

Report on the fitness for use in the British service of a wheeled ambulance transport conveyance moved by hand labour (Neuss'sche zweiräderige Bahre), the employment of which is stated to have been attended with special advantages during the recent war between Germany and Denmark in Schleswig-Holstein : together with a history of the class of conveyances to which it belongs, so far as regards their connexion with the objects of ambulance transport / by T. Longmore.

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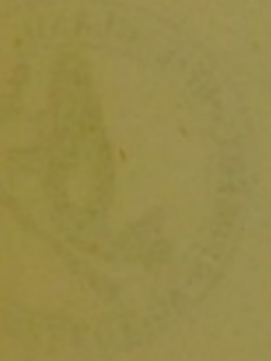
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REPORT
ON
THE FITNESS FOR USE IN THE BRITISH SERVICE
OF A
WHEELED AMBULANCE TRANSPORT CONVEYANCE
moved by hand labour.

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REPORT ON THE FITNESS FOR USE IN THE BRITISH SERVICE OF A WHEELED AMBULANCE TRANSPORT CONVEYANCE

moved by hand labour (*Neuss'sche zweirädrige Bahre*), the employment of which is stated to have been attended with special advantages during the recent war between Germany and Denmark in Schleswig-Holstein; together with a history of the class of conveyances to which it belongs, so far as regards their connexion with the objects of ambulance transport.

By DEPUTY INSPECTOR-GENERAL T. LONGMORE, Professor of Military Surgery
at the Army Medical School.

CONVEYANCES intended to be wheeled by men, known under the name of wheel-barrows, or hand-wheel litters, form a class of conveyances which has seldom been had recourse to for the systematic removal of sick and wounded of armies in time of war. The advantages of wheeled carriages moved by hand-labour for field service have not unfrequently been discussed of late years, but they have been very differently estimated: by some they have been unreservedly condemned, while by others they have been strongly advocated as a serviceable and economical form of sick transport. These opinions have, however, been put forward without much practical experience of their qualities or suitableness for use in campaigning. Vehicles of this kind have been used from time to time under casual circumstances where other transport was not available, or where they formed an ordinary method of carriage of the country, owing to local peculiarities of ground; they have been even constructed and despatched for use in the field on a special service in which the British Army was engaged, viz., in 1860; but it has only been very lately, during the late Schleswig-Holstein war of 1864, that hand-wheel carriages, specially constructed for carrying wounded, have been practically tested in active warfare. The experience gained in this latter campaign has led to the expression of such very strong opinions in favour of these particular carriages by eminent surgeons who regard their introduction as likely to form a new era in the arrangements of ambulance transport, that it seems desirable to enquire very particularly into the nature of their merits and comparative advantages as regards other more ordinary forms of conveyance.

The principal objects intended to be obtained by the construction of these hand-wheel litters are:—First, a more rapid removal of the wounded from the scene of conflict to the rear than can be obtained by the use of ordinary stretchers; Second, to compensate for the deficiency in the number of bearers usually available for transporting the wounded by lessening the fatiguing nature of the work; and Third, to avoid the necessity for increasing the number of animals employed in bearing cacolets and litières for transport service. They are not usually advocated for adoption with the view of using them as substitutes for ambulance carts or wagons on long journeys, as in transporting wounded from the field hospitals to general hospitals at a distance in rear, although they can be employed to supplement these more bulky and substantial conveyances, when necessary, even for this service; but they are recommended in preference to other conveyances for travelling over the spaces comprehended between the ground on which the wounded have fallen, or between the immediate rear of the spot where the fighting is in progress, and the first and second lines of surgical assistance.

The first object, rapidity of removal, is gained by the use of wheels, generally high wheels, by means of which the conveyance can be caused, at the cost of slight expenditure of labour, to pass speedily over rough fields as well as over regular roads; at the same time that the whole litter is made so light that if great obstructions are met with, such as interfere with the employment of the wheels, it can then be readily carried by a couple of bearers over them.

The second object is also gained by the wheeled construction of the litter. Experience has always shown, in cases of engagements attended with many wounded, that the number of bearers falls far short of the number required for

the regular and rapid removal of the sufferers. This deficiency is made the more manifest by the length of time occupied by the bearers in the removal of a single man on a stretcher, if the distance from the field to the first line of surgical assistance be considerable. Under these circumstances the two bearers, especially if the wounded soldier whom they are carrying is heavy, have either to halt and deposit the stretcher on the ground while they temporarily rest themselves, or have to be relieved for a certain distance by two other bearers. The fatigue of the usual limited number of bearers is also increased by the continuous nature of their work of repeated journeys without cessation for transporting the wounded between the field and the field-dressing stations, since so long as any wounded remain on the ground they cannot be allowed to stop from their duties for repose. The plan of the hand-wheel litter obviates in a great degree these sources of fatigue by the weight of the conveyance being transmitted through the medium of the wheels to the surface of the ground, instead of through the medium of the bearers; and at the same time by the circumstance that the slight effort which is required to set it in motion on ordinary ground can be varied either by the act of pushing, or by that of drawing the machine. One attendant is sufficient for the transportation of a patient lying on a well-made wheeled litter if the ground be favourable; and the rapidity with which it can be made to perform the transport from the field of action to the ambulance is still further calculated to lessen the evil arising from a deficiency in the number of hospital bearers, by the quickness of its return for the removal of other wounded who are requiring assistance.

The third object is also important. The disadvantages attending the collection of a large number of transport animals are sufficiently obvious, not only as regards the rations consumed by them, and the attendants required for their constant care, but also on account of the unhygienic condition which they tend to increase among bodies of troops. If, therefore, a litter can be fashioned calculated to lessen the necessity for employing a large number of transport animals, and there be no important objections to it in other respects, an undoubted improvement is effected in the system of ambulance transport.

But it remains a question for consideration, although the three objects above mentioned be successfully attained, whether conveyances wheeled by men are suitable in other respects for field service; at any rate, in such field service as British troops are likely to be engaged in. Considerations of cost, durability, portability, liability to injury, and capability of repair, arise on attempting to decide the question of general fitness of such conveyances for use in the British service.

Before entering upon these questions, and before describing the particular hand-wheel litters used during the late German-Danish war, it will be useful to refer to the several examples of this class of conveyances which have either been used, or proposed for use, at various periods. I will refer to them in the order in which they have been successively brought to notice.

Bautzen Wheel-Barrows. (Brouettes.)—Baron Larrey mentions in his account of the Russian campaign,* that after the battle of Bautzen, in Saxony, which was fought in the summer of 1813, two-thirds of the wounded were transported to Dresden by the inhabitants, at his suggestion and advice, in a very convenient kind of wheel-barrow which was in general use in that country for carrying provisions and merchandise. Every private person had several of these vehicles. All the road from Bautzen to Dresden, distant about 30 miles, had more or less inclination, so that the movement of these barrows met with no obstacle on this occasion. Baron Larrey relates that he had seen as many as 150 filing along the road, one after another; and that, from observation of them, he was convinced no kind of transport could be more favourable or more expeditious for the country. I am informed that these barrows, which are in general use in the south of Germany, are usually so curved and inclined that a person lying upon one of them would find his position very much more easy than he would upon another of which the floor was straight, as happens generally in English wheel-barrows, which require to be tilted up considerably when put in motion. They are lower, and are also much longer than these latter,

* *Mémoires de Chirurgie Militaire et Campagnes du Baron D. J. Larrey*, Paris, 1817, tom. iv. p. 168.

being readily able to sustain a person lying at full length, with the head and shoulders slightly raised. There is only one wheel, but this is broad, and from the general width and construction of the barrow, together with the aid of two short supports near the forepart of the conveyance, they are with difficulty overturned. It is, moreover, a light vehicle, and is not fitted with sides above the shafts, so that wounded or weak persons can be readily laid upon or removed from it. It is frequently in use in this part of Germany for the removal of persons who have met with accidents in civil life.

