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their genuine regret at unavoidable absence. It would, I think, be well that the fact should be widely known that any officer is entitled ex officio, to admission to the Society on the payment of a nominal fee. The Council welcomes papers from officers of the auxiliary forces, and, as I know from personal experience, the Society listens to our papers with an interest so remarkably well feigned as almost to deceive. Two meetings this session (February and May) have been set aside for papers from officers of the auxiliary forces; I shall be very glad to receive suggestions for discussions or titles of papers. Papers will also be read upon subjects which directly concern us, namely upon the function of the clearing hospital and upon the diseases to which auxiliary troops are specially prone.

The Honorary Secretaries, Fleet Surgeon Laurence Smith and Major Harrison, have secured for the opening meeting a paper upon what is, after all, the ultimate purpose of an armed force, the destruction of the enemy. Major Pilcher, who gives us his experiences with the new pointed bullet, is known to most of us; the few who do not know him personally are already under an obligation of gratitude to him which will shortly be increased.

THE POINTED BULLET.

By Major E. M. Pilcher, D.S.O.,
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Many of the great Powers have comparatively recently adopted a light pointed bullet in place of the more or less blunt-nosed one at present in use. So far as I am aware this bullet has not yet been submitted to the test of actual warfare, but a certain amount of experimental work has been done with it, the results of which are extant in various languages. To go fully into all these experiments is not the purpose of the present paper, as the time at my disposal is too short, but I hope to give some idea of the changes in wounding power which may possibly result from the qualities of increased ranging power and greater instability of the new missile.

Now the object of most of the changes in the shape and material of bullets, from the round sphere of soft lead to the thin elongated, cylindrical-bodied and taper-nosed "picket" made up of a hardened lead core and a harder rigid envelope, has been first and foremost an improvement in ballistic qualities,
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the chief of which are accuracy and range. It was to attain
the former desideratum that rifled arms were introduced in about
1800. Difficulties in making the soft round ball fit the grooves
of the rifling paved the way to the introduction of the cylin­
dro-conoidal bullet in 1851. The introduction of the breech-loading
principle in 1867 and of the magazine rifle in 1888, with their
increased rapidity of fire and the consequent need for increased
supplies of ammunition in the field set small arms experts to work
upon a class of ammunition which should be lighter, while the
growing importance of increased range and flat trajectory compelled
the rejection of the soft lead bullet which would not engage in high
pitched rifling, in favour of a hardened composite bullet, and of
black powder in favour of a mixture of nitro-glycerine and gun­
cotton. From the soft lead sphere to the composite bullet, then,
the path may be traced through the rifled barrel with gradually
increasing pitch, the breech-loading and magazine principles,
and the introduction of high explosives.

A second object of improvements in small arms projectiles
is the attainment of all those good military qualities which are
summed in the word handiness. As far as the nature of the
bullet is concerned the most important of these is weight, a
smaller and lighter bullet meaning that more ammunition can
be carried in pouch and bandolier, while the influence of a lighter
bullet on recoil and rapidity of fire may perhaps be considered
as secondary factors.

A third consideration, which seems to have been put some­
what in the background by the designers of the small-bore
bullet, is wounding effect. Having got the bullet to reach a
certain point with the most constant accuracy and with the
highest possible velocity, what is it going to do when it gets
there? I may say at once that no complaint was heard of a
want of wounding or stopping power until the small bore .303 in.
bullet was introduced in 1892. I need not recall to your minds
the controversy which was raging on this subject in that year
and subsequently. Experiments were made in many countries
on living and dead animals and on human cadavers, both with
full charges at normal ranges and with calculated charges at
short ranges, with the result that an astonishing diversity of
opinion was revealed. Some experimenters dubbed the new
missile humane, while others were contented with no less severe
an epithet than devilish. Meanwhile war experience, the only
trustworthy alembic of opinion, was accumulating and proved to
demonstration that neither side was altogether in the right. Compared with the Martini-Henri bullet it was found that with the new bullet—

(1) In highly resistant structures like bone explosive effects were seen at longer ranges.

(2) In soft parts with low resistance wounds were much less severe, due chiefly to the small calibre of the bullet.

(3) Owing to the flat trajectory and long range, more hits were made.

(4) Surgically, the small size of the openings and track in practically every structure but bone had an immense influence on the subsequent course of wounds, especially with reference to the likelihood of infection.

