Cost-effectiveness of negative pressure wound therapy in adults with severe open fractures of the lower limb: Evidence from the WOLLF randomised controlled trial

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Abstract

Aim

The aim of this study was to estimate the cost-effectiveness of negative-pressure wound therapy (NPWT) in comparison to standard wound management after initial surgical wound debridement in adults with severe open fractures of the lower limb.

Patients and Methods

An economic evaluation was conducted from the perspective of the United Kingdom National Health Service and Personal Social Services, based on evidence from the 460 participants in the Wound management of Open Lower Limb Fractures (WOLLF) trial. Economic outcomes were collected prospectively over the 12-month follow-up period using trial case report forms and participant-completed questionnaires. Bivariate regression of costs (£, 2014-15 prices) and quality-adjusted life years (QALYs), with multiple imputation of missing data, was conducted to estimate the incremental cost per QALY gained associated with NPWT dressings. Sensitivity analyses and sub-group analyses were undertaken to assess the impacts of uncertainty and heterogeneity, respectively, surrounding aspects of the economic evaluation.

Results

The base case analysis produced an incremental cost-effectiveness ratio of £267,910 per QALY gained, reflecting on average higher costs (£678; 95% confidence interval (CI): -£1082, £2438) and only marginally higher QALYS (0.002; 95% CI: -0.054, 0.059) in the NPWT group. The probability that NPWT is cost-effective in this patient population did not exceed 27% regardless of the value of the cost-effectiveness threshold. This result remained robust to several sensitivity and sub-group analyses.

Conclusion

This trial-based economic evaluation suggests that NPWT is unlikely to be a cost-effective strategy for improving outcomes in adult patients with severe open fractures of the lower limb.

Introduction

High-energy fractures of the lower limb are common in civilian and military populations,[1,2] with long-term consequences for the individuals affected and for the health services if inadequately managed.[3,4] In cases of ‘open’ fracture, exposure to contamination from the environment increases the risk of complications.[5] Infection rates may be as high as 27%, even in specialist trauma centres.[6]

Studies of the economic costs associated with the management of open lower limb factures are lacking. Limited evidence suggests that wound complications in patients with an open fracture of the lower limb, such as deep surgical site infection (SSI), lead to increased economic costs and significantly impaired health-related quality of life over the first 12 months following injury.[7]. One economic study conducted in eight US trauma centres estimated a mean two-year health care cost of $91,106 for patients treated with amputation (2002 prices).[8]

Current guidelines recommend that open lower limb factures are initially managed with antibiotics and surgical excision (debridement) to remove damaged tissue and contamination.[9] For those fractures that cannot be closed primarily after this first wound excision, the traditional approach in the UK National Health Service (NHS) and military practice has been to protect the wound from further contamination with the application of a temporary, sealed, non-adhesive layer, followed by further wound excision and definitive closure or soft-tissue reconstruction within 72 hours. Negative-pressure wound therapy (NPWT) has been recommended as the optimal form of wound dressing that can be applied to open fractures between the first wound excision and definitive closure.[9] NPWT creates a partial vacuum over the wound using suction to remove blood, exudate any residual bacteria from the area, and may also encourage the formation of granulation (healing) tissue.[10]

The decision surrounding whether to adopt NPWT as a treatment for open lower limb fractures should be informed by evidence on its clinical and cost-effectiveness. Published evidence on the cost-effectiveness of NPWT has been limited to other clinical indications, including high-risk caesarean section wounds,[11] infected vascular groin graft wounds,[12] and primary hip and knee replacements.[13] In this paper, we present the first economic evaluation of NPWT among adults with severe open fractures of the lower limb, based on evidence from the UK Wound management of Open Lower Limb Fractures (WOLLF) trial.

Methods

Trial background

The WOLLF trial (ISRCTN33756652) was a pragmatic, randomised controlled trial conducted in 24 specialist trauma hospitals in the UK Major Trauma Network during July 2012 through April 2017. Eligible patients, aged ≥16 years and presenting with a severe, open fracture of the lower limb, were randomly assigned on a 1:1 basis to NPWT or a standard wound dressing after the first surgical debridement of the open fracture wound. The trial required a sample size of 460 to detect a difference of eight points in the primary clinical outcome, the Disability Rating Index score (DRI; score 0 [no disability] to 100 [completely disabled]) at 12 months.[14] The sample size was calculated using a two sample *t*-test and assumed a standard deviation of 25, 90% power and a 5% significance level, and allowed for a margin of 10% loss during follow-up.[15] The study had the approval of the Coventry Research Ethics Committee

(REC reference 10/57/20) and the Research and Development department of each participating centre. Further details of the WOLLF trial, its sampling procedures, methodology, clinical outcome measures and response rates are reported elsewhere.[15]

Type of economic evaluation, study perspective and time horizon

The economic evaluation took the form of a cost-utility analysis, expressed in terms of incremental cost attributable to the NPWT dressing per quality-adjusted life year (QALY) gained. The QALY, a preference-based outcome measure that captures changes in both length and health-related quality of life, is recommended by agencies such as the National Institute for Health and Care Excellence (NICE) in England, for cost-effectiveness based decision making.[16] The primary analysis adopted a National Health Service (NHS) and Personal Social Services (PSS) perspective in accordance with NICE methodological guidance.[16] Cost-effectiveness was determined over a 12 month time horizon, which mirrored the follow-up period of the WOLLF trial. Consequently, no discounting of cost or QALY values was required.