Evans' Hand-Wheel Litter.—During the period of the Crimean War, in February, 1855, a surgeon in practice in London, Mr. G. Evans, published an account of a hand-wheel litter which he had planned as a subsidiary appliance or addition to the ordinary means for the conveyance of wounded from a field of battle. It was designed so as to be capable of carrying either one or two wounded men, one being in a recumbent, the other in a sitting position, and could be wheeled by one, or carried by two bearers, according to circumstances. As this litter is made on the same principles, and seems to possess several of the essential advantages of the Prussian two-wheeled hand-litter, which, according to the published reports, was found so effective at the recent attack on the Forts of Düppel and on other occasions, I append a drawing of it, and make a quotation of some of the uses for which its inventor constructed it to be suited. The drawing will sufficiently explain the nature of its construction without further description.

The conveyance represented (see sketch No. 1) was planned, according to its designer, to combine the following advantages:—

(a) Where the ground is favourable, two wounded men, with their arms, can be removed on it by one man.

(b) Where the ground is too rough for the wheels to be used, it can be carried so loaded, by two men as an ordinary litter.

(c) The back can be raised or lowered, to give the recumbent patient whatever degree of inclination the nature of his wound makes desirable.

(d) The back at the same time forms a commodious canteen, under lock and key, for the following important medical and surgical necessities: canteen of water, canteen of brandy, a drinking cup, field tourniquets, lint and tow, plaister and bandages, sponges, set of metal splints, paddings and tapes, a hand lantern, can of oil and cotton, &c., and lucifer matches. In addition, one or more pairs of crutches can be slung underneath the litter.

(e) The litter can also be used in the field as an operating table; and the chair removed from the litter, can be used for operations in the upper extremities.

(f) After the wounded are removed, these litters can be usefully employed in collecting muskets, accoutrements, &c., scattered about the field.

(g) The wheels being removed, this litter forms an excellent bedstead for the hospital; where the chair will be scarcely less useful to the wounded.

(h) Any number of them attached to a regiment can be made most useful when not needed for field or hospital purposes, in removing provisions, stores, clean or foul linen, from one point to another.

(i.) The litter can be made with shafts sufficiently long to admit of a mule drawing it, either with wounded on it or loaded with five or six cwt. of stores; or so loaded, it can be attached to the rear of a baggage waggon on a line of march.

(k) Though weighing, with its wheels and springs, only about 30 lbs., this litter is nevertheless remarkably strong in its construction; and by simply unscrewing the springs and wheels it becomes capable of easy and close stowage on board ship, and is as promptly put together again, immediately it is landed.

In April 1855, the litter thus described was examined by a Board of Army Medical Officers in London. Their report was unfavourable to its introduction into the military service. The weight was considered to be too great for the conveyance to be conveniently drawn by manual labour with the aid of its wheels, or to be carried, when divested of them, in the way that the ordinary stretcher is carried. I have not myself had the opportunity of seeing one of these litters.

Ordnance Ambulance Barrows.—In October 1856, two forms of ambulance barrows, one barrow having only one wheel, the other being two-wheeled

were sent from the War Department for examination and report by a Committee of Military Medical Officers. Neither of these barrows were approved of for field purposes. The special reasons for which these conveyances were condemned by the Committee are not stated in their proceedings, but the general principles of all such conveyances were disapproved of by these officers, so that they were induced to remark that "no hand carriage with wheels is adapted to field service."

China Ambulance Barrows.—In the year 1860 a considerable number of ambulance barrows, with two wheels, were despatched from this country to assist in meeting the requirements of the British forces then assembling in China. These conveyances have been since generally spoken of as "China barrows." When, in consequence of the disastrous affair which occurred at the mouth of the Peiho River in the summer of 1859, it was determined to force a way to Peking, it was found that the nature of the country, and the means of transport that could be obtained on the route from the place of landing to the Chinese capital, could not be ascertained with any degree of certainty. The immense distance of the scene of hostilities from England precluded many arrangements from being made that might otherwise have been resorted to. The state of the roads that would have to be travelled over was unknown, and it seemed not impossible that all the ordinary transport animals of the country would be removed by the Chinese. It was determined, therefore, to send means of sick-carriage adapted for meeting every kind of emergency. Improved ambulance carts, as well as litières and cacolets, were provided in case horse or mule labour might prove to be available; in addition to the ordinary stretchers, dhoolies were sent on from India for native bearers; and the barrow, which is now under consideration, was also forwarded under the idea that it might be advantageously employed, both for commissariat and ambulance purposes, with the aid of Chinese labourers collected in the lower provinces. The extensive and easy means of river carriage which were found, however, to exist almost up to the walls of Peking, obviated the need of using these conveyances, and, among other circumstances, prevented the opportunity from being afforded of testing practically the utility of the hand-barrows for ambulance transport.

The China ambulance barrow (sketch No. 2) has the general appearance of a small cart open in front, but closed at the sides and behind. In this state it forms a suitable cart for the conveyance of stores or provisions from the rear to the front, being capable of being drawn by a single man or small horse, placed between the shafts.

When about to be arranged for ambulance purposes, a change in the arrangement of the cart has to be made. The hind board is first taken out, and the two sides, which are hinged, and of a height exactly to meet each other when lowered, are then made to fold down on the body of the cart. The hind board is next laid across in front and secured. Two iron uprights, each fitted at its upper extremity with a strong india-rubber spring and broad hook, are now inserted in iron collars, one at each side near the hind part of the body of the cart. The hooks connected with the springs are for the purpose of receiving and supporting the ends of the two poles of a regulation stretcher; the other ends of the poles of the stretcher are supported by two iron crutches which are made to screw into the shafts of the cart near their handles. If a bearer now places himself between the shafts, he can lay hold both of the shafts and of the ends of the stretcher poles; and when the shafts are raised to a convenient height for the man to draw the cart, the stretcher is brought into a horizontal position clear of contact with the wheels, or any other part of the barrow. The stretcher could not be used without the sides of the barrow being turned down, because, if they were left upright, the poles of the stretcher would be brought into contact with them. (See drawing No. 3.)

The transport is rendered easy to the patient by the action of the springs which assist in supporting the stretcher upon which he is lying. Ropes are supplied with means of hooking them to projections from the axles, for attaching an additional bearer to add to the traction, if necessary, as in ascending a steep slope. A keg for water is suspended from the under part of the barrow.

A pattern of the China barrow, complete for ambulance purposes, including the stretcher, has been carefully weighed at Netley. The weight was found to be 234 lbs. 9 oz.