(5) Though against big game or extremely determined foes like Ghazis, the stopping effect was often insufficient, yet on the whole the small-bore bullet had an efficient wounding effect when used between civilized peoples, and the compensating military advantages were considerable, while the ballistic improvement was so great as almost to condone the alleged want of man-stopping power.

This summary may serve to introduce the comparison I propose to institute between the new pointed bullet and the ogival-tipped bullet in present use. I have given a photograph of four of these
new bullets and a table showing the characters in which they differ from their ogival-tipped predecessors. You will see that they all differ slightly but not materially in the relation of length to calibre. One has no envelope, but is a solid picket of copper-zinc. Of the three composite missiles the material of the envelope is cupro-nickel in two, nickelled steel in the third, while the core is hardened lead in two, and in the third hardened lead in the lower two-thirds and aluminium in the upper third. So much for their differences. Taking their common features I find that two are constant, namely the sharp point and the diminution in weight. On the face of it both these characters are essentially ballistic and tend to an increase or retention of velocity. The same charge will produce a higher muzzle velocity in a lighter projectile, and Mr. Boys' diagram demonstrates the value of a sharp point against air resistance. The diminished size of the following eddy with the pointed bullet should be noted. This can be taken to represent the backward pull of the displaced air and can be further diminished by tapering the base, as has been done in one of the examples figured (B); but this slight backward pull, like the feathering of an arrow, has its value in keeping the base of the bullet behind its point and so increasing the steadiness of flight.

But there is another ballistic property of these projectiles which does not immediately appear. It is usual to consider the wounding effect of a bullet as being chiefly due to its velocity, its cross section area and the character of its envelope. The last of these three factors is one of immense importance from our point of view, the principle which underlies it being the fact that the presentation of a large area on impact gives the major part of its wounding power to a bullet whatever may be its remaining velocity on impact, and the character of the envelope obviously determines the liability of the bullet to break up or mushroom. When the deficiency of the small bore bullet in stopping power was first made manifest, an endeavour was made to reproduce the mushrooming qualities of the old leaden bullet by various devices with which you are all familiar, and which practically all meant that the bullet broke up, the leaden core on impact leaving its hard sheath and being spread abroad or broken up in the tissues.

There are, however, other means whereby increased area on impact is brought about. One is seen in the natural flight of the bullet. It has frequently been observed that at very long ranges

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1 Without necessarily involving any alteration in the shape of the bullet.
the degree of bone injury is unexpectedly extreme, and the accepted explanations have been, first that the bullet moving in the tangent to the curve of the trajectory, which tangent approaches the perpendicular at long ranges, must necessarily make a lateral impact, and secondly that although the movement of rotation declines more slowly than that of projection, yet at ranges exceeding 1,000 yards the gyroscopic steadiness due to rotation is gradually lost, and wobbling takes place about the line of the trajectory, causing lateral impact in certain positions of the wobble. Here, then, are principles of extreme importance as regards wounding effect. Can a bullet be so constructed as to have a natural tendency to make lateral impact at all ranges? And if so what are the physical features to be emphasized in its manufacture to that end?

Now there is reason to think that the mere relation of length to cross section area may have a great effect in producing a tendency to unsteadiness. I have added therefore to the four pointed bullets an example of the Japanese bullet of .256-in. calibre and 1.28 in. in length. This bullet which is evidently quite up to the average in length, but considerably below all the others in calibre, is reported from the Russo-Japanese campaign to have made at 800 to 1,000 paces larger perforations than at shorter ranges owing to the unsteadiness of the bullet, and at these distances clothing, &c., was often carried into the wound. Lateral impact seems the only explanation of these effects.

There is another physical peculiarity of the pointed bullet which must be noted. The effect of shaving off the tip and shoulder to a fine point is to throw the centre of gravity very far back, so that a greater length of the bullet lies in front of than behind the centre of gravity. In some of these bullets a large part of the cylindrical body is sacrificed to increase the length of the slope of the pointed portion. No bullet travels with absolute accuracy in the curve of the trajectory. But whereas a slight deviation of the point might not affect the substantial accuracy of flight, on impact the longer the space between the tip and the centre of gravity the more effective would be the couple which tends to make the bullet revolve upon a transverse axis. And this principle is effective at all ranges. We may expect the pointed bullet, then, to develop unsteadiness immediately upon impact, thus developing to a high degree the principle of wounding effect due to increased area on impact. It is a modification of the wobble impact glorified into a military factor of great importance.