Costings of NPWT and standard dressings

Staff and consumable resource inputs for both types of wound dressings, and number of dressing changes, were estimated using prospectively recorded data for a sample of 38 WOLLF participants (n=20 randomised to NPWT; n=18 randomised to standard wound dressing). The NPWT dressing comprised of the dressing pack (an average cost for the available sizes was used), the canister and the pump (a daily rental cost was applied to the period of initial hospitalisation relevant to the open fracture wound). The type of standard wound dressing was left to the discretion of each surgical team. NHS costs for staff and consumable resource inputs associated with wound dressings were obtained from the finance department within the sponsor site, University Hospitals Coventry and Warwickshire NHS Trust.

Costing of initial hospitalisation and readmissions

For many participants within the WOLLF trial, their inpatient resource use was complex and featured multiple procedures and postoperative complications as well as multiple readmissions. In order to estimate the cost of each initial hospital admission, we extracted information from the battery of trial case report forms on all procedures carried out, including those associated with postoperative complications and further surgical interventions. Using the HRG4+ 2015/16 reference cost guidance, participant-level profiles of procedures were assigned to healthcare resource groups (HRGs) for each initial admission, which were then related to costs using the NHS reference cost 2014/15 schedule.[17] Where insufficient information was available to reliably assess the procedure(s) carried out during the initial inpatient admission, further operation notes and/or discharge letters were requested from trial sites for clarification.

In order to assign costs to readmissions, it was first necessary to determine which readmissions were related to the open fracture, which was based on clinical judgement using complication data reported by independent research staff at six weeks post-randomisation, data provided by participants within questionnaires completed at three, six, nine and 12 months post-randomisation, and data extracted from trial serious adverse event forms completed by the local trial staff. Operation notes were then requested from sites for all relevant readmissions, allowing the procedures carried out during each readmission to be determined. HRG codes could then be determined for each readmission and related to NHS reference costs. For cases where there was evidence of a related readmission, but the specific procedure carried out was unknown, a weighted average of the base costs, average length of stay and excess bed day cost for the five most common procedures carried out during readmissions was assumed.

Measurement of broader resource use

As well as hospital inpatient resource use related to the initial admission and readmissions, data were also collected on broader NHS and PSS resource use as well as societal resource use for the period between randomisation and 12 months post-randomisation. Trial participants self-completed resource use questionnaires at three, six, nine and 12 months post-randomisation, reporting their use of hospital outpatient and day care services, community health care, medications, personal social services and aids and adaptations that could be attributed to the open fracture. The three month questionnaire covered the period from initial hospital discharge to three months post-randomisation, with subsequent questionnaires retrospectively covering each three month period. Further questions captured wider societal attributable resource use, with data collected on time off work, over the counter medications, aids and adaptations purchased privately as well as any additional costs borne by participants themselves, their partners or their friends and relatives.

Valuation of broader resource use

Resource inputs were valued using a combination of primary research, based on established accounting methods, and data from secondary national tariff sets. Costs were applied to inpatient hospital care resource use as described above. For outpatient hospital care, costs per contact from the 2014/15 NHS Reference Costs schedules were multiplied by numbers and types of contacts in each hospital department.[17] For community health and social services, unit costs were primarily extracted from the PSSRU Unit Costs of Health and Social Care compendium.[18] Where trial participants provided data on the mean duration of each community health or social care contact, the unit cost per minute was applied to these inputs. Where unavailable, the mean cost per contact was used. Medication costs were derived from NHS Prescription Cost Analysis database.[19] Where data on dose, the number of uses daily and the number of days of use was available, this granulated information was used to inform medication costs. Where this was unavailable, a combination of clinical input and the mean values of other trial participants using the same medication was used. Aids and adaptations were valued using a combination of data from NHS Supply Chain Catalogue as well as other sources.[20] For aids and adaptations that could reasonably be assumed to be returned to the NHS following use, items were assumed to last for five years with no resale value and a discount rate of 3.5% was used to calculate an annuitised cost, which was then applied to the period of use during the trial.[21] Time off work was valued using income data from the Office for National Statistics 2014 New Earnings Survey, categorised by age and gender.[22] Unit costs were inflated/deflated to 2014-15 prices where necessary using the NHS Hospital and Community Health Services Pay and Prices Index for health service resource inputs, and the Consumer Prices Index for broader resource inputs.[18]

Calculation of utilities and QALYs

The health-related quality of life of WOLLF participants was measured using the EuroQol EQ-5D-3L collected at baseline (including an assessment of immediate post-injury health-related quality of life, as well as separate retrospectively recalled pre-injury values) and at three, six, nine and 12 months post-randomisation.[23] The EQ-5D-3L consists of both a descriptive system and a visual analogue scale ranging from 100 (best imaginable health state) to 0 (worst imaginable health state). The descriptive system defines health-related quality of life across five dimensions: mobility, self-care, usual activities, pain and anxiety or depression. Responses in each dimension take the form of "no problems", "some or moderate problems" or "severe or extreme problems". Responses to each of these five dimensions can then be valued on a health utility scale from -0.59 to 1, with negative values relating to health states considered worse than death, zero equivalent to being dead, and 1 being a state of full health. For the purposes of this study, the York A1 tariff set was applied to each set of responses to generate an EQ-5D utility score for each participant.[24] QALYs were calculated as the area under the baseline-adjusted[25] utility curve of EQ-5D-3L utility scores across the (immediate post-injury) baseline, three, six, nine and 12 month time points, using the trapezoidal rule.[21]

Within the WOLLF trial, the SF-12 v2 was also collected at baseline, as well as at three, six, nine and 12 months post-randomisation. The SF-12 v2 is a generic health measure with 12 questions covering aspects of physical and mental health across eight dimensions. The UK standard gamble tariff was applied to the responses to the SF-12 in order to generate SF-6D utility scores, from which QALYs could be re-calculated using the trapezoidal rule for the purposes of a sensitivity analysis.[26]