Neudörfer's Hand-wheel Litter.—Early in the year 1864, before the war with Denmark commenced, Dr. J. Neudörfer, an Austrian military surgeon, and Professor of Surgery in the University of Prague, published the first part of a handbook on military surgery.* Dr. Neudörfer had acted as Principal Medical Officer of the ambulance of the 8th Corps d'Armée of Austrian Infantry during the Italian campaign of 1859, and at the close of the war had been placed in charge of a division of the Military Hospital at Verona. He had thus been able to gain considerable experience in all matters relating to wounded in time of war. Dr. Neudörfer, from this experience, was led to object to all the existing forms of litters, both to those borne by bearers, and to those on the backs of animals, as well as to all the ordinary forms of ambulance waggons. He defined the following to be the requisites for a transport vehicle, suitable for field purposes:—1st. That it should not require to be drawn, or to be carried by any animal. 2nd. That it should be capable of being managed and drawn by one man. 3rd. That it should be as competent to travel over fields and rough places as over regularly made roads. And 4th. That it should be strong, light, durable, cheap, and portable. These conditions, he thought, would be fulfilled by a litter, or handbearer, on a two-wheeled frame or car of iron, very light, and with large wheels.

Carriages on the principles thus enunciated by Dr. Neudörfer were constructed by Messrs. Fischer, of Heidelberg. These conveyances have been made capable of transporting either one wounded soldier or two at the same time.

The following is a short description of one of these litters:—The two wheels are each about four feet in diameter. The framework, which is supported on springs between the wheels, admits of adjustment, so that a wounded person can be placed in any desired position, recumbent, sitting, or half-sitting, and half-reclining. When two patients are carried, they recline back to back. Beneath the litter there is a netting, within which a knapsack or surgical materials can be carried, and means are also provided for carrying one or two muskets. In Dr. Neudörfer's hand-wheel litter, the stretcher, or canvass frame, upon which the patient rests, is removed from the machine and laid on the ground when a patient is about to be placed upon it; and it is said that the stretcher can be readily replaced in its former position with the patient upon it. The conveyance can be taken to pieces for packing, and by the stretcher portions being folded up and placed between the two wheels, which are then brought near to each other, the whole machine can be reduced to occupy a space having its sides equal in length to the circumference of the wheels, by seven inches in width. I am not aware that any conveyances, made precisely in accordance with the description above given, have been actually used in military service, neither have I myself had the opportunity of examining them.†

The illustrations numbered 4 and 5 have been copied from photographs, furnished by Messrs. Fischer, of some of these carriages, which they have manufactured in accordance with Dr. Neudörfer's designs.

Neuss's Two-Wheeled Litter.—(See drawings Nos. 6 and 7.)—Early in the course of the war of last year, between Germany and Denmark, the Russian Johanniter Orden (Knights of St. John)‡ had carriages constructed on principles in a great degree similar to those described by Dr. Neudörfer at the factory of the Messrs. Neuss, Government carriage builders at Berlin, but differing in many points of mechanical detail. These carriages were constantly employed in the service of the Prussian wounded throughout the war; but their practical advantages were particularly noticed at the time of the storming of the forts of Düppel. These are the litters to which especial reference has been made at the commencement of these remarks.

* Handbuch der Kriegs-Chirurgie, ein Vade-Mecum für Feldärzte, nach eigenen Erfahrungen bearbeitet, von Dr. J. Neudörfer, etc., etc., Erste Hälfte. Leipzig, 1864.

† One of Neudörfer's litters has been written for from Heidelberg for the purpose of testing its qualities at Netley.

‡ This charitable order established an ambulance at Nübel, at a distance of three miles from the heights of Düppel, and near the road leading both to the forts and to Sonderburg. They also established, by permission of the Prussian Government, other field-hospitals at the seat of war.

One of these conveyances has been obtained from the makers at Berlin for the Army Medical School, with the intention of examining carefully into its alleged merits, and testing them by practical trials, so far as opportunities can be afforded at a home station in time of peace for such observations.

The following is a description of the construction of the conveyance.

It consists of a litter partly made of wood and partly of canvass stretched between two side poles, and placed upon springs; these springs being again made to rest upon an iron axle-pole connecting the two wheels upon which the weight of the whole machine, when in motion, is supported. The side poles are provided with handles at both ends. A single man, on grasping two of the handles at either end, can wheel the machine either by pushing it from behind or by drawing it from the front; or two men, one in front and one behind, can together push and draw it, or can carry the litter, if required, without the wheels being brought into contact with the ground. In order to combine lightness with solidity, the framework has been made of hickory wood. The wheels are also constructed on a peculiar plan, with a view to obtaining the same ends; for each nave is of unusual length, and the spokes, twelve in number, radiating from it to the circumference are alternately inclined in opposite directions, so as to cross each other at very acute angles, and distribute support evenly from whatever side pressure may be principally exerted. (See sketch No. 8.)

Means are provided to support the litter firmly when at rest, and in the absence of an attendant. These means consist of two pairs of strong, well-connected props, one in front and one behind. The hinder prop alone, in conjunction with the wheels, forms a sufficiently stable support for the conveyance. Each prop is so joined to the framework, that, when the two together are resting on the ground, they stretch out at obtuse angles with the middle portion of the litter in opposite directions, and thus ensure perfect stability of the whole. By a simple arrangement, a man pushing this litter from behind, can, without moving from his place, either raise or lower, as well as fix in position at pleasure, both the front and hind supports. The hind support consists of a single piece, but the front support is jointed, so that, when shortened, the litter resting on the wheels and upon this shortened front support has such an inclination given to it, from the head downwards towards the foot, that the ingress or egress of a patient is greatly facilitated.

Considerable attention has been paid in the design of this litter to securing an easy and steady position for a patient while being transported in it. The patient does not lie in a completely horizontal posture; his head and back are somewhat raised, and inclined at an angle with the pelvis and thighs, and these again form an angle with the legs. The head of the patient rests upon a pillow covered with glazed cloth or leather; the back, pelvis, and thighs upon a flexible support of sailcloth, while the part for supporting the legs and feet consists entirely of wood. There are two padded supports for the arms and elbows of the patient. A folding sailcloth hood is fixed to the upper end of the carriage, and can be drawn over the head and shoulders of the patient, so as to form a sun-shade or protection against rain, without interfering with the free access of air. A cover of sailcloth is also rolled up and fastened by two straps at the foot of the litter. This covering, when unrolled, can be drawn up so as to lie under the upper edge of the expanded hood, and be fastened to the upper part of the framework. By these means the patient, during transport, can be protected against dust or inclement weather on every side.

Under the part which is made to support the head and shoulders of the patient, there is a space enclosed within two wooden sides, and a floor of strong sacking, capable of carrying refreshments, bandages, or other parcels to the front, or of receiving the knapsack or accoutrements of a wounded man who may have to be transported to the rear. This space is covered behind with a canvass flap secured by a button.

The weight of the litter complete as thus described, on weighing it at the Royal Victoria Hospital, has been found to be 109 lbs. 13 oz. avoirdupois.

As already mentioned, very strong testimony has been given in favour of this form of litter by some of the surgeons who saw them in use in the late Schleswig-Holstein campaign. Dr. Gurlt, Professor of Surgery in the Royal

Prussian University at Berlin, thus writes of it from his own practical experience :*—"If I am asked how this litter answers, I can guarantee its excellence from my own observation. The circumstances under which these litters were employed before and after the storming of the forts of Düppel were particularly favourable, because good roads, or the high road to Sonderburg, could be used in moving the wounded from the front to the rear, and thence to the hospital. But I have also seen them answer well on uneven ground, ploughed fields, and the like. Even obstacles of a formidable nature which could never be passed by an ordinary waggon, are easily overcome by these two-wheeled litters; for, with two men only with them, they can be easily lifted over such impediments, like the ordinary hand litters, without any interference from the wheels, on account of their extreme lightness.

