 6,000 ft. and struck the front of a house in a narrow street. The house was struck at the level of the first floor; to do this the bomb must have had either forward or lateral deflection.

The accuracy of bomb dropping is thus influenced by many factors—for example, height of aeroplane from ground, its air speed, its ground speed, wind velocity, gravity, etc.; thus the chances of obtaining a direct hit on

FIG. 1.—Showing various pieces of exploded aeroplane bombs dropped by German aviator.

a particular object, unless large ones, such as a collection of troops or transport, large buildings, massed shipping, etc., are rather small.

When a bomb is dropped it comes rapidly to earth with a peculiar hissing shriek, quite unlike the whistle of a shell. On explosion it sends up a cloud of smoke and debris about 30 ft. high.

INJURIES.

These are much akin to the injuries produced by common high explosive shell. Death or more or less severe injuries may be due to the following causes:

From the Actual Shock of the Explosion.

That is the effect produced on the individual by the disturbance in the air, created by the sudden expansion of the contents of the shell.

(a) The shock may actually kill without producing any visible destruction of tissue.

Two civilians were found lying dead 5 ft. from a hole in the street made by a bomb. There was slight frothing at the mouth, but no wounds, fractures, burns, or any visible injuries.

(b) The explosion may blow off limbs, or shatter them severely, or cause multiple wounds. The traumatic shock in all these cases is very severe, and many cases never rally.

A number of civilians were standing round one of the Allies' aeroplanes when a bomb, which was being handed up by a mechanic to the observer, fell and for some unexplained reason exploded. Six people were instantly killed. All had compound fractures, some severely shattered limbs, whilst others had the whole or a portion of an extremity blown off. Curiously enough, the mechanic escaped with nothing more than a wound of the forehead, whilst the observer, who was thrown 30 ft. in the air, came down unharmed, except for slight wounds of face and arm, due to small fragments of the bomb. He suffered in no way from shock, and was able to walk into hospital unaided.

A bomb exploded 5 ft. from a Belgian officer. He sustained a compound comminuted fracture of the left leg and two deep wounds on the front of both thighs. The shock was very marked, and he died the same night. On opening up the thigh wounds, no fragments of bombs or shrapnel bullets were found. The wounds were due to explosive effect alone.

A bomb exploded a few feet from the following cases, the injuries received being due to explosive effect: A civilian, aged 40, had a wound exposing the muscles of the neck and trachea, and a compound comminuted fracture of the left leg. Amputation of the leg was performed, but he died shortly afterwards. A boy who had compound fracture of femur and severe shock never rallied, and died the same night.

From Flying Fragments of Bomb.

The pieces into which a bomb bursts are never very large, the largest being 2 in. by 2 in., whilst many are quite small. Persons standing within 30 ft. of the explosion are likely to be injured. Beyond that range the chances of escape are much increased, but a flying fragment may injure severely at 150 ft. from the explosion.

A civilian standing 30 ft. from a bomb explosion received a large wound in the abdominal wall from a flying fragment. Viscera protruded, and he died a few hours after admission to hospital.

A woman, about 20 ft. distant, had a perforating wound of thorax and penetrating wounds of abdomen and right thigh. She died on the way to hospital.

A man, about 40 feet distant, received a penetrating wound of abdomen. No exit wound discovered. He was operated on, but the fragment was not found at the time. He died later of general peritonitis.

A woman, 30 ft. distant, received a flying fragment in the left side of the chest. Further history unknown.

A woman, standing 30 ft. from a bomb explosion, received multiple wounds from small fragments as follows: Small penetrating wounds of left foot, left thigh, right arm, left breast, and left eyelid. A left metatarsal bone was fractured.

At a distance of 50 to 60 ft. from where a bomb exploded flying fragments entered a cellar (many of the Continental cellars, although underground, have part of the door, window, or grating above the street level) and wounded three people—

- A woman received a wound on left breast.
- A woman received a deep wound of thigh.
- A child received a slight wound of breast.

From Burns.

Signs of burning and charring are rarely found alone, and are usually accompanied by other more serious injuries.

D

When present they only occur to those in close proximity to the explosion.

A bomb exploded about 5 ft. from a soldier, shattering his left leg, fracturing the right tibia, cutting his lip and nose, and causing superficial burns all over the body. He died soon after admission.

A soldier in a stooping position a few feet from where a bomb fell had his left buttock blown off and the wound absolutely charred. This case did extremely well.

From Fumes.

Although we have no cases amongst our records it is quite possible that the fumes given off at the time of the bomb explosion might have a fatal or stupefying effect on those in the vicinity.

From Wreckage Displaced by Bombs.

