

Ministry of Defence

Synopsis of Causation

Lower Limb Amputation

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Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

- 1.1. Amputation has been part of human civilisation for thousands of years. Remains of prosthetic replacement limbs have been found in Egyptian tombs and, in New Mexico, negative imprints of mutilated hands have been discovered.
- 1.2. Religious practices have used amputation as both ritual and punishment. Today, in some Middle Eastern countries, limbs are regularly amputated as a form of punishment.¹
- 1.3. In the United Kingdom, World War One left a legacy of over 41,000 major limb amputees. The vast majority were at a "transfemoral" level, with some "through hip". There were 11,600 upper limb amputees. By 1938 there were 3,400 surviving amputees in receipt of artificial limbs. World War Two resulted in a further 9,000 amputees. The Korean war and the Falklands conflict increased the number of war related subjects. Recent military operations have added to the amputee population.²
- 1.4. Military amputees are generally a younger group who include both victims of actual military conflict and of non-combatant trauma, for example, road traffic accidents and military exercise incidents.
- 1.5. In global terms, amputation is not an uncommon result of trauma but, in Western society, vascular disease in older age groups is the commonest problem resulting in lower limb amputation.
- 1.6. In 1997-1998 there were 5,896 new patients referred to the United Kingdom Prosthetic Service for artificial limb provision.^{3,4} The majority are elderly subjects with poor blood circulation. Trauma-related cases are uncommon, representing only 5% of all referrals.
- 1.2. Lower limb amputation is the ablation of a leg at any level from below the pelvis.
- 1.3. Level definitions are defined in the British Standard BS 7313 Part 3: 1993, ISO 8548-2: 1993. This part of BS 7317 was prepared under the direction of the Health Care Standards Policy Committee and is identical to ISO 8548-2. The system is designed to meet the needs of different members of the clinic team to enable the description of the stump to be recorded in a standard way that can be easily incorporated in reports. It is also in a form that is adaptable for computer recording.
- 1.4. Lower limb amputation level nomenclature:
 - Hemipelvectomy (high amputation of the leg)
 - Hip disarticulation (formerly known as through hip)
 - Transfemoral (formerly known as above knee)
 - Knee disarticulation (formerly known as through knee)
 - Ankle disarticulation (also known as the Syme amputation)

- Partial foot (includes Charcot and Lisfranc amputation)
- Toes

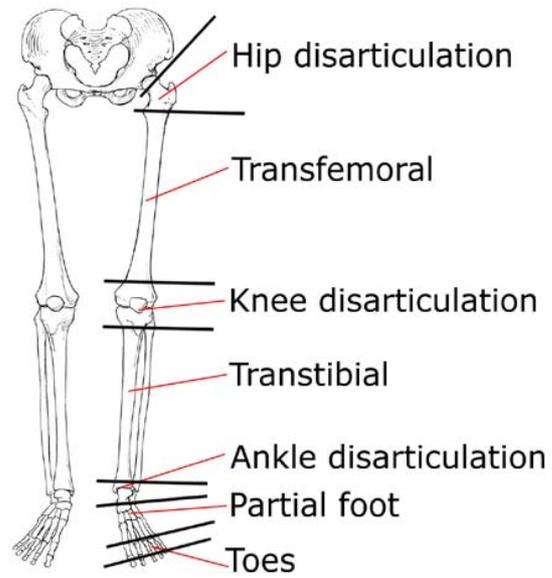


Figure 1 Lower limb amputation level nomenclature

2. Clinical Features

- 2.1. Some idea of the most frequent sites of amputation can be obtained from the 4,584 new lower limb amputations referred to the English prosthetic service in 1997-1998, which fell into the following categories (in percentages):
 - Transtibial 50.6%
 - Transfemoral 8.8%
 - Knee disarticulation 2.8%
 - Partial foot 0.7%
 - Ankle disarticulation 0.6%
 - Hip disarticulation 0.2%
 - Toes 2.3%
 - Double lower amputation i.e. amputation of both lower limbs 3.9%^{5,6}
- 2.2. These figures reflect amputations performed with later referral for prosthetic replacement; no accurate national figures for the total number of amputations are available. However, about 60% of those with transfemoral amputation are too infirm for fitting. This is usually due to the amputee being insufficiently robust for prosthetic use. Those with transtibial amputations fare better, with over 80% achieving a successful prosthetic fitting.
- 2.3. From a functional point of view, the level of amputation is extremely important.
 - The transtibial amputee requires about 30% more energy to walk, compared with a non-amputee. These patients also retain the knee joint, which enables them to walk more efficiently, with limb strength and proprioception below the knee being retained
 - The transfemoral amputee uses over 70% more energy to walk. The stump is more difficult to fit comfortably and the resulting gait is less cosmetic, requiring a mechanical knee joint, as well as a prosthetic foot
 - Amputees with even higher levels of amputation are more compromised
- 2.4. Younger amputees have a higher fitting rate and subsequently greater prosthetic use than older subjects. This is due to the fact that they are physically fitter and usually do not suffer from additional medical problems. The traumatic amputee may however have associated injuries and these may affect the final outcome, both from a prosthetic fitting viewpoint and psychological acceptance.
- 2.5. Amputation level also has a significant effect on the psychological acceptance of the surgery by the amputee. The lower the amputation level, the less detrimental the psychological effects.^{2,7}