"Besides this, on exceedingly uneven ground, jolts and rough movements can be spared the wounded man by attentive porters; for, as soon as the litter must pass over hillocks and through ditches, all jolting of the vehicle can be prevented by lifting one or both wheels from the ground. On even roads, one man is able to convey this litter long distances without fatigue, alternately pushing or pulling, according as he places himself behind or in front of the conveyance.

"On the march these litters are either pushed or pulled by the men, and they can be used, as I have often seen them, for holding their knapsacks: or two or more of them can be fastened behind each other to the rear of a waggon; or, lastly, by removing the wheels, they can be easily packed upon waggons."

Dr. Neudörfer, the Austrian military surgeon whose name has been before mentioned, has also borne strong testimony to the success of these two-wheeled conveyances in the late campaign against Denmark. He writes, in the course of an official report on the wounded in Schleswig, as follows, respecting them :†—"Although, from the very nature of war, it is impossible to provide completely for the requirements of the wounded, yet it would be impossible to shut our eyes to the immense improvement that these wheeled carriages present over all former means of transport. It was proved beyond doubt that in my wheeled barrows severely wounded men could be transported with even less injury than in other carriages, both over rough ground and high roads; that they, moreover, required fewer men than other conveyances, and that these men, being less fatigued, could continue at their work for longer periods together."

The opinions expressed by these eminent and experienced surgeons are entitled to great respect; and, after careful examination and trial of the two-wheeled litter, I am led to agree with much that has been advanced by them in favour of this field conveyance. But, although believing it likely that wheeled hand-litters may be destined hereafter to take an important part in the transport of wounded in time of war, especially on the Continent, I cannot concur in the opinion that they are calculated to supplant the ordinary means of conveyance borne by men and animals. Neither does my observation of the wheeled litter lead me to believe it to be adapted to the *general* requirements of transport conveyances for the British military service, although, in certain situations, and under special circumstances in that service, I think it may constitute a form of conveyance preferable to any other for removing the wounded from the place of action to the first line of surgical assistance, and thence to the field hospitals.

I will briefly explain the grounds on which the views I have just expressed have been based, and define the limitations which it appears to me the circumstances of the British service will cause the use of these wheeled litters to be subjected to, in case they are introduced among the number of its conveyances for sick and wounded soldiers.

Firstly, as to its fitness as regards the ease afforded by it to a wounded man during the act of transportation. All the requirements in this respect are met, as far as practicable, by the two-wheeled litter. It is superior, as regards ease of position, to either the plain stretcher or to the mule litter. This fact is

* "Militär Chirurgische Fragmente, von Dr. E. Gurlt, Berlin, 1864," p. 7, &c.

† "Aus dem feld-ärztlichen Berichte über die Verwundeten in Schleswig, von Dr. J. Neudörfer, Berlin, 1864," pp. 7, &c.

owing to the soft, and at the same time firm, nature of the support, as well as to the respective degrees of inclination given to the head, shoulders, and thighs of the patient. It is the easiest position in which a patient could be placed who is faint from loss of blood or from the effects of injury, while, in whatever region of the body the wound may have been received, the injured part may be as carefully protected from additional hurt during the conveyance as on an ordinary stretcher, and more so than on either the cacolet or mule litter. The only conveyance, perhaps, which offers equal advantages in regard to securing ease of position for the patient is the Indian dhooley. The back of the conveyance is not adapted for being raised or lowered, as in Evans' hand-litter; but it can rarely happen that such a change is necessary during the first transport of wounded, for which the latter is chiefly designed, and firmness is gained by the absence of the mechanical contrivances which would be necessary for such an adaptation. At the same time the head and shoulders of the patient can be readily raised, if necessary, as in ordinary stretchers, by placing articles of clothing beneath them.

When the ground is level, over a gravel road, or over pasture, for instance, the patient is not subjected to jolting from the motion of the conveyance. The springs prevent this. When the conveyance is wheeled over ploughed land, there is more jolting than there is when a patient is carried upon an ordinary stretcher by well-trained bearers. This jolting can be prevented, in the same way that it is in the stretcher, by two bearers carrying the wheeled litter. It is, however, a heavier load for the bearers.

If the road be favourable, the patient can be much more rapidly conveyed to the place of surgical assistance than he can be by the ordinary stretcher, or even by the mule-litters; for the animals carrying these latter conveyances have to be restricted to a walking pace.

Secondly, as regards advantage in saving of labour. If the ground be favourable, one man can easily transport a patient by means of this conveyance to any usually required distance, and with very little fatigue, because the muscular exertion is moderate, and is capable of being varied. Under these circumstances, there is very considerable saving of labour, both from one man being able to do the usual work of two or more men, from his being able to accomplish it more speedily, and from his being less fatigued at its conclusion, and, therefore, the sooner available for other duty. Evans' and Neudörfer's two-wheeled litters would appear to be even more economical in labour than Neuss's, as, with them, under similar circumstances, two men, it is stated, could be easily transported by a single porter. Practical experiments, with a view to comparing the relative amount of ease and speed with which these litters, when supporting two persons, can be wheeled by a single attendant, are necessary for establishing this point. The small wheel of Evans's litter would probably cause the speed of its movements to be less, and the exertion of the porter to be greater, when compared with either Neuss's or Neudörfer's litters.

If, however, the ground be unfavourable, two men are required for the transport of a patient; and there does not appear to be any reason for concluding that the two-wheeled litter would, so far as labour is concerned, be then more advantageous than an ordinary stretcher, or so advantageous as the mule transport of two men under the guidance of a single soldier.

Thirdly, as to its portability. The Berlin litter can be readily transported when ordinary roads, railroads, or moderately even ground, are available, either by being moved on its own wheels, or by its wheels being removed and packed with the litter. But, under these latter circumstances, the package is a large one, and not calculated to resist with impunity any rough usage.

It is not fitted for transport by sea. It cannot be taken in pieces, so as to be put together into a compact package. Although the wheels are removed it is still bulky, and there remain many projecting parts, and these of comparatively little power of resistance, which will be constantly exposed to injury in the movements of a transport vessel in bad weather. This defect would quite unfit it, in its present state, for the general requirements of the British service. It is a necessity arising from the insular nature of Great Britain, that such conveyances should be simple in construction, easily taken asunder and packed, that such packages should be fully capable of resisting the shocks to which they are liable during a sea-voyage, and that the parts should be fitted for being

readily put together again on landing at the conclusion of the voyage. These qualities are not found in the Berlin two-wheeled litter.*

Fourthly, as to its capability of repair. Independently of the inconveniences which would arise from its bulk if it had to be transported in its complete state, the nature of the construction of the conveyance would cause it to be easily injured if subjected to undue violence, whether on shipboard or elsewhere. If the wheels or springs were injured, they could not be repaired under ordinary circumstances in the field. Spare wheels would be required to be taken for supplementing those which might be damaged, as is done in ordinary ordnance carriages. This objection would not hold good if the means of repairing such defects were at hand, as they probably were in Germany.