The injuries thus received so far have been slight, and have been due to falling stones, bricks, mortar, etc. The usual aeroplane bomb is not sufficiently powerful to so wreck an ordinary house that the wreckage falling would cause severe injuries. Most of the injuries have been slight bruises, and no deaths have been recorded.

From Accidents.

These occur to individuals in their hurry to escape from danger from above.

A bomb fell in the narrow street of a French town, when a woman with a child in her arms (some 50 yards away) made a wild leap for safety, fell down some cellar steps, and crushed her child to death.

From Anti-aircraft Missiles.

During hostile aerial raids the air positively teems with metal from all kinds of anti-aircraft guns, and the danger to curious and ignorant onlookers from falling missiles is very great. It is surprising that so few have been injured from this cause, and the number of escapes have been truly wonderful. The base of a 75 mm. shell, weighing 3½ lb., came down very close to one of our officers, and had it struck would have caused instant death. The missiles that are likely to return from the air during the defence are:

1. Bullets from rifles and machine guns. These come down with surprising velocity, sufficient to kill or injure severely. Some have been found imbedded in woodwork, and others with their noses turned or flattened, due to the tremendous impact on the ground.
2. Pieces of shell, of varying size, and shrapnel bullets from proper anti-aircraft guns.
3. Bases and pieces of common shell, solid shell, and unexploded shell.

Fig. 2 shows the base of a French 75 mm. shell and a large portion of a shrapnel bursting shell. They came down together with French mitrailleuse bullets in the outskirts of a town during a hostile aerial raid.

RANGE OF BOMB FRAGMENTS.

Our observations on the first series of bombs dropped showed that most of the fragments were driven upwards at about an angle of 30 degrees, so that an individual lying flat on the ground in the vicinity would probably escape unhurt. These

bombs also made a fairly deep hole in the ground, as a rule about 2½ ft. deep. Latterly the bombs dropped have exploded so that the fragments have been driven along parallel to the ground, as well as upwards to an angle of 60 degrees. Bomb fragments have been found embedded in walls at a distance of 150 ft. from the explosion.

DESTRUCTIVE EFFECTS.

These have been noticed on streets, houses, sheds, sand, and shipping:

- (a) *Streets.*—The hole produced is 2 or 3 ft. wide and 1½ to 2 ft. deep. Windows in the vicinity for

FIG. 2.—Showing anti-aircraft missiles, which came down in the outskirts of a town during a hostile aerial raid. a, Base of French 75 mm. shell. b, Large piece of shrapnel bursting shell.

50 to 100 yards around are shattered. A plate glass window 40 ft. from a bomb explosion showed multiple stellate fractures, a frost-like arborescent appearance being produced. Wooden shutters and doors at 30 ft. distance have been perforated, whilst in others bomb fragments have been found embedded. Pieces have been driven along parallel to the ground in through (Continental) cellar doors and windows, injuring people within. A bomb bursting in the street would send fragments through the ground floor and first floor windows, but not through the masonry. Safety lies in keeping against the wall, indoors on the ground floor, out of the line of windows.

(b) *Houses*.—The usual 20 lb. bomb employed from an aeroplane will go through an ordinary roof and explode in the top room. We have not found one which has penetrated further. A wire splinter-proof netting would cause the bomb to explode outside, and only some fragments would probably come through the roof. Sand also acts as a good protective, but its weight precludes its use on most roofs.

A bomb came through the roof of an ordinary dwelling house and exploded in the top room, wrecking everything in it, but no fragments penetrated the floor below.

A bomb struck the projecting ledge of a house roof and burst, dislodging some tiles and bricks, blowing in the windows, damaging property in the upper rooms, and the fragments spent themselves in the street below, killing two soldiers who had taken protection in a doorway. Such doorways and passages afford little protection.

A bomb, with either a forward or lateral deflection, struck the front of a house and destroyed a good deal of the masonry, and wrecked furniture, etc., within. Fortunately no one was injured.

(c) *Sheds*.—The glass and wooden roof of a large shed (a hangar) was pierced by a bomb, which must have exploded just after entry. The fragments were driven downwards, perforating in many places a canvas covering, and killing two people below. No others were injured.

(d) *Sand*.—We have records of six bombs exploding on a sandy beach. The hole produced is usually $3\frac{1}{2}$ to $4\frac{1}{2}$ ft. wide and 1 to 2 ft. deep. Case fragments are found embedded in the sides of the crater. On explosion a spray of wet sand is carried laterally for a distance of 30 ft. Bags full of sand form an ideal protection on a bomb-proof shelter.

(e) *Shipping*.—A bomb fell on a barge, and, exploding, made a hole in it, causing it to sink rapidly.

PRECAUTIONS TO BE TAKEN DURING HOSTILE AERIAL RAIDS.