2.6. **Summary.** It can be seen that the lower the level of amputation, the better the overall wellbeing of the subject.

3. Aetiology

3.1. **Military injuries**^{8,9} These affect the younger age groups. In a small sample of military-related amputees the average age at time of injury was 25.9 years. (This sample was collected from a UK Limb Fitting Centre in 1999, and most amputees dated from World War Two, during which conscription was in operation up to the age of 50 years.) These amputations are often accompanied by other injuries. Delays in treatment, due to difficulties in evacuation, the distance to an appropriate field hospital or access to sufficiently trained medical personnel, affect the final outcome for the amputees. These may be a result of:

3.1.1. **Direct shot** including high energy transfer bullet wound.

3.1.2. **Blast injury** This is caused by the large volume of gas produced when the explosive detonates. Injuries are divided into 4 groups:

- **Primary:** subjects close to the explosion have damage to air filled cavities, for example, the middle ear, lung, and bowel
- **Secondary:** due to impact from items energised by the explosion, for example, preformed metallic fragments
- **Tertiary:** when the subject is accelerated against a fixed object
- **Quaternary:** injury caused by collapse of any building secondary to the blast event

The relevance of these groups is that those with secondary, tertiary and quaternary damage may suffer significant injury resulting in damage to a limb leading to amputation. In some subjects there may be significant injuries with all four group injuries occurring.

3.1.3. **Shrapnel or fragmentation injury.**

3.1.4. **Burns.**

3.1.5. **Frostbite.**

3.1.6. **Any combination of the above.**

In addition traumatic amputations can be the result of road traffic accidents, or as a consequence of sport injuries and other military activities.

3.2. **United Kingdom amputee population.**

3.2.1. The average age for lower limb amputation in the United Kingdom is about 70 years. It has been reported that 22% of lower limb amputees are over the age of 80.^{5,10}

3.2.2. 60% are male and 40% are female.

3.2.3. In the UK lower limb amputations are due to:

- **Vascular disease** 90%, consisting of atherosclerosis 60%, diabetes mellitus 30%
- **Trauma** 5%
- **Neoplasm** 1%
- **Other causes** 4%. This includes subjects with renal failure, on dialysis intervention, transplant subjects, and failed orthopaedic internal prosthetic replacements. Additionally about 1% of those referred to the UK prosthetic services have a congenital limb deficiency⁴

3.2.3 The high incidence of vascular disease is a reflection of the prevalence of atherosclerosis in the UK community. This is partially due to the smoking habits and diet of society. It is to be hoped that with increased public health information and advice this problem will reduce. There is increasing evidence that the incidence of heart disease as a result of atherosclerosis is diminishing in the UK. This is likely to be due to health care information reducing the risk factors, for example smoking reduction and better diet.

3.2.4 **Diabetes mellitus** is an increasing problem in the western world. Increasing levels of obesity, due to inappropriate diet, has resulted in a great increase in the incidence of diabetes mellitus.¹¹ The long-term effects of diabetes mellitus include both arterial damage and neurovascular impairment. This may lead to ulceration of distal parts of limbs, and subsequent amputation.¹²⁻¹⁶

3.2.5 In 1990, the World Health Organisation produced the St Vincent Declaration which stated that the incidence of amputation of a limb, as a result of diabetes mellitus, should be reduced by 50% by 2000. This reduction has not been achieved in any part of the world except Scandinavia.¹²

3.3. Global consideration.

3.3.3 Trauma due to the explosion of discarded ordnance is, without doubt, one of the most frequent causes of amputation affecting specifically young civilians. Significant numbers of women and children are maimed by inadvertently handling unexploded ordnance.

3.3.4 The amputation levels resulting depend, to some extent, on the cause. Small mines produce either upper limb injuries and body damage when handled, or lower limb damage. Larger ordnance often produces significant body damage.

3.3.5 The International Committee of the Red Cross reports that 800 people die each month from uncleared ordnance. Of these, 10% are children.