Fifthly, as to the cost. Dr. Neudörfer has made a calculation of the probable cost of an equipment of these litters, when made according to his designs, necessary for an Austrian army of forty brigades, supposing that all other forms of sick transport conveyances be abandoned. He remarks as follows:—"I find that my vehicles can be made, strong and fit for service, for about 100 florins each (10*l.*); so that, for each infantry brigade, 5,000 florins (500*l.*), and for an army of forty brigades, 200,000 florins (20,000*l.*) will be the cost. This sum is large, but, as every nation must necessarily improve its artillery and keep progress with the times, so must it similarly improve the means of transport for its wounded, unless it wishes to be left behind in the race both of military science and of philanthropy."† The cost of the Berlin two-wheeled litter sent to the Army Medical School was 15*l.*, irrespective of the expenses of its carriage from Berlin to England. But the real cost of these conveyances can only be ascertained by actual experience in field use, for the cost is not merely the first outlay, but should include the expenses of repairs, and, indeed, involves the whole question of strength and durability when a comparison between it and the other transport conveyances in this respect is instituted.

In conclusion, on considering all the circumstances above stated, it does not appear that the two-wheeled litter, notwithstanding its alleged utility and success in the late war against Denmark, is fitted for the *general* service of the British army for the transport of wounded in time of war. Here, its want of portability for stowage on board ship, its liability to injury, and the absence of facilities for repair, counterbalance its advantages. It would certainly be unwise to recommend it as a substitute for transport conveyances, the superior merits of which in respect to those qualities in which it is defective, and which are so important in the British service, have been practically tested and established, before it has received a more extended trial than it has hitherto been subjected to in field operations.

On the other hand, the superior advantages of these litters over other conveyances in the exceedingly easy position afforded by them to sick or wounded soldiers, in the little injury the patients are liable to be subjected to from shocks or from jolting during the transport, in the rapidity of their movement, the economy of labour, the ease with which they can be caused to travel long distances, together with the fact that they possess sufficient strength for all ordinary legitimate uses, render them not only appropriate, but, perhaps, the most appropriate transport conveyances that can be devised for use under certain special circumstances. Among a civilised community, with good roads, so that the ground between the scene of action and the lines of surgical assistance is likely to be tolerably regular and level, and where no necessity exists for transport by sea, or close package of the vehicles themselves, they seem to offer every advantage that can be expected to be found in any ambulance carriage.‡

* Even in the passage from Hamburg to Southampton on a steamer, and carefully packed, the two-wheeled conveyance obtained for the Army Medical School had one handle broken off, and was defective from the loss of two or three minor parts which had to be replaced before it could be fitted for use.

† Op. Cit., p. 10.

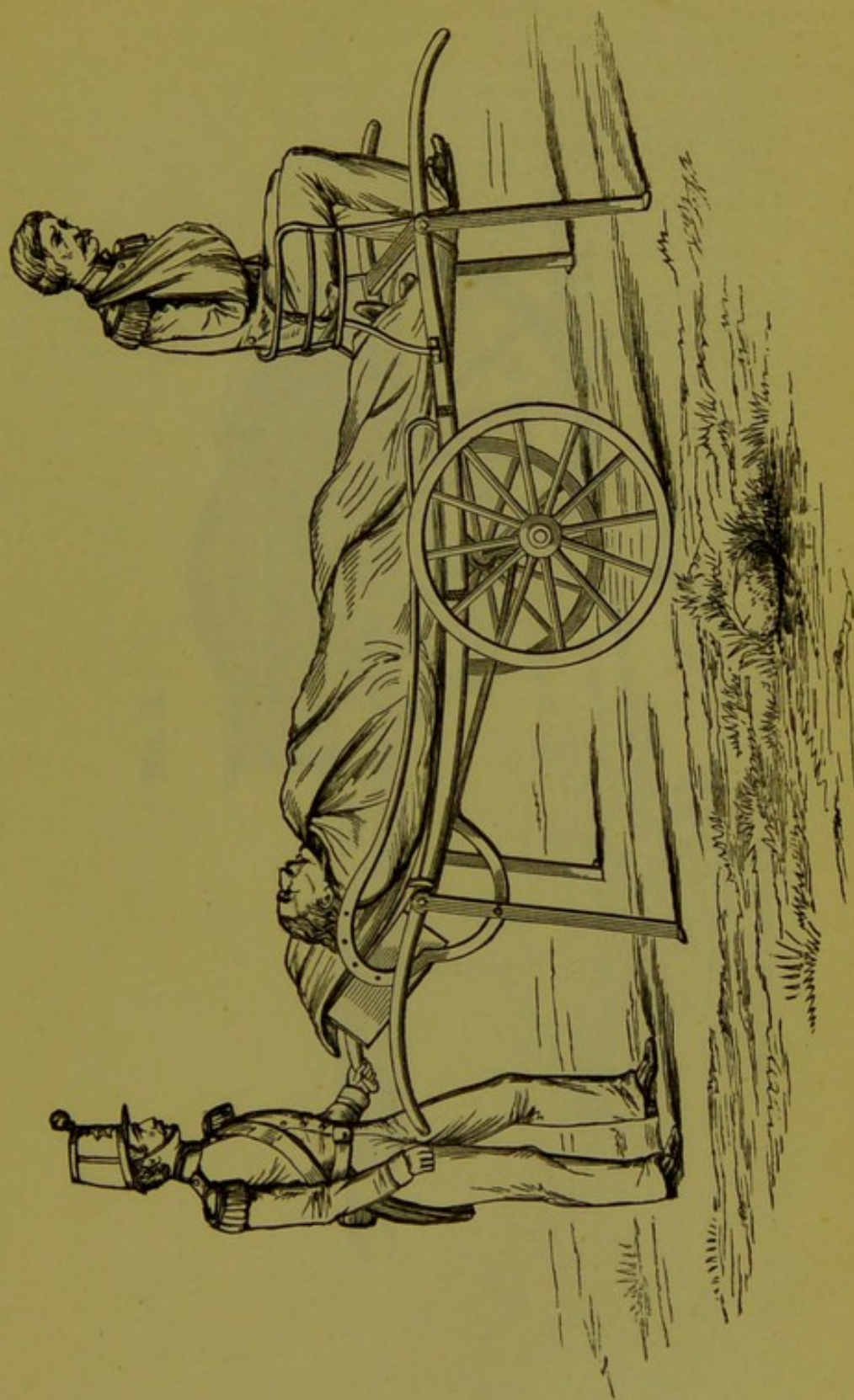
‡ One of these litters has been in use during the present year up to this date, (2nd June, 1865) in removing invalids requiring a recumbent position from the landing place to the Royal Victoria Hospital. The first part of the road from the beach has a very steep incline, the remainder has only a gentle slope. The regulation stretcher, Russell's spring dhooley or stretcher, Hopper's invalid chair, the China ambulance barrow, have been also employed for the same purpose. Preference has

Two other advantages, not enumerated in the above *resumé*, may be noticed. With the hand-wheel litter, it is not necessary to disturb the patient during the transport, in case of the conductor wishing to halt for a time, as must be done, to a certain extent, where the bearers of a stretcher place it on the ground in order to give themselves rest. Neither does it require any training to be able to conduct the movements of the wheeled litter, but only common care and attention; whereas, with the ordinary stretcher, a certain amount of previous practice is necessary to enable the bearers to carry a wounded man in such a way as not to aggravate his suffering by jolting or uneven movement. With mule-ambulance transport, also, quietness of the animal, and special training of the conductor, are both necessary to ensure ease to the patient; and with ambulance carts and waggons, considerable skill is required for driving properly. Nothing can be simpler than the management of the two-wheeled litter.