Missing data

Missing data were anticipated to be a problem. For all analyses except the complete case analysis, multiple imputation was therefore used. Multiple imputation produces unbiased estimates of a treatment effect provided data are missing at random (i.e. missingness is not related to the value itself, but is related to the values of observed variables) or missing completely at random (i.e. missing data has no relation to the value of any other factors in the study population). Missing at random mechanisms within our data were explored using logistic regression analysis with missingness (of costs and QALYs) as the (binary) response variable and baseline covariates as explanatory variables. Multiple imputation using chained equations with predictive mean matching was carried out on total QALYs over the entire one year follow-up period, total costs in each follow-up period (baseline to three months, three to six months, six to nine months and nine to 12 months) and on pre-injury and post-injury baseline EQ-5D utility scores.[27] Also included within the imputation models were predictive covariates. These included: costs associated with initial hospitalisations and dressing changes, trial site, Gustilo-Anderson wound grade,[28] gender and age. A total of 69 imputed datasets were generated for the base case analysis, following the "rule of thumb" suggested in recent methodological guidance, which were subsequently combined using Rubin's rule.[27]

Analyses of clinical outcomes, resource use and costs

A mixed-effects regression analysis, with recruiting centre as a random effect, and fixed terms to adjust for age group, sex, baseline preinjury score and Gustilo-Anderson wound grade was used to test for treatment group differences for the primary clinical outcome.[15] Resource use items were summarised by trial allocation group and follow-up period and differences between groups were analysed using two-sample *t*-tests for continuous variables and Pearson chi-squared (χ^2) test for categorical variables. Means and standard errors (SEs) for values of each cost category were estimated by treatment allocation and follow-up period. Statistical differences in mean costs by treatment allocation were assessed using two-sample *t*-tests. Mean total costs by treatment allocation and follow-up period were also estimated. Statistically significant differences in the mean total costs were assessed using non-parametric bootstrapping with replacement, based on 1000 replications.

Cost-effectiveness analysis

Bivariate regression using seemingly unrelated regression was used to model total costs and total QALYs over the one year follow-up period. This approach allows for correlation between costs and outcomes and estimates the two regression equations jointly, potentially improving the precision of the estimates. By specifying the treatment group as an indicator within each equation, the incremental costs and QALYs attributable to NPWT were estimated, whilst controlling for baseline covariates (age, gender, trial site and Gustilo-Anderson wound grade). Within the equation for QALYs, baseline EQ-5D utility scores (both pre-injury and post-injury) were included to adjust for potential baseline imbalances between the trial allocation groups.[25] Cost-effectiveness was expressed in terms of an incremental cost-effectiveness ratio (ICER), defined as the incremental cost of NPWT divided by the incremental QALYs produced by NPWT. The ICER was then compared to cost-effectiveness threshold values for an additional QALY. The NICE cost-effectiveness threshold for UK-based studies ranges between £20,000 and £30,000 per QALY.[16] In addition, a £15,000 cost-effectiveness threshold was considered to reflect more recent trends in healthcare decision making.[29]

By bootstrapping[30] the data with replacement and recalculating these incremental costs and QALYs 1000 times, a cost-effectiveness plane was populated with 1000 simulated ICER values.[31] The cost-effectiveness plane provides a graphical representation of ICER values with the difference in QALYs between NPWT and standard wound dressing shown on the X-axis (ICERs to the east of the origin represent positive QALY effects), while the Y-axis shows the difference in cost (ICERs to the north of the origin represent positive cost effects). Net monetary benefits were estimated from the incremental costs and QALYs at each given cost-effectiveness threshold value and reflect the resource gain or loss due to investing in NPWT, given that resources can be used elsewhere within the NHS at the same cost-effectiveness threshold.[32] By calculating net monetary benefits for each of these 1000 simulated ICER values at levels of the cost-effectiveness threshold varying from £0 to £50,000 per QALY gained, the probability of cost-effectiveness of NPWT (defined as the proportion of positive net monetary benefits at a given threshold level) was calculated, and plotted as a cost-effectiveness acceptability curve.[33]

Sensitivity and sub-group analyses

Several sensitivity analyses were undertaken to explore the effects of alternative perspectives or scenarios on the cost-effectiveness results. The cost-effectiveness analysis was therefore repeated under the following assumptions: 1) adopting a wider societal costing perspective, i.e. including costs to individuals and the broader economy; 2) calculating QALYs using the SF-6D instead of the EQ-5D-3L; and 3) restricting the analysis to complete cases only.

A single pre-specified sub-group analysis was also conducted to explore potential heterogeneity in the incremental cost-effectiveness of NPWT related to whether or not there was evidence of deep infection, assessed using the CDC SSI algorithm.[34]

All statistical analyses were conducted using Stata SE V.14 (Statacorp. Stata Statistical Software: Release 14: College Station, TX: Statacorp LP, 2015). Results of statistical tests were considered statistically significant if *P*-values were less than 0.05 (5% significance level).