3.3.6 In Afghanistan alone, prior to 2001, over 500 mine injuries occurred monthly, with 150 deaths.

3.3.7 Unsafe industrial practices contribute significantly to lower limb amputation and, unsurprisingly, upper limb amputation.

4. Treatment

4.1 Traumatic amputation.⁹

- 4.1.1 Traumatic amputation level selection is often totally dependent on:
- The need to save life rather than salvage the limb
 - The condition of the fragment of limb and its viability
- 4.1.2 Medical personnel are fully aware of the need to salvage as much as possible given that there will probably be the opportunity to undertake reconstruction at a later date. The balance between the need to save life and the need to retain as much tissue as possible is a dilemma that the surgeon has to resolve. The military situation may affect this decision.
- 4.1.3 Initial stabilisation of the casualty with a later amputation is better for the survival of subjects, and allows time to assess tissue viability in relation to stump wound healing. Naturally, this may not be possible in a theatre of war, but is an optimal situation. It is accepted practice to remove dead and contaminated tissue, fragmented bone and all foreign material. The wound is then washed and left open and a dry, bulky, sterile dressing is applied. Later amputation is then a planned surgical procedure.

4.2 Associated injuries

- 4.2.1 Any associated injuries may be an important determining factor in the overall assessment of the subject, and their subsequent management and rehabilitation.
- 4.2.2 **Infection** In the traumatic amputee, tissues are almost invariably contaminated by the local environment. The infection that can follow can easily undo the surgeon's efforts to preserve limb remnants. **Gas gangrene** is a significant problem that requires careful management in both avoidance and treatment. This is caused by an infection by *Clostridium welchii* and results in gas being formed in dead tissues, so increasing the area of damage. In addition toxins are formed which, if absorbed into the circulation, may result in death. Early excision of the dead and contaminated tissue, and appropriate antibiotic treatment, are necessary to ensure the survival of the subject.
- 4.2.3 The associated injuries that the military amputee may have can be of such a severe nature that the traumatised limb is of less immediate importance, thus the final level selected may not be optimal.
- 4.2.4 **Contralateral limb damage** (the opposite limb to the amputation side) is almost invariable, due to the destructive nature of ordinance; this may significantly affect subsequent mobility.
- 4.2.5 **Blast injury**. The degree of injury imposed by blast may lead not only to amputation but also to other injuries which may result in greater morbidity. The overall morbidity, not only the amputation, will need to be considered in the management of this type of injury. The topic is considered in more detail in the Synopsis *Blast Injury*.

- 4.2.6 **Frostbite.** This presents specific problems with both management and amputation level selection. Initial re-warming requires care, and the demarcation of tissue viability can take a considerable time to finalise. The subject may have to wait longer than a week, and, in some cases, up to three weeks before the optimal amputation level is selected.
- 4.2.7 Additionally, the use of anticoagulants may reduce the necessity for amputation. These need specialist facilities for their prescription and monitoring.
- 4.2.8 Long-term sequelae of frostbite include: altered sensation of the affected parts (includes the stump, if involved in the frostbite process), abnormal sweating, tendon contractures, osteoporosis of the affected bones and cartilage damage.¹⁷ The topic is considered in more detail in the Synopsis *Cold Injury*.

4.3 **Vascularly compromised subjects.**

- 4.3.1 It is accepted that the transtibial amputation is the level of choice for the vascularly compromised subject.
- 4.3.2 In the case of ankle disarticulation which is, of course, lower than transtibial, the wound is often difficult to heal and the prosthesis is bulky and somewhat uncosmetic. This is less of a problem for a male amputee who wears trousers and thus can hide the prosthesis but may, however, be important for psychological reasons. Those who have diabetes mellitus do have better healing rates at this level when compared with those who have significant atherosclerosis.
- 4.3.3 The “Gold Standard,” described by the International Society for Prosthetics and Orthotics, is a transtibial to transfemoral ratio of at least 3:1 for vascularly compromised patients.¹⁸
- 4.3.4 The transtibial amputation provides:
- preservation of the anatomical knee joint
 - a more comfortable prosthesis
 - a functional device
 - a cosmetically acceptable limb replacement
- This is the level to which all surgeons should aspire when undertaking amputation surgery.
- 4.3.5 Many elderly patients have additional significant pathologies. These include heart disease, neurological problems (including cerebral vascular accidents i.e. strokes), diabetes mellitus and arthritis. All of these problems can have a profound effect on the patient's ability to use an artificial limb successfully.
- 4.3.6 In the case of the vascularly compromised amputee, the affected foot and limb may have developed gangrene and the use of prophylactic antibiotics is frequently advocated to avoid further development of infection. This infection could result in delayed healing or even recourse to further surgery. The healing

is further compromised by the existing poor vascular condition of the affected limb.