To turn from theoretical considerations to the facts brought out
by experiment, I should begin by saying that probably experiments upon the smaller domestic animals recently killed give results which are nearest to the truth. Human cadavera always give an exaggerated idea of the injuries produced, owing partly to post-mortem rigidity, partly to the inevitable hardening which accompanies any process of preservation. And the bones of the larger domestic animals such as horses, cows and donkeys are so much harder and more resistant than human bones that it is impossible to fairly infer from injuries produced in them what human bones would show under like circumstances. It should also be added that reduced and calculated charges at fixed short ranges were found, in experiments with the ogival tipped bullet, to produce more humane effects than full charges at ordinary ranges.

Premising so much I will shortly summarize the results of experiments with bullets A and C, and I think we may assume that they are typical of the kind of wound which may fairly be expected from this class of projectile.

The experiments with A bullet were made on recently killed sheep and horses with calculated charges at a fixed short range, the bones being subsequently skiagraphed, and the soft parts carefully dissected. The bullets, after traversing the body of the animal, were caught in boxes containing sawdust, and their position and integrity carefully noted. The velocities were calculated for ranges varying from 100 to 2,000 yards.

The entrance wounds were invariably small and typical. Explosive exits were observed in 30 per cent of wounds, and in one-third of these the soft parts only were involved. The effect of high remaining velocity is seen in the greater frequency of explosive exits at ranges up to 500 yards, and of high resistance in the explosive exits shown in wounds of the hard bones of the horse. There were no explosive exits at 1,500 and 2,000 yards.

The bullet was deformed in 28 per cent, and broke up in 13 per cent. This was due to its composite character, and was not unusually frequent. Deformation on impact was a common character of Mauser bullets in South Africa.

Lodgment in the tissues occurred in 10 per cent, and then only at ranges over 1,500 yards.

Turning on a transverse axis occurred in 63 per cent of all wounds. Deflection (by which, as compared with turning, I mean that the bullet took a new direction) also occurred in 13 per cent of cases, and this at all ranges, and even in soft tissues. This is unusual as compared with the ogival-tipped bullet, and is probably
due partly to the unsteadiness and partly, perhaps, to the lightness of the bullet.

As regards the severity of the injuries produced only 17 per cent can be compared with the slighter perforations of the ogival-nosed bullet. The remainder were decidedly severe at all ranges, and this severity was especially noticeable in the soft parts, where experience of the ogival-tipped bullet has led us to expect simple perforation. So far as our own war experience has taught us, explosive exits are invariably associated with bone injury, but the Russian experience in Manchuria against the unstable Japanese bullet was that soft parts also (and typically the large solid viscera, such as the liver, kidney and spleen) showed explosive effects at short ranges. Here, then, is a notable increase of severity in wounding effect as compared with the ogival-tipped bullet. Thus tracks through muscles were an inch or more in diameter, often with explosive exits, wounds in soft viscera like the heart showed a good deal of laceration at the point of exit of the bullet, and the wounds in the various parts of the intestinal canal showed rents rather than simple perforations in nearly all cases.

Injuries to bone looked rather more severe in the dissected specimens than in their skiagrams. The highest degrees of comminution seen occurred in the cannon bones of horses at 300 to 500 yards. But these bones have a very thick layer of compact tissue in the walls of the shaft and would offer a very high degree of resistance to the bullet. Nothing comparable in solidity is found in the human body. In most of the other diaphyses it is possible to trace the type injury described by Mr. Makins, the stellate, the wedge and the oblique, though it must be admitted that the degree of comminution was high at all ranges, and in most cases there was a considerable space quite cleared of bone. This, however, may be frequently seen with the ogival-tipped bullet at short ranges. The superior wounding effect of the new bullet is due to its greater ranging power and consequent extension of distance at which high comminution may be seen. But, judging by the skiagrams, there was no greater appearance of that complete severance of small bone fragments which necrose and delay consolidation so much in all severe bullet wounds of shafts. This is where a dissected specimen may be somewhat misleading. It shows all fragments, whether completely separated and useless or partially adherent by periosteum and of great value in maintaining a certain continuity between the broken ends, and affording a kind of framework, in the interstices of which callus is laid down. Wounds of cancellous bone of any
thickness, such as the ends of the larger bones and the bodies of the vertebrae, showed a much higher degree of severity than similar wounds with the ogival-tipped bullet. A small opening, a large track and considerable comminution was the rule, especially at the point where the bullet left the bone, and in the soft parts immediately beyond. These results are quite explicable upon the theory that instability is developed immediately upon impact, and further illustrations of the same effects are afforded by multiple wounds. Thus a bullet involving both scapulae in an animal inflicted incomparably greater damage on the second after comparatively clean perforation of the first, and a wound of the heart inflicted by a bullet which passed through an intercostal space was of nothing like the severity of the injury produced by a bullet which had previously touched a rib.