Results

A total of 460 participants were consented into the WOLLF trial, of whom 226 were randomised to the NPWT dressing and 234 to a standard wound dressing. There was no statistically significant difference in the mean Disability Rating Index score at 12 months (45.5 (standard deviation (SD): 28.0) in the NPWT group vs 42.4 (SD: 24.2) in the standard dressing group; mean difference −3.9 in favour of standard dressings with 95% confidence interval (CI): −8.9 to 1.2; *P* = 0.132; from adjusted mixed-effect regression analysis). Full details of the clinical outcomes of the WOLLF trial are reported elsewhere.[15] The completeness of the relevant health economic data items, by trial group, follow-up point and resource category is provided in Appendix I. Complete economic profiles, encompassing all cost and utility data at all time points, were available for 144 (31%)

participants [65 (29%) participants in the NPWT group and 79 (34%) participants in the standard dressing group] with evidence that participants with complete data were unrepresentative of the total study population. In particular, complete economic profiles were more likely to be available for women and for older age groups.

Resource use and economic costs

Primary procedures, and their associated lengths of hospital stay, are broken down by trial arm and detailed in Appendix II. The most common primary procedure was the latissimus dorsi free-flap, which was performed in 130 trial participants. There was a statistically significant difference in the percentage of participants receiving a sliding hip screw as their primary procedure between the two trial arms (0 (0%) in the NPWT group vs 8 (3.4%) in the standard dressing group; P = 0.005 from χ^2 test). There were no other statistically significant differences in the type of fixation nor in length of stay for each primary procedure between the two trial arms.

The resource components associated with NPWT and standard dressings, as well as dressing changes, and their associated economic costs are summarised in Table I. Appendix III presents resource use values for trial participants with complete data by trial allocation, follow-up period and resource category. Mean hospital readmission rates related to the open fracture wound were similar between trial arms (0.22 vs 0.22 between initial hospital discharge and 3 months declining to 0.11 vs 0.11 during the 9-12 month follow-up period). Within outpatient resource use, the department with the highest mean number of visits per participant was NHS physiotherapy, which peaked at 4 visits during the 3-6 month follow-up period for participants randomised to standard dressings. During the 6-9 month follow-up period, participants randomised to standard dressings made significantly more NHS physiotherapy visits (mean of 3.21 vs 1.64; *P* = 0.040 from two-sample *t*-test), an effect mirrored for private physiotherapy visits (0.78 vs 0.41), although the latter difference was not statistically significant (*P* = 0.265 from two-sample *t*-test). Prescription medication usage was highest during the first three months post-randomisation (53% of all participants). During the 3-6 month follow-up period, this had fallen to 42% of participants, with higher medication usage amongst participants randomised to standard dressings (48% vs 36%; *P* = 0.044 from χ^2 test). Resource use values were combined with unit costs for each resource item (Table II) to estimate economic costs for each resource category.

Economic costs for trial participants with complete data are presented in Table III by trial arm, study period and cost category. With the exception of the cost of the initial inpatient stay (including costs associated with dressings and dressing changes), there were no statistically significant differences in costs between the trial arms during any study period or in any cost category. For the initial patient stay, mean unadjusted costs were £1,223 (bootstrap 95% CI: £211, £2,364) higher in the NPWT arm (*P* = 0.030 from two-sample *t*-test). Over the entire follow-up period, mean unadjusted NHS and PSS costs, inclusive of the additional cost of the intervention and associated dressing changes, were £14,079 in the NPWT group, compared to £14,002 in the standard dressing group, generating an unadjusted mean cost difference of £77 (bootstrap 95% CI: -£2,114, £2,925; *P* = 0.953 from two-sample *t*-test).

Cost effectiveness results

Table IV summarises the cost-effectiveness results based on the WOLLF trial. The base case analysis, using multiple imputed data, covariate adjustment and conducted from a NHS and PSS perspective, produced an ICER of £267,910 per QALY gained, reflecting higher costs and marginally higher QALYs, on average, in the NPWT arm. The probability that NPWT is cost-effective didn't exceed 27% across a range of cost-effectiveness thresholds (24.4% at the widely used £20,000 cost-effectiveness threshold), whilst mean net monetary benefits were negative across a range of cost-effectiveness thresholds. The cost-effectiveness plane and cost-effectiveness acceptability curve that summarise the results of the base case analysis are displayed in Figure I. The cost-effectiveness acceptability curve shows that the probability that NPWT is cost-effective does not exceed 0.27 regardless of the value of the cost-effectiveness threshold.

Sensitivity and subgroup analyses

A range of sensitivity analyses explored the effects of uncertainty surrounding components of the economic evaluation (Table IV). Adopting a broader societal perspective that additionally included costs that fell outside of the NHS and PSS sectors increased the mean ICER to £282,858 per QALY gained, largely driven by an increased incremental cost attributable to NPWT, whilst the probability that NPWT is cost-effective did not exceed 11%. When QALYs were calculated using the SF-6D utility measure rather than the EQ-5D-3L, NPWT was strictly dominated by standard dressings, implying that NPWT resulted in both higher costs and worse outcomes, on average. Finally, restricting the analysis to complete cases resulted in a qualitative change in the direction of the results with NPWT becoming dominant in health economic terms, that is, it generated both lower costs and higher QALYs, on average. In this analysis, the probability that NPWT is cost-effective exceeded 70% across a range of cost-effectiveness thresholds.

A pre-specified subgroup analysis was also carried out to explore the cost-effectiveness of NPWT in those participants with a deep infection (Table IV). NPWT was dominated in this group of participants, generating increased costs and lower QALYs, on average, whilst the probability of cost-effectiveness did not exceed 15% across a range of cost-effectiveness thresholds.