- 4.3.7 The contralateral limb may also have a compromised circulation and its management may need careful consideration. The presence of another infected limb may interfere with the overall management of the subject.
- 4.3.8 The surgeon usually has some time to select the appropriate level of amputation. This is because the vascularly compromised patient is less likely to present as an acute problem. However, the surgeon must operate to preserve as much of the limb as possible, creating the optimum stump for prosthetic fitting, yet allowing primary healing. Significant delays may reduce the likelihood of an optimal level of amputation.
- 4.3.9 In the United Kingdom, level selection is undertaken using a variety of clinical tools to optimise the surgical outcome. These may also be available to the military surgeon removed from the incident area, and if the patient has undergone primary survival procedures and is stable, the surgeon may have time and the clinical tools to select the most functional level of amputation.
- 4.3.10 The use of vascular assessment methods include:
- Arterial ultrasound including ankle brachial index
 - Magnetic resonance imaging
 - Light guide spectrophotometry and cutaneous oximeter assessment
 - Thermography
 - Evaluation of venous status
 - Careful visual scrutiny by the experienced surgeon

These are all used to help the surgeon select the level that is as distal as possible, yet allow primary healing.

- 4.3.11 The vascularly compromised patient may have had previous vascular surgery in an attempt to salvage the limb and avoid amputation. These vascular procedures may, on some occasions, compromise the surgeon's ability to salvage a limb at a lower level.¹⁹
- 4.3.12 At the time of surgery, there may also be problems with the nutritional status of the subject, which can interfere with the healing of the stump. This is particularly true in elderly patients who may have been ill for some considerable time prior to amputation surgery.
- 4.3.13 Despite optimum management, a significant number of stumps are slow to heal. Up to 20% have delayed healing and may require local surgery or revision to a higher level.¹³
- 4.3.14 Infection, ischaemia and deep vein thrombosis are important problems. Prophylactic antibiotics and anticoagulants are often used to reduce these continued problems.

- 4.3.15 In recent years, the introduction of **osseous integration** has been developed. This uses the introduction of a pin into the distal end of the remaining bone, exteriorised through the skin. The prosthesis fixes directly on to the pin, without the need for a socket. Theoretically, there is less trauma to the stump, and direct feedback to the amputee from the stump when walking. Initial experience is varied but trials continue.

4.4 Complications

- 4.4.1 **Deep vein thrombosis.** In all surgical situations deep vein thrombosis can occur. This is the clotting of blood in the deep veins of the leg and sometimes those of the abdomen. This occurs when the subject is immobilised for a prolonged period, for example post-operatively, when pain and sedation reduce the subject's ability to move about. Without appropriate management, the condition may have fatal consequences. The clot may become dislodged and as veins lead to the heart and subsequently to the lungs, the clot may lodge in the pulmonary (lung) vessels. This may block the blood supply to the lung and thus result in death. Anticoagulants and other medications are used to reduce the development of this problem.
- 4.4.2 **Pain** The surgeon has to cut through different types of tissue including skin, muscle, blood vessels, nerves and connective tissues. The management of the cut tissue may have an effect on subsequent healing.
- 4.4.3 Immediate post-operative pain management is no different from that following any surgery and is usually in the form of opiate medication. Once the initial trauma of the surgery is over, less powerful analgesics may be used. Most patients are free of the requirement for pain relief within 4-6 weeks of surgery. There is one issue that is unique to amputation surgery, and that is the phantom limb phenomenon described below.
- 4.4.4 Pain can occur at any time, can vary in its severity and duration and may make prosthetic fitting difficult as the socket has to fit the stump accurately. The pain may become chronic and this is much more difficult to manage. Pain clinics in the NHS have a range of strategies to help these patients, and for many, considerable success is possible. For some (and there are no figures to say how many, but in the author's opinion it may be up to 5% of amputees) the problem is significantly difficult and directly affects the well-being of the person.
- 4.4.5 However, the pain may be mild and cause no problem at all to the amputee. It can disappear totally or return in a different form some considerable time after the initial injury. The author had one amputee who developed intractable pain in his stump more than 20 years after the initial road traffic accident that resulted in him losing his leg just below the hip joint. There is no method of predicting the future pain problem of an individual; however, it is not usually a severe difficulty, and successful management is usually possible.
- 4.4.6 **Neuroma.** One other specific area that causes considerable difficulty is the transected nerves. The proximal (upper part) end of the cut nerve attempts to regenerate to link up with the distal (lower) part. To do this, it produces a swollen bulb of nerve tissue which has the potential to link up with the distal end, so restoring the neural connection. In the amputee, the bulbous end still develops and forms a nerve end swelling that can be very sensitive to external stimuli.