If an enemy were to attack the shores of this island, and a conflict occurred, I cannot imagine a more efficient hand-conveyance than such wheeled litters would afford. The wounded could be rapidly transferred by their means from the scene of action to the stations for the first dressings, and from these latter to appointed hospitals; or, if a railway were near at hand, could be carried to stations for removal to longer distances with the greatest amount of ease that the particular conditions of each wounded man would render admissible. The circumstances under which they seem to have been so successfully employed after the assault on the forts of Düppel and elsewhere in the recent war between Germany and Denmark, appear, from the descriptions, to have been of a nature, in many respects, similar to those I have just contemplated, and these are the conditions for which careful examination of the Berlin hand-wheel litters would have led me to conclude them to be particularly well adapted, even without the practical proofs of their advantages which that campaign is stated to have afforded, and to which I believe their employment should be limited.

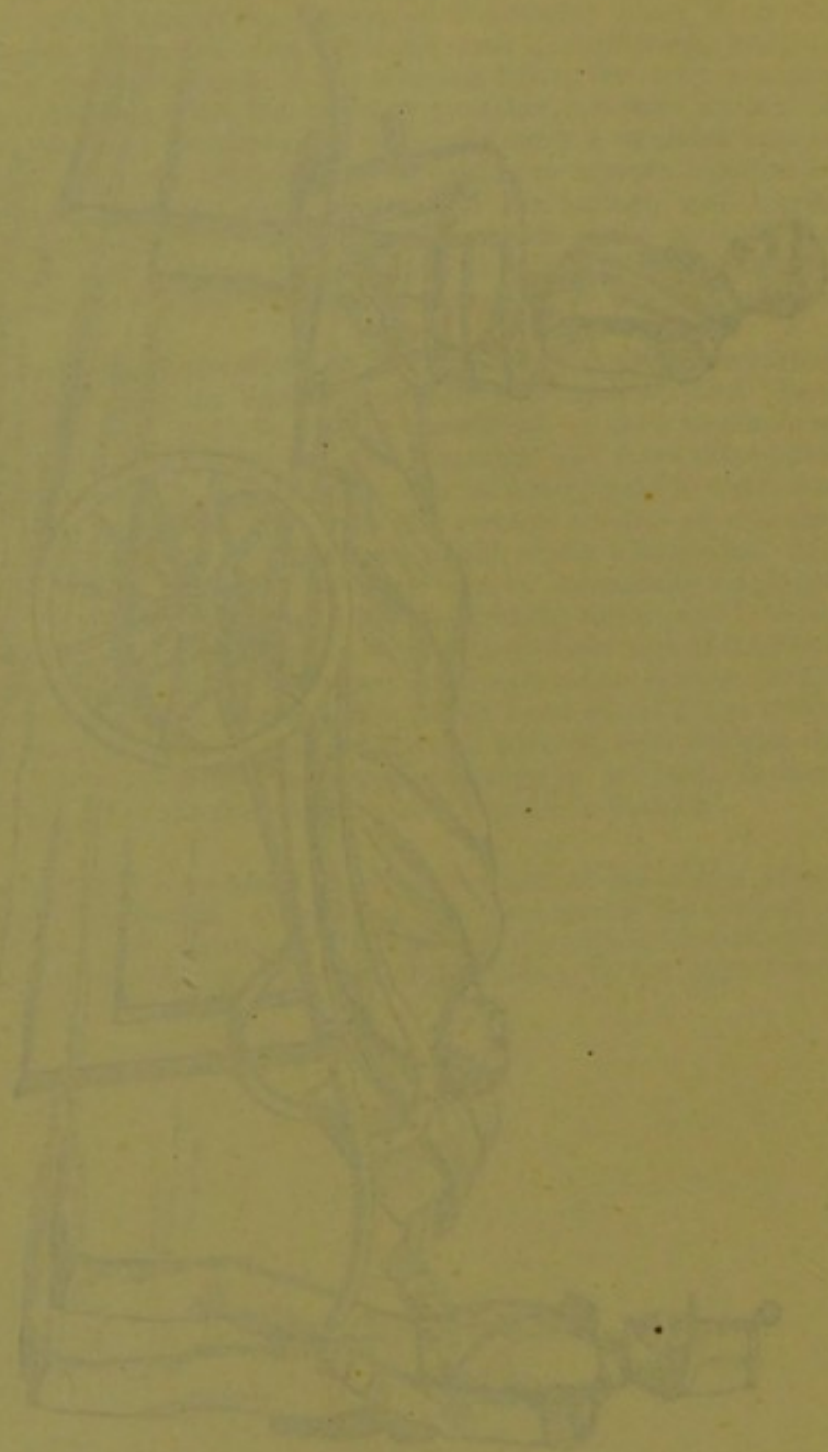
been universally given to the two-wheeled litter, on account of the several advantageous qualities above enumerated. On arriving at the entrance of the hospital, no difficulty has been experienced in carrying the litter with the patient upon it up the six steps leading into the corridor, or, if the wheels be shifted, to the upper stories of the building.

No. 1.



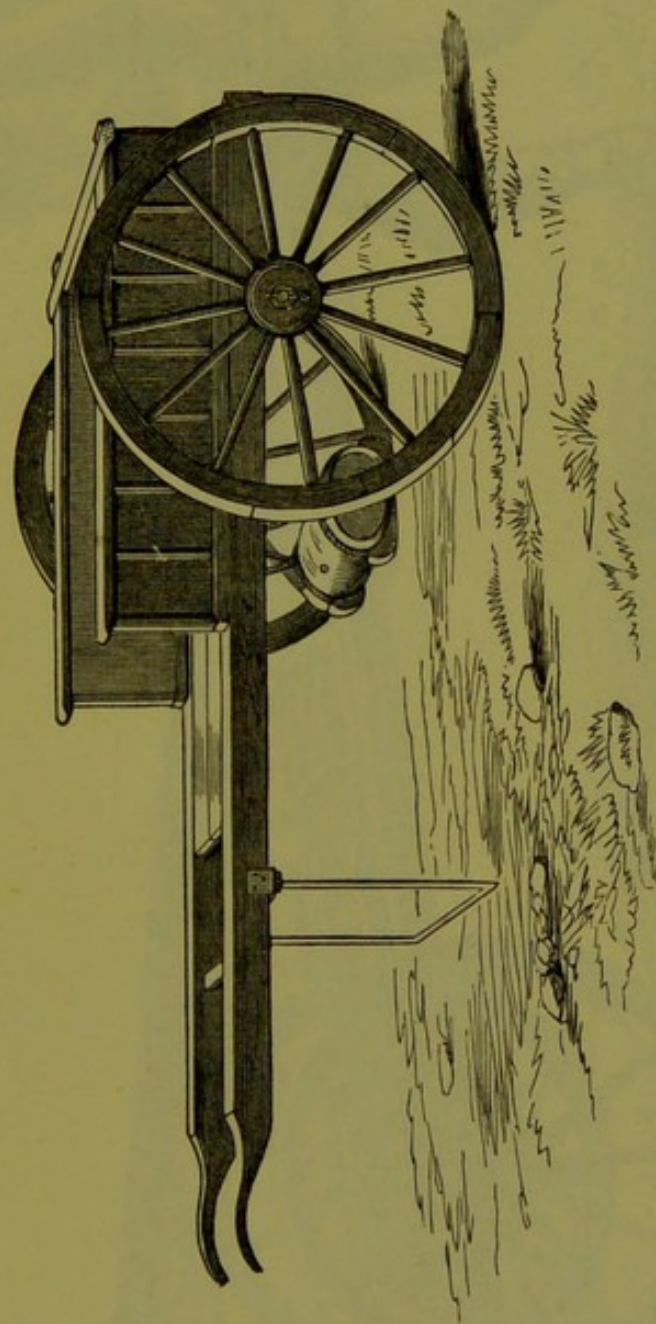
Evans's Hand-Wheel Litter.