Discussion

This paper presents the first economic evaluation of NPWT among adults with severe open fractures of the lower limb, based on evidence from the WOLLF trial. The study revealed very little difference in health-related quality of life outcomes measured during the 12 months following injury. The cost-effectiveness conclusions are therefore largely driven by mean cost difference between the comparator interventions. The base case analysis that used multiple imputed data and covariate adjustment generated a mean ICER of £267,910 per QALY gained, well in excess of accepted cost-effectiveness thresholds.[16] Consequently, the probability that NPWT is cost-effective did not exceed 27% in the base-case analysis. This result remained robust to several sensitivity analyses and the pre-specified sub-group analysis. The only exception to this pattern of results followed the complete case analysis, which was restricted to 31% of the study population, where NPWT was associated with lower costs and higher QALYs, on average.

Previous economic evaluations of NPWT were conducted in clinical contexts outside of the management of open fractures of the lower limb,[11-13] and therefore a comparative assessment of cost-effectiveness evidence is not possible. Moreover, previous economic analyses of lower limb fractures have either taken the form of cost of illness studies,[35] which cannot inform decisions around allocative efficiency, or have focussed on other elements of the care pathway, such as the use of locking and non-locking implants, whilst also excluding assessments of health-related quality of life outcomes and cost-effectiveness.[36] In the absence of directly related evidence from the broader literature, evidence from this study provides the sole source of information on the cost-effectiveness of NPWT among adults with severe open fractures of the lower limb that clinical decision-makers can draw upon.

The economic evaluation reported in this paper was conducted according to nationally agreed design and reporting guidelines.[16,37] It was based on a pragmatic randomised, multi-centre, controlled trial that avoids many of the selection biases that characterise observational studies and that provided a vehicle for comprehensive prospective assessments of resource use and preference-based health-related quality of life outcomes. The study's cost accounting was rigorous and included all significant resource items calculated from a NHS and PSS perspective and additionally from a societal perspective. A comprehensive analytical strategy was pursued to handle sampling uncertainty surrounding the baseline ICERs and decision uncertainty surrounding the value of the cost-effectiveness threshold. Moreover, the pre-specified analytical design allowed for the estimation of longer term cost-effectiveness beyond the trial time horizon in the event of evidence for benefit over the medium term. We believe that the absence of significant differences in costs or preference-based health-related quality of life outcomes over the 12-month trial time horizon suggests that long-term extrapolation would not have affected the cost-effectiveness findings.

Readers should consider a number of caveats when interpreting the study results. First, as expected in the context of emergency surgery in severely injured patients, some patients were found to be ineligible for inclusion in the trial following randomisation as a result of, for example, permanent cognitive impairment that could not be recognised at an earlier stage within the care pathway. Nevertheless, 460 of the 485 (95%) patients who were randomised and deemed eligible for the trial agreed to participate, suggesting that the cost-effectiveness results are generalisable to the broader UK adult population with severe open fractures of the lower limb. Second, several categories of resource use, such as community health and social care resource use, were measured through repeated participant recall over three month periods, which can be prone to recall biases.[38] Nevertheless, we had no evidence of a differential effect of recall biases between the trial arms, which could have required a further adjustment of our cost-effectiveness estimates. Third, complete health economic data over the study follow-up period was only available for 31% of trial participants (Appendix I) with evidence that participants with complete data differed from those with incomplete data across a range of clinical and sociodemographic characteristics. Had our base case cost-effectiveness analysis only considered individuals with complete economic data, we would have removed 69% of participants from the analysis, which would have likely biased the results. We therefore handled missingness within the health economic data through recommended multiple imputation techniques that address the inherent biases associated with estimating effects on the basis of complete data.[39] Moreover, the base case cost-effectiveness outcomes remained robust following additional sensitivity analyses that tested alternative missing data mechanisms and alternative model specifications that varied the explanatory variables incorporated. Finally, our approach to estimating QALYs, which involved assessing health-related quality of life outcomes at three month intervals, may not have captured the short-term disutility of NPWT immediately post-randomisation. Nevertheless, the NPWT device was worn for a mean of only 3 days (range 2-5 days) and, consequently, any associated disutility is likely to have minimal impact on incremental QALY calculations.

In conclusion, this study found that NPWT is unlikely to be a cost-effective strategy for improving outcomes in adult patients with severe open fractures of the lower limb. Data from our study can be used to inform future economic evaluations and value of information analyses that prioritise randomised controlled trials and other empirical research studies in this area.

Supplementary material

Tables showing: (i) completeness of health economic data by trial group, follow-up point and resource category (Appendix I); (ii) primary initial procedures by trial arm (Appendix II): and (iii) resource use values by trial allocation, follow-up period and resource category in patients with complete data (Appendix III).

Acknowledgments

The data used for this study is from the Wound management of Open Lower Limb Fractures (WOLLF) randomized controlled trial, which was funded by the UK National Institute for Health Research Health Technology Assessment (HTA) Programme (project number 10/57/20) and was supported by the National Institute for Health Research Oxford Biomedical Research Centre. The funder has not been involved in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript nor in the decision to submit the manuscript for publication. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. The two main commercial entities in this sector funded the excess treatment costs of the NPWT dressings but had no part in the design, conduct or reporting of the trial.

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Conflicts of interest

ML Costa is a member of the UK NIHR HTA General Board; SE Lamb is a member of the UK NIHR HTA Additional Capacity Funding Board, HTA end of life care and add-on studies, HTA Prioritisation Group and HTA Trauma Board.