On head quarters being notified of the approach of enemy aircraft, warning signals should be given to the community, such as the firing of a gun, hoisting of a flag on the town hall, blowing of a ship's siren, use of a military rattle, etc. Orders should be given beforehand that all except those connected with anti-aircraft defence must seek cover indoors, preferably in basement cellars, or, failing these, on the ground floors, away from the line of windows. "Get in and get under" is the motto for safety. It must be remembered that it is extremely difficult for the onlooker below to gauge with any accuracy the position of the aeroplane relative to his position on the ground. The danger zones are, as a rule, immediately in front of, and lateral to, the approaching aeroplane; the areas of safety lie directly behind its flight. But it must not be forgotten that a well-banked turn may quickly alter the aeroplane's direction and so place an individual below in the danger area. Fire stations should be notified, and doctors, first-aid crews, and ambulances made ready on telephonic communication. School children should not be sent home from school but congregated on the ground floors out of the line of windows. If people flock into the streets to watch events, they are exposed to as much danger from falling anti-aircraft missiles as from the enemy's bombs, and needless casualties will ensue. On no account must unexploded bombs be handled or touched; a guard should be put over them and the nearest authorities notified. Houses that require to be specially protected should have a splinter-proof netting arranged over, and some feet above, the roof. This would cause the bombs to explode outside the roof, and only a few fragments would probably penetrate the roof. Sand in bags can be used if its weight can be sustained. As hospital ships must at times be in ports which are liable to aerial attacks, we recommend that such ships that have their wards directly under the upper

deck should make use of a similar splinter-proof netting. In houses the best protection is afforded by underground cellars, especially those built under the foot-path and not directly under the house. In Continental cellars, which are partly above the street level, people are safe if they keep away from the cellar window, door, or grating, as the case may be. The same applies to the ground-floor room of an ordinary house. Avoid upper rooms, windows, and doorways. In the street, passages and entrances to shops, etc., afford no protection, and are to be avoided. If a passage open at both ends is one's only shelter, it is better to take the centre of it and lie down.

The precautions to be taken in buildings where there are more or less large collections of people, such as factories, schools, works, barracks, etc., depend upon the size and type of the building. When there are upper stories the individuals should be collected on the ground floor, with the same precautions as for a house. When there are no upper stories and the building has a ground floor only—for example, a hangar or some hospitals—those locally in authority should see if there is in the vicinity another building affording protection. If so, arrangements should be made for occupying this on hearing the warning signal, and this should be practised and carried out as for fire drill, to avoid panic, especially so with school children. If no such safety building exists, the best measure to adopt is to build beforehand some type of bomb-proof shelter within the building. We have seen a very good one made in the large shed of a works from the available material present. The sides consisted of tins or drums containing sand or non-inflammable merchandise, the roof was of timber supported by powerful props, and on the top of this were placed bags of sand 1 ft. thick. This is almost certain, we think, to keep out all fragments of a bomb exploding, as it would, just inside the roof of the shed. Provision should be made for the interior lighting of all bomb-proof shelters, as a dark place crowded with people, who may be already in a high state of excitement, is conducive to panic. Inhabitants in towns subject to air raids paste broad strips of paper diagonally over the inside of their windows, thus preventing glass falling outward and injuring people below.

Aeroplanes, as well as airships, can and have been used on many occasions during this war for making aerial attacks by night. We have had the experience of two such enemy raids. A point worth remembering is that on a bright, clear, moonlight night an aeroplane is extremely hard to see, and almost everything is in the enemy's favour. The pilot can see well and cannot be seen; he can fly fairly low and thus make more accuracy in bomb-dropping.

AN APPLIANCE FOR USE IN SEVERE INJURIES OF THE UPPER EXTREMITY.

BY
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THE difficulties in readily dealing in a satisfactory manner with severe gunshot wounds of the upper arm, elbow, and forearm, where there exist infected wounds communicating with a fracture, have led me to devise the splint or supporting apparatus which I am about to describe.

All surgeons engaged in war surgery are familiar with the practical difficulties encountered in the treatment of these cases. Broadly the main difficulties are:

(1) To immobilize the part in such a manner as to secure the fragments of a fractured bone in good position.

(2) To fit such an apparatus as shall, whilst resting and fixing the part in a favourable position, at the same time permit ready access to the wound with the minimum possible disturbance of the limb as a whole during the necessary wound treatment—for these cases require frequent irrigation and dressings.

(3) To fit an apparatus which is comfortable to the patient, and which permits him, if he is in bed, to change his position from time to time without pain.

In regard to (3) some of the appliances and methods one sees in use, whilst perhaps satisfactory from a mechanical point, leave the patient all the time in relative discomfort.