- 4.4.7 Various surgical techniques have been tried to reduce the development of these neuromas, which can result in both nerve pain and phantom sensations that are described below.
- 4.4.8 Neuromas can occur wherever a nerve has been cut. In the author's experience the transtibial amputee has occasional problems between the cut ends of the tibia and the fibula. This can sometimes be helped by an injection of a steroid into the area of the probable neuroma, even sterile water in this area has been found to help, possibly by reducing the scar tissue and adherence of the neuroma to surrounding tissues. In the transfemoral stump there is often more tissue to bury the neuroma, and this cushioning can reduce the problem. A similar injection can occasionally help. Prosthetic management may similarly reduce the problem but on occasions surgical intervention, with removal of the neuroma, may produce a satisfactory result. In some cases nothing seems to produce relief. Only in a few subjects however is the problem completely unsolvable, or at least reduced to a tolerable level.
- 4.4.9 Management of the discomfort and pain resulting from neuroma can be very problematical. The range of pharmaceutical products used is large, with great individual variations of success.

4.5 **Phantom phenomena**

- 4.5.1 Ninety percent of amputees experience **phantom sensations**. This is the feeling that the removed limb is still present. The feelings are quite varied in their manifestation, for example, tingling, burning and numbness. There is often a truncation of the foot into both the removed and remaining limb.
- 4.5.2 The phenomenon can be continuous or intermittent, with various triggers causing the sensation to manifest itself. These include micturition, and touching the skin at "trigger" points. Additionally, stump neuroma may result in these phenomena, producing both sensation and painful feelings.
- 4.5.3 **Phantom pain** occurs in about 30%-50% of amputees. The pain can manifest as an occasional stab of mild pain or any degree up to severe, intractable, excruciating, continuous pain.
- 4.5.4 There is some evidence that traumatic amputees experience more phantom feelings than vascularly compromised subjects.²⁰ However, both civilians and military personnel are reported to experience the same incidence of phantom phenomena and pain.¹⁴
- 4.5.5 **Phantom sensations** may appear at any time, sometimes immediately after surgery or even several years later. There is no method of predicting when, or if, they will appear, what degree of discomfort will result or indeed if the sensation will be uncomfortable at all. There is little need to treat the sensation itself and normally, explaining the condition and likely outcome to the patient is sufficient.
- 4.5.6 Treatment for **phantom pain** is extremely difficult. No specific method of management has been yet found, despite a wide range of strategies being tried. Antiepileptic medications have proved of value for some subjects. Hypnosis may help some. Cannabis has been also reported as helpful. Surgical removal of neuroma can help.

- 4.5.7 There is no method of predicting either the severity or the duration of the problem. Psychological management can significantly reduce the way that a subject manages the discomfort; this with medication usually reduces the symptoms to an acceptable level.
- 4.5.8 The level of amputation has little effect on the incidence of these phenomena.
- 4.5.9 It is worth noting that most amputees self-manage these sensations once the aetiology is explained to them. Reassurance that viability of the stump is not compromised is important.

4.6 Psychological problems

- 4.6.1 The loss of a limb is a serious injury and the subsequent psychological trauma can be severe. The effect of the initial loss can cause marked depression, which may be long lasting.
- 4.6.2 The effect is somewhat dependent on the level of amputation, those with the higher levels of loss having the greater psychological problems. Those with multiple amputations (several limbs) naturally have a much wider range and depth of problems, both psychological and physical.
- 4.6.3 Traumatic amputees have been found to have more difficulties than vascularly compromised subjects. The vascularly compromised subject has often been ill for some time prior to the amputation surgery and may have had considerable pain in the affected limb for months, resulting in the surgery being considered a relief. There is also time to counsel the person prior to the event. The traumatic case often has had little such time to pre-adjust to the surgery and the subsequent change of lifestyle. Counselling may be of help.^{2,7}
- 4.6.4 The person's self-image may also change, leading to personal difficulties. Additionally, the traumatic subject will have to consider potentially significant changes in lifestyle. Being quite often younger, they are concerned with the future of their family, personal relations and earning capacity.
- 4.6.5 Vascularly compromised amputees, although usually older, may also have to change their lifestyle, becoming less mobile, possibly moving home and accepting more community support.
- 4.6.6 Counsellors and psychologists are often involved in both the initial pre/post-operative period and the long-term care of both groups of subjects. The attendance at limb-fitting centres may provide an important lifeline as they offer access to trained experienced personnel.
- 4.6.7 The membership of amputee support groups can also be helpful. These are both locally based and nationally organised. In these groups people with similar experiences can meet and exchange views.²²
- 4.6.8 Encouraging active involvement in sporting activities is important from physical, psychological and social viewpoints. This encourages the individual to further reintegrate into society.