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Table I: Staff and consumable costs (£, 2014/15 prices#) associated with dressings and dressing changes

Dressing variable	Cost	Source
NPWT dressing elements		
VAC dressing pack	31.67	Personal communication
VAC canister	34.87	Personal communication
VAC pump - daily rental cost	17.56	Personal communication
Standard dressing elements		
Mepitel 8cmx10cm	3.46	NHS supply chain 2015/16
Dressing gauze	0.21	NHS supply chain 2015/16
Formflex Natural Sterile Padding Bandage 10cm x 2.7m	0.39	NHS supply chain 2015/16
Premier Band Light Support Bandage 10cm x 4.5cm	0.60	NHS supply chain 2015/16
Mean cost per dressing change - NPWT	22.40	
Mean cost per dressing change - Standard dressing	6.12	
Mean additional cost of NPWT	16.28	
Mean number of dressing changes - NPWT	2.05	
Total additional cost of NPWT dressing changes	33.37	

Where relevant, prices were deflated to 2014/15 prices using the NHS hospital and community health services pay and prices index. VAC denotes vacuum-assisted closure.

Table II: Unit costs for resource items; (£, 2014/15 prices#)

Resource category (unit used for costing purposes)	Unit cost	Unit cost (per minute)	Source
Outpatient care			
Orthopaedics (visit)	112.5		NHS references costs 2014/15
Pathology (visit)	77.7		NHS references costs 2014/15
Radiology (visit)	82.37		NHS references costs 2014/15
Physiotherapy (NHS) (visit)	46		NHS references costs 2014/15
Physiotherapy (Private) (visit)	45.54		NHS references costs 2014/15
Emergency Department (visit)	140.59		NHS references costs 2014/15
Community health care			
GP visits in surgery (visit)	44.46	3.8	PSSRU 2014/15
GP home visits (visit)	43.32	3.8	PSSRU 2014/15
GP telephone contacts (contact)	26.98	3.8	PSSRU 2014/15
Practice nurse contacts (contact)	14.47	0.93	PSSRU 2014/15
District nurse contacts (contact)	38	1.12	PSSRU 2014/15
Community physiotherapy contacts (contact)	34.05	0.61	PSSRU 2013/14
Calls to NHS direct (call)	20.18		bbc.co.uk
Calls for an ambulance or paramedic (call)	99		PSSRU 2014/15
Occupational therapy contacts (contact)	77.69	0.61	PSSRU 2013/14
Personal social services			
Meals on wheels (meal)	6.55		PSSRU 2009/10
Laundry services (service)	9.78		housingcare.org
Social worker contacts (contact)	49.28	1.32	PSSRU 2014/15
Care worker contacts (contact)	18.5	0.62	PSSRU 2014/15
Aids and adaptations			
Crutches (item)	5.06		NHS supply chain catalogue 2015/16
Stick (item)	3.94		NHS supply chain catalogue 2015/16
Zimmer frame (item)	21.54		completecareshop.co.uk
Grab rail (item)	1.61		NHS supply chain catalogue 2015/16
Dressing aids (item)	5.34		NHS supply chain catalogue 2015/16
Long-handle shoe horn (item)	1.66		NHS supply chain catalogue 2015/16

#Where relevant, prices were inflated/deflated to 2014/15 prices using the NHS hospital and community health services pay and prices index.

Table III: NHS and Personal Social Service Costs (£, 2014/15 prices) by cost category and follow-up point; complete cases

Cost category	NPWT Mean Cost (95% CI)	Standard Mean Cost (95% CI)	Mean Difference	Bootstrap 95% CI#	*P* value±
Baseline to 3 months (n = 285 complete cases of 460 total)					
Initial inpatient stay	10324.1 (9422.5, 11225.7)	9101.0 (8475.6, 9726.4)	1223.1	(210.6, 2363.8)	0.030
Inpatient care	717.9 (344.7, 1091.1)	814.5 (480.9, 1148.1)	-96.6	(-568.6, 434.6)	0.705
Outpatient care	545.9 (439.5, 652.3)	625.5 (532.8, 718.2)	-79.6	(-216.2, 70.7)	0.271
Community care	263.9 (175.7, 352.1)	280.7 (214.3, 347.1)	-16.8	(-121.0, 101.0)	0.766
Medications	25.9 (10.6, 41.2)	19.3 (12.8, 25.8)	6.6	(-6.3, 28.5)	0.440
Personal social services	32.0 (3.0, 61.0)	85.3 (18.5, 152.1)	-53.3	(-154.8, 1.8)	0.153
Aids and adaptations	10.2 (7.1, 13.3)	13.6 (8.3, 18.9)	-3.4	(-10.8, 1.8)	0.277
Total NHS and PSS cost	11919.9 (10930.7, 12909.1)	10939.9 (10237.8, 11642.0)	980.0	(-162.5, 2255.0)	0.115
3 months to 6 months (n = 277 complete cases of 460 total)					
Inpatient care	724.7 (323.5, 1125.9)	842.6 (513.9, 1171.3)	-117.9	(-582.3, 464.9)	0.656
Outpatient care	542.8 (441.1, 644.5)	591.7 (494.3, 689.1)	-48.9	(-193.7, 96.5)	0.496
Community care	349.2 (164.8, 533.6)	174.7 (123.9, 225.5)	174.5	(36.3, 459.1)	0.076
Medications	46.2 (0, 101.3)	23.4 (3.2, 43.6)	22.8	(-13.9, 134.8)	0.449
Personal social services	200.6 (0, 522.8)	49.9 (1.1, 98.7)	150.7	(-34.6, 857.5)	0.367
Aids and adaptations	7.7 (2.0, 13.4)	7.9 (2.8, 13.0)	-0.2	(-7.4, 7.9)	0.965
Total NHS and PSS cost	1871.1 (1261.3, 2480.9)	1690.1 (1311.8, 2068.4)	181.0	(-464.7, 996.0)	0.622
6 months to 9 months (n = 262 complete cases of 460 total)					
Inpatient care	651.9 (361.8, 942.0)	461.3 (161.4, 761.2)	190.6	(-263.5, 572.7)	0.371
Outpatient care	290.2 (232.8, 347.6)	386.8 (293.1, 480.5)	-96.6	(-225.3, -1.1)	0.086
Community care	101.3 (58.6, 144.0)	101.5 (60.7, 142.3)	-0.2	(-58.6, 58.0)	0.994
Medications	27.1 (8.7, 45.5)	12.1 (5.2, 19.0)	15.0	(0.2, 42.4)	0.135
Personal social services	37.3 (0, 78.3)	31.7 (0, 69.9)	5.6	(-49.4, 63.9)	0.843
Aids and adaptations	1.5 (0.3, 2.7)	1.3 (0.1, 2.5)	0.2	(-1.8, 1.9)	0.751
Total NHS and PSS cost	1109.5 (763.8, 1455.2)	994.6 (636.3, 1352.9)	114.9	(-403.6, 598.8)	0.652
9 months to 12 months (n = 322 complete cases of 460 total)					
Inpatient care	440.4 (80.7, 800.1)	275.1 (119.7, 430.5)	165.3	(-111.5, 765.9)	0.409
Outpatient care	261.7 (197.0, 326.4)	254.3 (189.8, 318.8)	7.4	(-87.7, 95.7)	0.873
Community care	50.3 (22.5, 78.1)	66.8 (35.0, 98.6)	-16.5	(-61.7, 22.5)	0.444
Medications	16.4	24.6	-8.2	(-44.6, 9.7)	0.504