These results, the most important features of which are given in the above summary, are of great interest though not quite as complete as might be desired. We should have liked more information on head wounds, a class of injury which for obvious reasons can hardly be reproduced in animals in a form comparable to like injuries in man. And injuries to the larger viscera have to be inferred from wounds of soft parts as a whole. But I think the following points stand out:

(1) Wounds of entry do not as a rule exceed the calibre of the bullet in size.

(2) The simple flesh wound type of injury is uncommon. Wounds of soft parts usually exceed considerably the diameter of the bullet in size, and the laceration of the viscera is more severe than with the ogival bullet.

(3) Explosive exits are common at ranges up to 500 yards at least, and are seen in wounds of soft parts only as well as in those of bone.

(4) Comminution of both compact and cancellous bone is rather more severe, especially on the exit side of the wound.

(5) At all ranges the bullet has a marked tendency to turn on its short axis on meeting with any considerable resistance.

These two main theses, the tendency of the pointed bullet to turn and the resulting increase in wounding effect, is also illustrated and supported by a long series of experiments with Bullet C. It is impossible to do more than summarize them, and I thought perhaps the best plan would be to shortly describe three experiments in order to give you an idea of the path and behaviour of the bullet after impact.
In the first experiment four pasteboard screens each composed of two walls of pasteboard rather less than \( \frac{1}{2} \) in. thick separated by a 2 in. interval filled with sawdust, were erected, each one 12 ins. behind the other. Behind this series of screens and at a distance of nearly 5 ft. was a box to catch and stop the bullets and containing a thickness of more than 4 ft. of sawdust for that purpose. A shot fired at 1,250 yards range pierced the first two screens without turning. The front wall of the third screen had a somewhat enlarged but round opening, the back wall showed an oblique exit. The bullet then entered the front wall of the fourth screen obliquely with the point to the left, made its exit with the point above and to the left, and after crossing five feet of air space entered the bullet-catching box with the point below and to the left. On this shot the experimenter remarked that the resistance of the sawdust was obviously the sole factor in causing the turning, because round openings only were made in five pieces of cardboard placed 2, 12, and 20 in. from each other without sawdust and fired at at the same range.

In the second experiment the screens and bullet-catcher were arranged as before, but in front of them was placed a human hand at a distance of 32 in. from the first screen. A shot involving the first phalanx of the fourth and the middle phalanx of the fifth finger was fired and its course marked on the screens. The first entry wound in the finger was round and small, the first exit oval, the second entry was oval, the second exit a long slit larger at one end than the other. And it will be seen that in traversing the screens and the intervening air spaces up to the bullet-catcher the bullet made a complete turn upon its transverse axis. That this result is not quite invariable was shown by the third experiment.

In this the screens and bullet-catcher were placed as before, and in front of them was placed a human thigh separated by an interval of 32 in. from a human leg which again was 4 in. from the nearest screen. The thigh was an injected and preserved specimen, the leg a fresh specimen. A shot was fired which made a flesh wound first in the thigh with a typical small bore entry and for exit a vertical slit rather longer than the diameter of the bullet. The bullet then entered the leg preparation just internal to the tibial crest, making an entry nearly round and but slightly larger than a normal entry, comminuted the tibia and fibula, and made an explosive exit on the outer side. The entry into the first screen showed the bullet with deformed point, and turned into an oblique position with the point downwards. But instead of the continued
turning noted in the second experiment, all the succeeding screens show that the bullet retained much the same position in passing through them and through the 12 in. intervening air spaces, and it was not until the final air space of 5 ft. was reached that a further small amount of turning took place. The sudden stoppage of turning was almost undoubtedly due to the fact that the crushing together of the bullet against the hard edge of the tibial crest (an effect often noticed before) brought the centre of gravity farther forwards so that it corresponded more nearly to the centre of the bullet's length and so interfered with the turning forces.

These experiments seem to me to show first that the new bullet has a tendency to turn on meeting with any resistance, and secondly, that the side pressure to which it is subjected in the tissues has a tendency to control and check the turning. You will observe that in air spaces where resistance is least, turning is most marked. In soft tissues, such as the abdominal cavity and the lungs (in which gas is, in a manner of speaking, a normal constituent of the organs), turning will be probably a good deal more marked than in more compact tissues, such as muscle and bone, but in both it will be sufficiently marked to give high wounding effects.