4.7 Prosthetic fitting⁶

- 4.7.1 In the UK artificial limbs are provided without charge to all those eligible for free NHS treatment. The provision is undertaken at designated Limb Fitting Centres all over the country. They are NHS-run with NHS medical consultant personnel, physiotherapists, occupational therapists, nurses and other healthcare professionals available, usually on site. There are a few private prosthetic companies.
- 4.7.2 For prosthetic fitting to be successful, the rehabilitation has to be fully coordinated, with a team of dedicated healthcare professionals. The team often includes: the medical rehabilitation specialist and the surgeon, nursing staff, physiotherapist, occupational therapist, the prosthetist, social worker, chiropodist for the care of the sound foot, the amputee counsellor/psychologist and other amputees.⁶
- 4.7.3 Initial prosthetic assessment is often undertaken jointly both by the physiotherapist, the prosthetist, and the rehabilitation consultant. The use of an early walking aid is frequently used to help the team decide the suitability of the subject for fitting. It is also used in the commencement of early walking training.
- 4.7.4 The prosthesis can be fitted as soon as the stump is healed, and in some circumstances earlier. This can be as early as three weeks post surgery. However, it can be some considerable time later. This is especially true when there is delayed stump healing or other associated injuries, as well as psychological trauma.
- 4.7.5 In some centres this rehabilitation is undertaken in a specific amputee centre, in other areas this is undertaken as an outpatient, once the stump is healing.
- 4.7.6 The **fitting success** does depend on the level of amputation and the age of the subject:
- **Transtibial** Between 90% and 60% fitting rates depending on the centre providing the rehabilitation service
 - **Transfemoral** Between 70% and 40%^{7,6}
- 4.7.7 **Walking aids** in the form of stick(s) or crutches are often used, for a limited period in some cases, in others indefinitely.
- 4.7.8 Multiple amputations do limit the ability to use an artificial limb. The fittings are individually no different, but to use more than one limb is difficult. The energy required is greater and the gait achieved, if both limbs are fitted, is not very efficient or cosmetic.
- 4.7.9 Relatively few bilateral transfemoral amputees use their prostheses as their sole means of mobility. Most do use a wheelchair for some of the day.²³ However, there are exceptions and a few are very mobile. Those with bilateral transtibial amputations frequently do manage to walk remarkably well. However, these amputees do not walk as much as those with single amputations. Lower limb amputees are not as mobile as their age related peers.^{21,24}
- 4.7.10 Following successful fitting the amputee will require **lifelong prosthetic care** because:

- Stumps change shape over the years thus the sockets need adjusting or replacement
 - The needs of amputees change
 - Prosthetic replacements change and the devices require care and maintenance
 - New, appropriate devices are being constantly developed and these may be available to the prosthetist to supply
- 4.7.11 Between 84% and 95% of fitted amputees use their prosthesis for part of the day but it is known that on average elderly amputees do not walk as much as their peers. Wheelchairs are often provided to augment the overall mobility of the subject.
- 4.7.12 Traditionally, prostheses used leather, wood and metal in their construction. However, contemporary devices use silicone, titanium, carbon fibre, aluminium, polypropylene, electrical controlling devices and plastic components.
- 4.7.13 Recent introduction of high definition silicone cosmetic covers has improved the appearance of the final limb. They are, however, expensive and have a short life span, for example, the guarantee on some is only 3 months. The provision of these special covers is limited and a special case has usually to be made for their prescription under the NHS.
- 4.7.14 All these devices enable most young amputees to return successfully to society, and the older amputee to enjoy the remaining years of their lives.
- 4.7.15 Limb fitting centres can provide limbs for specific sporting activities, for example, for running, sailing and skiing. These are usually supplied by special request of the amputee. Membership of sporting associations is encouraged and this ensures that the appropriate prescription is provided.
- 4.7.16 It should be remembered that those in less well-developed countries have a greater problem in being mobilised. There are often limited prosthetic services, less community support and potentially significant social stigma. This frequently results in a far from satisfactory outcome and greater morbidity.