	(4.8, 28.0)	(3.4, 45.8)			
Personal social services	38.2 (0, 90.1)	35.7 (0, 80.8)	2.5	(-65.8, 71.6)	0.943
Aids and adaptations	4.1 (0, 8.2)	4.6 (0, 11.9)	-0.5	(-14.7, 5.1)	0.918
Total NHS and PSS cost	811.2 (410.8, 1211.6)	661.1 (470.6, 851.6)	150.1	(-176.1, 815.4)	0.508
Baseline to 12 months (n = 152 complete cases of 460 total)					
Total NHS and PSS costs, including intervention costs	14078.9 (11906.0, 16251.8)	14002.1 (12721.0, 15283.2)	76.8	(-2114.3, 2925.4)	0.953

± Two-sample *t*-test; # Calculated using non-parametric bootstrap estimation using 1000 replications, bias corrected.

Table IV: Cost-effectiveness results for base case analysis and sensitivity and sub-group analyses

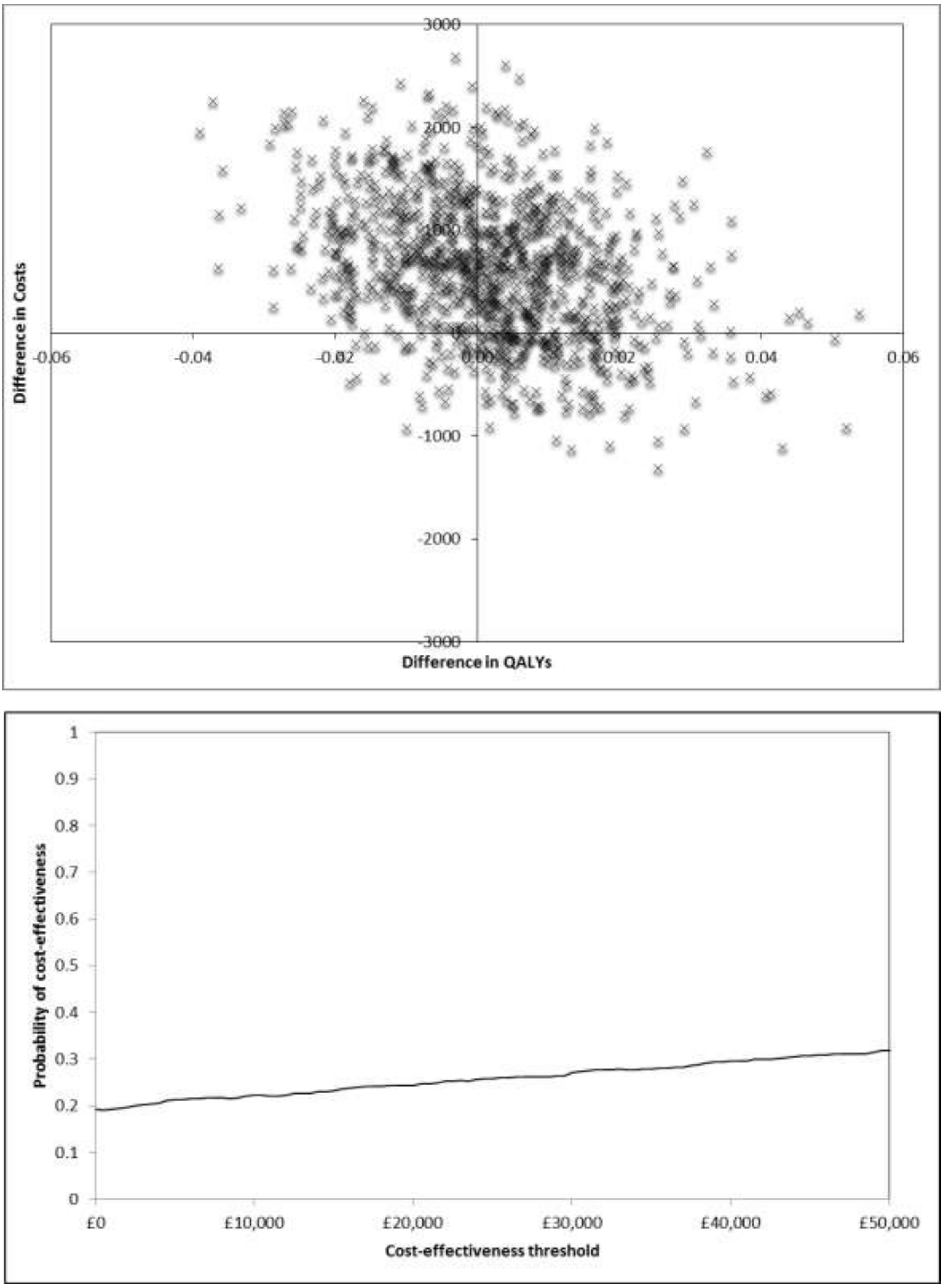
Base case and sensitivity analyses	Incremental cost (95% CI)	Incremental QALYs (95% CI)	ICER	Probability cost-effective[1]	Probability cost-effective[2]	Probability cost-effective[3]	Net monetary benefit[1] (95% CI)	Net monetary benefit[2] (95% CI)	Net monetary benefit (95% CI)[3]
Base case NHS and PSS perspective, imputed costs and QALYs, covariate adjusted±	678 (-1082, 2438)	0.002 (-0.054, 0.059)	£267,910	0.233	0.244	0.271	-615 (-2163, 848)	-606 (-2210, 938)	-588 (-2320, 1169)
Societal perspective, imputed costs and QALYs, covariate adjusted±	2264 (-1271, 5800)	0.008 (-0.043, 0.059)	£282,858	0.076	0.081	0.104	-2156 (-5177, 826)	-2121 (-5197, 922)	-2051 (-5324, 1163)
QALYs calculated using SF-6D, imputed costs and QALYs, covariate adjusted±	796 (-925, 2518)	-0.002 (-0.030, 0.027)	Dominated	0.119	0.120	0.127	-823 (-2216, 585)	-833 (-2268, 595)	-853 (-2347, 674)
Complete case analysis, covariate adjusted#	-452 (-2926, 2022)	0.022 (-0.041, 0.086)	Dominant	0.709	0.721	0.736	760 (-1820, 3401)	862 (-1919, 3745)	1068 (-2195, 4694)
Subgroup analysis: deep infection≠, imputed costs and QALYs, covariate adjusted±	3295 (-3680, 10269)	-0.036 (-0.243, 0.171)	Dominated	0.139	0.137	0.142	-3821 (-11083, 3414)	-3982 (-11557, 3777)	-4304 (-12455, 4155)