THE GREAT HINDU TEMPLE



No. 1

No. 2.



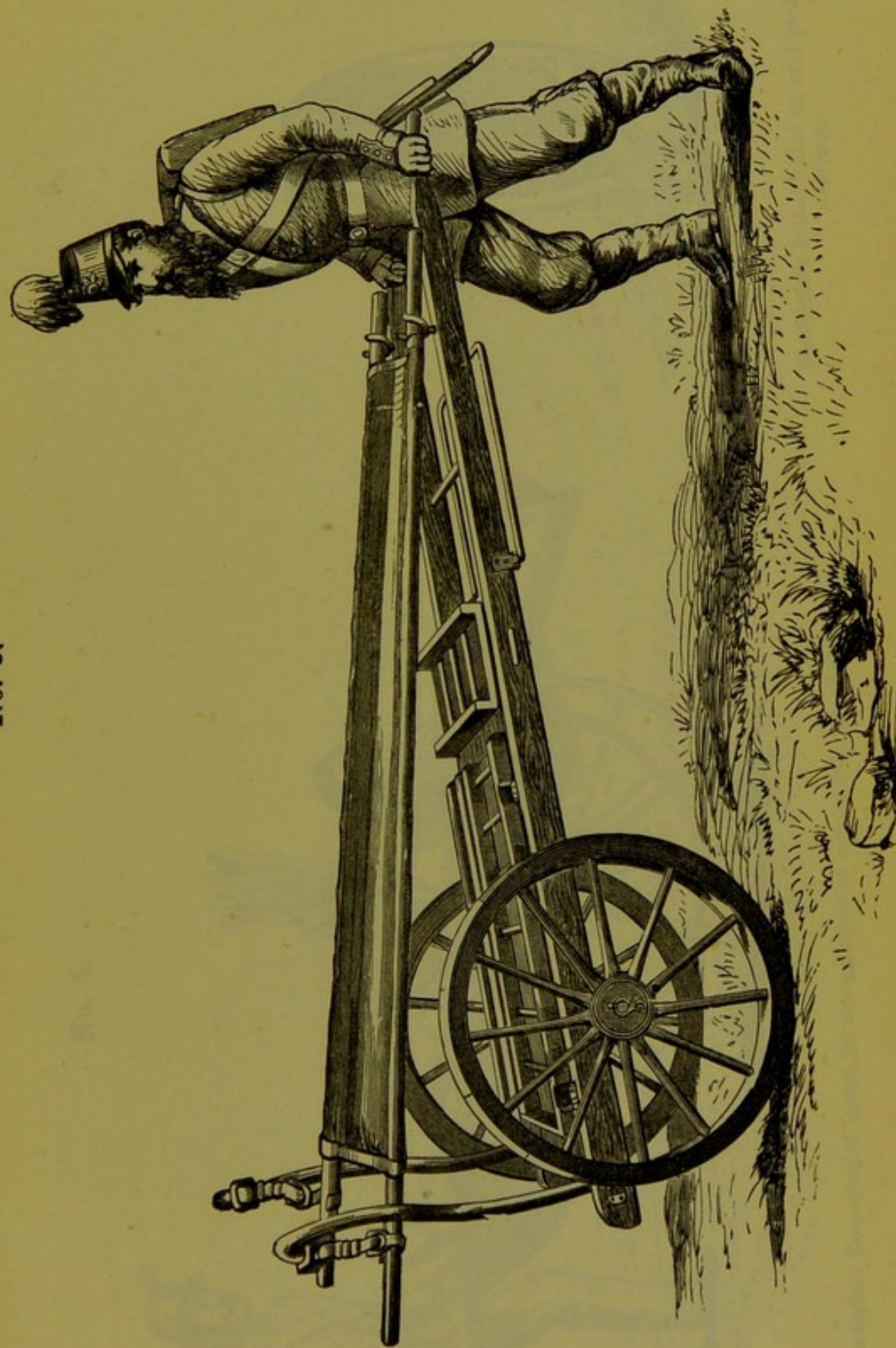
The China Hand-barrow, arranged as a Commissariat Store-cart.