5. Prognosis

- 5.1. Traumatic amputees appear to have a normal life expectancy, unaffected by the level of amputation or the age at amputation. Associated injuries may produce significant morbidity.
- 5.2. In a Finnish study in 1965 on 311 Finnish war veterans, there was little evidence of increasing vascular disease, but in 1990 a study reviewing 91 veterans, 75% were reported to have vascular disease. Although none was reported to have required amputation of another limb, it is possible that this may occasionally happen.
- 5.3. There are no figures of survival for bilateral traumatic amputees; theoretically they should have a similar life expectancy to their peers. The only caveat is the development of obesity and subsequent related problems.
- 5.4. The age of the primary vascularly compromised amputee at time of surgery is about 70 years.
- 5.5. The long-term survival of vascularly compromised amputees has been reported from Dundee as about 5 years. Those who had the amputation as a result of diabetic vascular disease have a shorter life expectancy.¹²
- 5.6. All amputees have the potential to develop secondary pathologies as a result of prosthetic use. This may be, for example, spinal and hip arthritis as a result of the unnatural gait. This problem may reduce the effectiveness of the prosthesis.
- 5.7. Those with more than one amputation do develop more problems as a result of the unnatural gait. The human frame is designed to walk with the intact limbs. The prosthesis is designed to replace the natural limb but there are limitations which result in unnatural biomechanics. The long-term effect of these altered biomechanics is unnatural strain on the hips, spine and cervical bones. In a study of British military veterans with amputations, osteoarthritis of the hip was reported in 61% on the amputation side and 23% on the non-amputation side. This compares with only 11% of a similar UK population. This indicates that veteran amputees do develop an increased incidence of osteoarthritis.²⁵ However, in discussion with orthopaedic surgeons (personal communications) this has not led to the requirement for prosthetic joint replacement. This suggests that the arthritis is not severe. This may be due to the fact that although the amputee is mobile with a prosthesis their activity levels are less than their peers. Thus the mechanical damage is less than one would expect. Interestingly in individuals who were born without an upper limb or with a deformed upper limb it is observed that arthritis in the "sound" upper limb does increasingly occur at about 40 years of age, about 20 years earlier than their peers. This is assumed to be due to the extra use the sound limb has to undertake, even if an upper limb prosthesis is fitted and used. (Personal communication).
- 5.8. In a study of traumatic lower limb amputees reported in 2005, back pain was reported in 81% of transfemoral amputees, and 62% in transtibial amputees.²⁶ Furthermore, in those who reported "severe back pain" 89% had phantom pain and 81% had stump pain. It can thus be seen that back pain is common and in some there are significant associated problems in the form of phantom and stump pain. However, the back pain was not due to degenerative arthritis but to mechanical pain in the spinal joints. This may be partly due to the reduced physical lifestyle adopted by the amputee.¹⁷ This is reported to be managed by general practitioners,

physiotherapists and rehabilitation and rheumatology specialists rather than with orthopaedic surgical intervention. The phantom pain is, as stated above, difficult to treat. It can occur immediately after the amputation, or it can occur at any time after the surgery. It may even occur for the first time years later, at any level of discomfort.

- 5.9. Stump pain and the development of neuroma may similarly appear at any time after the amputation and can be mild or severe. This is discussed above. However, careful prosthetic fitting and analgesic prescription lessens the problem for the amputee. The problems may arise decades after the initial trauma.
- 5.10. The longer the amputee survives, the more likely it is that secondary disabilities will develop. These secondary problems, for example arthritis may be very debilitating. However, with advances in prosthetic engineering it is hoped that the development of these secondary problems will lessen.
- 5.11. The traumatic amputee may also have additional problems as a result of the initial trauma. The effects of these may compound the difficulties and subsequent lifestyle changes, including family life and work prospects.
- 5.12. There is a potential risk of the development of a sedentary lifestyle with the subsequent increased risk of obesity, atherosclerosis and diabetes. In the author's experience, this seems to be more theoretical than actual. Amputees certainly do utilise more energy when walking than their healthier peers, and this may help reduce the potential risk of developing the problems above. Those with less mobility, for example multiple amputees, are even more likely to become obese. This in turn may lead to the development of atherosclerosis and diabetes mellitus. However, with the increasing health advice and life style changes these problems may become less of a problem in the future. Encouragement to be involved in sport and other pursuits should encourage the amputee to keep active. Those with high levels of amputation or multiple amputations will be even more likely to develop a wide range of mechanical and psychological problems.
- 5.13. Unfortunately, the availability of clinical psychologists is limited in the UK but their involvement in the long-term management of those with significant psychological problems is extremely valuable.
- 5.14. The involvement of physiotherapists, gait analysts and prosthetists may reduce the development of secondary problems, as may integration into society, involvement in sport and suitable employment.