I may quote the conclusions arrived at by the author of the above experiments in his own words. "The chief characteristics of the sharp pointed bullet as compared with the ogival are, the much increased initial velocity as well as the unusual tendency at all ranges to continued turning, as soon as the slightly turned point meets greater resistance on one side."

Consequently we may expect larger skin openings on the exit side, as a rule, with greater consequent liability to skin infection, more severe injury to soft parts, in which the viscera will share to a marked degree, but perhaps no such corresponding, at any rate no extreme enhancement of injury to bone, with the possible exception of cancellous bone.

To sum up, then, it would seem that in the pointed bullet we have a projectile which causes wounds of a definitely increased severity, when compared with the ogival-tipped small bore bullet. But when we go farther back to the days of large bore bullets, I question if the contrast is by any means so striking. Few of us have seen many wounds at short ranges by Snider and Martini bullets, and fewer still those of the old leaden bullet. But there is no doubt in my own mind that they were of a more severe type (at short ranges) than those with which we have been familiar since 1892. I had once on the Indian Frontier an
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opportunity of seeing a number of wounds which had been inflicted by Pathans armed with Sniders and Martinis, and I was greatly struck with the severity of the injuries produced. I remember especially a Gurkha with both bones of the forearm shattered and the tissues frightfully lacerated by a Snider bullet. Explosive exits, in short, are no new things, and indeed, it is doubtful if those we see are so severe as when the effect of large bore was added to high velocity and short range. One gets hints of this from strange quarters. Remember the remark of Archibald Forbes, the war correspondent, that in the battlefields of 1870 it was easy to distinguish men wounded in the chest by the whistling of air in and out of the wounds. Now nothing is better established than the fact that pneumothorax is a very uncommon complication of small bore wounds of the chest. Wounds with the pointed bullet, then, seem to be in part a reversion to an old type due to large bore and short range. Add a high increment of velocity, so that the same effects are produced at comparatively long ranges, and you have precisely the injuries we are discussing, with this exception, that in an uncertain proportion no turning, or very slight turning, takes place, and the simple flesh wound type is possible even when bone is involved.

It is to be remembered, too, that no experimental work, however realistic the conditions are made, can possibly reproduce exactly the varying possibilities of impact in actual warfare. Exactly the same prognostications of increased severity were made when the ogival small bore bullet was introduced, and were shown by war experience to be only partially correct. Moreover, a bullet acting in a manner and upon principles similar to those which underlie the movements of the pointed bullet has been actually used in Manchuria, and it is quite clear that severe results did not invariably ensue. Nevertheless, experiment is the groundwork of reasonable presumption, and with proper reservations and allowances should be a guide to preparation for war. Some, at any rate, of the prophecies which our friends across the water are so fond of making came true as regards the ogival small bore, and it would be wise for all nations to be prepared for some of the new effects foreshadowed in this paper.

DISCUSSION.

Lieutenant-Colonel J. B. Wilson, R.A.M.C., thought that the results of experiments on dead carcases should be taken with a certain amount of reserve, since parts hanging up were in a different physical condition from living animals on their feet. He agreed with Major Pilcher that
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the essential difference between the new types of bullet and the old ones was their tendency to turn on their short axis.

Major E. B. Waggett, R.A.M.C., asked whether the material of which the bullet was composed had any influence on the wounds produced by it.

Major H. A. Bray, R.A.M.C., asked whether the great proportion of large exit wounds, which one would expect in the future, would not necessitate some changes in the first field dressing.

Fleet-Surgeon Home expressed the opinion that one would probably find great differences between the wounds produced in dead carcases and those produced in tense living tissues.

Major Pilcher, in reply, said that there was no evidence as to the influence of the material composing a bullet on the wounds made by that bullet. With regard to the criticism as to the differences between experimental results on carcases and those actually got in living bodies, the results of experiments with the ogival bullet were confirmed in the main by the results found in the field. With regard to Major Bray's suggestion it was very probable that some modifications in the first field dressings would be called for, but a large number of the exit wounds would be such that no first field dressing would be effective.

The President, in thanking Major Pilcher for his interesting paper, said that it was such papers which illustrated the necessity for such societies as the United Services Medical Society, since the constant changes in war material and war methods necessitated constant study and discussion on the part of the medical branch of the Army to keep abreast with them.