THE CHINESE PAPER-MILL, AS A COMMERCIAL ENTERPRISE



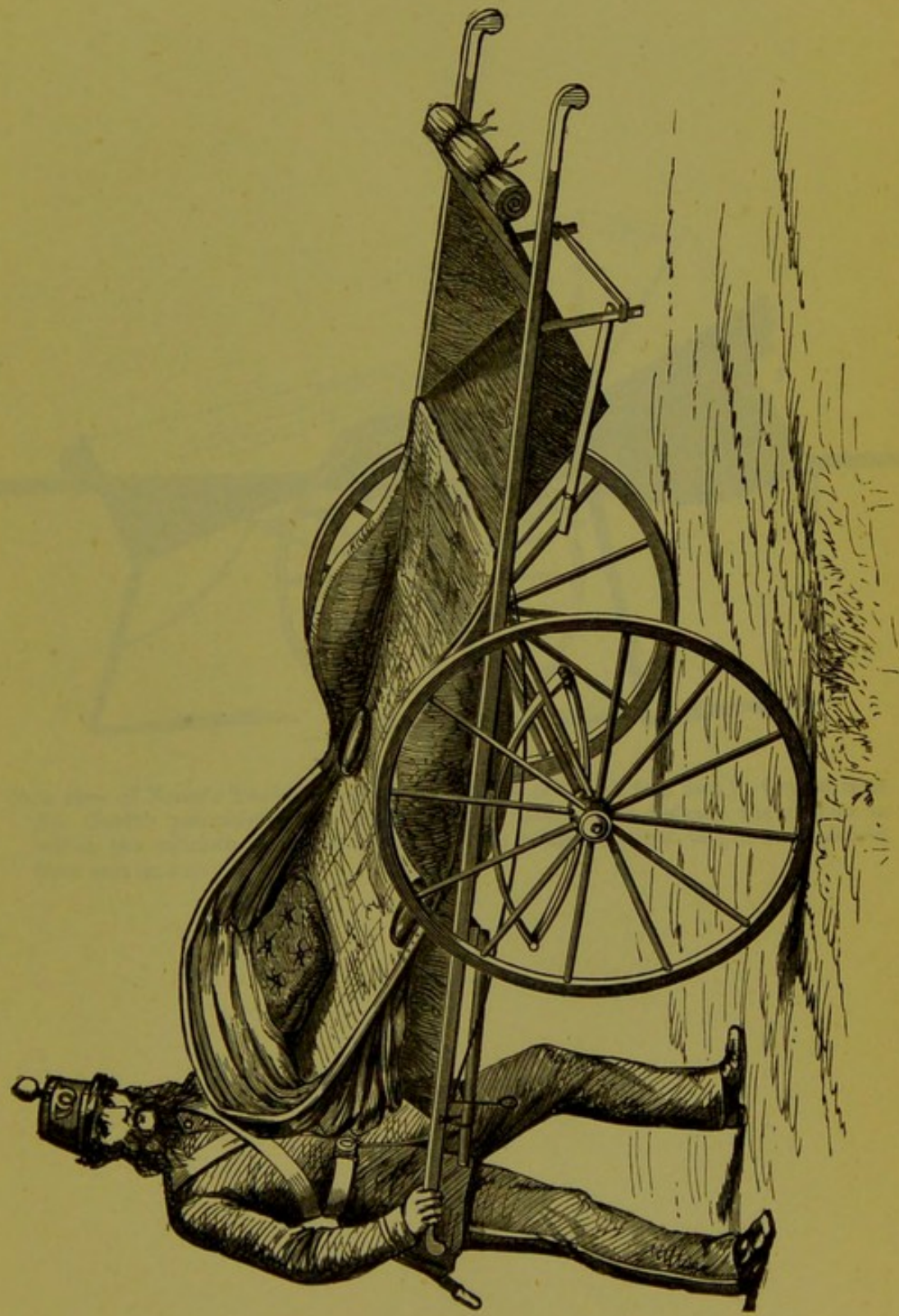
PLATE I

No. 3.



The China Hand-barrow, arranged for Ambulance Transport.

No. 6.

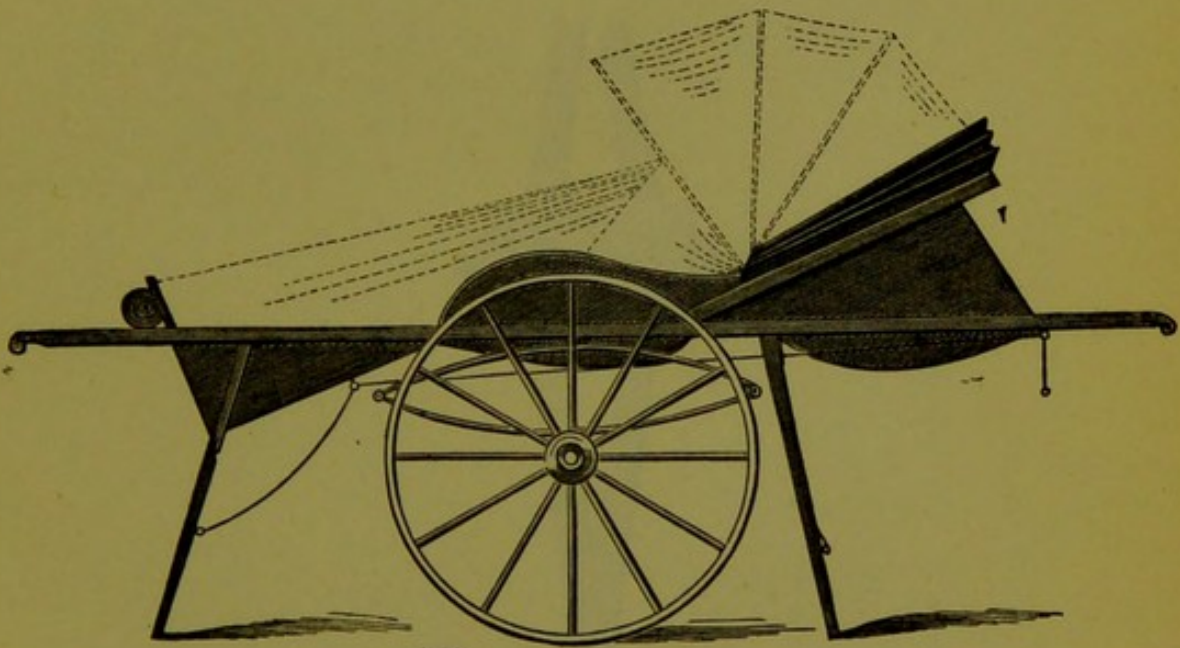


Neuss's Two-wheeled Litter, as seen in perspective. (From a drawing by Assistant-Surgeon H. C. Gillespie of the litter at the Royal Victoria Hospital.)



1000

No. 7.



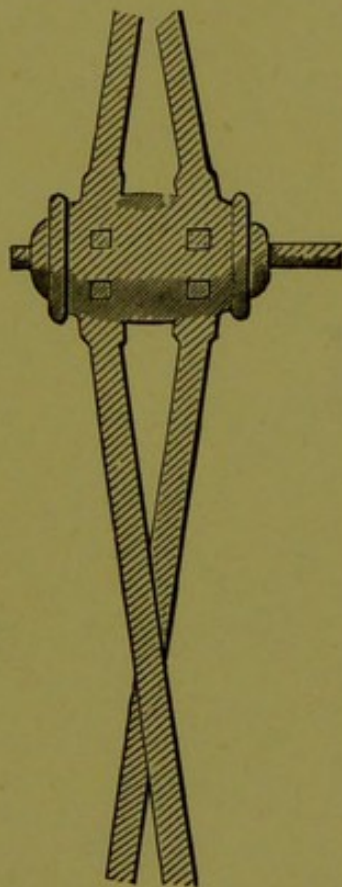
Side view of Neuss's Two-wheeled Litter. (Scale of $\frac{1}{2}$ inch to 1 foot.) Copied from Dr. Gurlt's pamphlet before quoted. The dotted lines indicate the manner in which the sailcloth hood and cover are used when required to protect a patient from rain or sun.

No. 7.



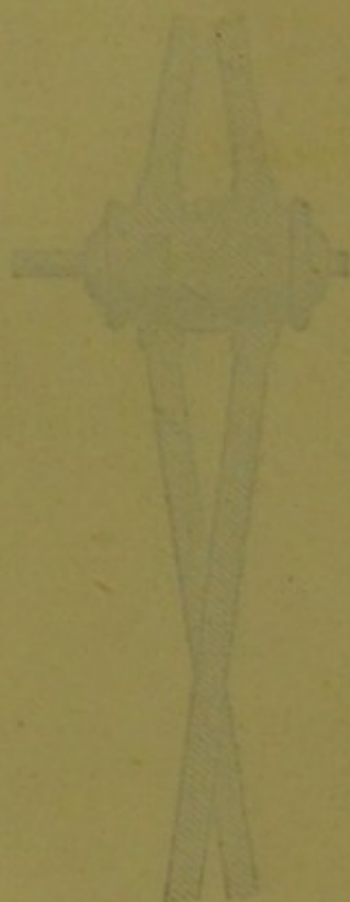
This view of James's Patent wheel shows the mode of 4 spokes in 1 foot. (Copied from
the original of the original patent model. The dotted lines indicate the manner in
which the spokes are joined and show the mode of joining to form a pattern.
from one to another.

No. 8.
Neuss's Two-wheeled Litter.



Construction of the wheels.
(See descriptive remarks.)

No. 8.
Hewitt's Two-Pronged Fork.



Construction of the wheel.
(See descriptive remarks.)