6. Summary

- 6.1 Military related amputees are a young population.
- 6.2 Their life expectancy is similar to that of their peers, although it will depend on the severity of the overall injuries.
- 6.3 Long-term artificial limb use is associated with an increase in back pain although not specifically osteoarthritis, but the timescale for this development is unpredictable.
- 6.4 Lower limb amputation is associated with the premature development of arthritis in the hip on the amputated side (61%) and on the non-amputated side (23%) (expected incidence 11%).²⁵ This does not lead to an increase in the need for prosthetic hip replacement as compared to the non-amputee population.
- 6.5 The long-term success of the rehabilitation process depends not only on the level of amputation, but also other associated injuries affecting the overall morbidity. These other injuries may have more significance in the final outcome than the amputation alone.
- 6.6 Stump pain is common and can occur at any time after the amputation, even 20 or more years later.
- 6.7 In some, this is due to the development of neuroma which may require surgical excision. In some cases this does not relieve the problem.
- 6.8 Stump pain can also occur from prosthetic use.
- 6.9 The prosthetic socket imposes considerable pressure on the stump, which in turn was not designed biologically to function as a weight bearing structure.
- 6.10 Prosthetic advances have improved the comfort and function of artificial limbs; however, they are not perfect replicas of the natural limb.
- 6.11 Phantom phenomena are almost universal.
- 6.12 These phenomena can be in the form of simple sensation, or severe intractable pain.
- 6.13 Phantom sensation occurs in over 90% of all amputees.
- 6.14 Phantom pain occurs in about 30%-50% of amputees. There is some evidence that traumatic amputees have more pain than other amputees.
- 6.15 The level of amputation has no effect on the phantom incidence.
- 6.16 Management of phantom pain is difficult; there is a huge range of methods that have been tried. In some, no treatment works totally successfully.
- 6.17 The effects of war will continue to cause significant injury to non-combatants, as well as combatants, as long as uncleared ordinance is left in the wake of military conflicts.
- 6.18 Health and safety improvements should reduce industrial related injury.
- 6.19 Increased vehicle safety design will reduce road related injuries.

- 6.20 Vascular surgery is continually improving and advances should reduce the need for amputation for both traumatic and vascularly compromised subjects.
- 6.21 Diet changes should reduce the current unremitting increase of the incidence of diabetes mellitus, and subsequent lower limb amputation.
- 6.22 Prosthetic developments will hopefully reduce the secondary pathological problems that inevitably occur with long-term artificial limb use.
- 6.23 Similarly, there should be reductions in the incidence of atherosclerosis, with the reduction in smoking and improved diet. Public health messages should reduce the need for lower limb amputation.

7. Related Synopses

Upper Limb Amputation

Osteoarthritis of the Hip

Osteoarthritis of the Knee

8. Glossary

ankle brachial index	This is a test which measures blood pressure at the ankle and in the arm while a person is at rest. Measurements are repeated after 5 minutes of walking on a treadmill. By dividing the highest blood pressure at the ankle by the highest recorded pressure in either arm, the ankle brachial index (ABI) can be calculated.
atherosclerosis	Characterised by the deposition of atheromatous plaques containing cholesterol and lipids on the innermost layer of the walls of large and medium-sized arteries.
contralateral	Taking place or originating in a corresponding part on an opposite side.
deep vein thrombosis	Deep venous thrombosis is a condition where there is a blood clot in a deep vein (a vein that accompanies an artery).
ischaemia	Localised tissue anaemia due to obstruction of the inflow of arterial blood.
magnetic resonance imaging	A process of imaging using radio frequency pulses displayed as a visual image on a computer screen.
micturition	Urination.
neoplasm	An abnormal new growth of tissue in animals or plants; a tumour.
osteoporosis	A disease in which the bones become extremely porous, are subject to fracture, and heal slowly.
proprioception	The unconscious perception of movement and spatial orientation arising from stimuli within the body itself.
tendon contractures	An abnormal, often permanent shortening, as of muscle or scar tissue, resulting in distortion or deformity, especially of a joint of the body.

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Further reading

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Graham LE, Parke RC. The Northern Ireland troubles and limb loss, a retrospective study. Prosthet Orthot Int 2004;28:225-9.

Considerable information is also available from the following:-

British Society of Rehabilitation Medicine
c/o Royal College of Physicians
11 St Andrews Place
London. NW1 4LE
www.bsrm.co.uk

International Society for Prosthetics and Orthotics
Borgervaenget 5
2100 Copenhagen Ø
Denmark.
www.ispo.ws

British Limbless Ex-servicemen's Association
Frankland Moore House
185/187 High Road
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Roehampton Lane
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