ICER denotes incremental cost-effectiveness ratio. Dominated denotes that NPWT is associated with higher costs and lower QALY's, on average, in comparison to standard dressing. Dominant denotes that NPWT is associated with lower costs and higher QALY's, on average, in comparison to standard dressing.

± Sample size: n=226 (NPWT), n= 234 (standard dressing); # Sample size: n=65 (NPWT), n= 79 (standard dressing); ≠ Sample size: n=35 (NPWT), n=33 (standard dressing).

[1] Assumes a cost-effectiveness threshold of £15,000 per QALY. [2] Assumes a cost-effectiveness threshold of £20,000 per QALY. [3] Assumes a cost-effectiveness threshold of £30,000 per QALY.

Figure I: Cost-effectiveness plane and cost-effectiveness acceptability curve for base case analysis



Appendix I: Completeness of health economic data by trial group, follow-up point and resource category

		NPWT n (%, N=226)	Standard n (%, N=234)	Total n (%, N=460)
Health-related quality of life				
	Pre-injury baseline EQ-5D	220 (97%)	231 (99%)	451 (98%)
	Post-injury baseline EQ-5D	210 (93%)	226 (97%)	436 (95%)
	3 month EQ-5D	152 (67%)	175 (75%)	327 (71%)
	6 month EQ-5D	146 (65%)	166 (71%)	312 (68%)
	9 month EQ-5D	144 (64%)	154 (66%)	298 (65%)
	12 month EQ-5D	172 (76%)	192 (82%)	364 (79%)
	QALYs complete cases	94 (42%)	124 (53%)	218 (47%)
Resource use/Economic costs				
3 months	Inpatient care	157 (69%)	174 (74%)	331 (72%)
	Outpatient care	148 (65%)	164 (70%)	312 (68%)
	Community care	148 (65%)	162 (69%)	310 (67%)
	Medications	142 (63%)	159 (68%)	301 (65%)
	Personal social services	144 (64%)	158 (68%)	302 (66%)
	Aids and adaptations	144 (64%)	162 (69%)	306 (67%)
	Total costs	136 (60%)	149 (64%)	285 (62%)
6 months	Inpatient care	145 (64%)	164 (70%)	309 (67%)
	Outpatient care	142 (63%)	157 (67%)	299 (65%)
	Community care	138 (61%)	156 (67%)	294 (64%)
	Medications	136 (60%)	155 (66%)	291 (63%)
	Personal social services	141 (62%)	157 (67%)	298 (65%)
	Aids and adaptations	138 (61%)	156 (67%)	294 (64%)
	Total costs	128 (57%)	149 (64%)	277 (60%)
9 months	Inpatient care	145 (64%)	150 (64%)	295 (64%)

	Outpatient care	140 (62%)	143 (61%)	283 (62%)
	Community care	138 (61%)	138 (59%)	276 (60%)
	Medications	139 (62%)	143 (61%)	282 (61%)
	Personal social services	141 (62%)	142 (61%)	283 (62%)
	Aids and adaptations	139 (62%)	140 (60%)	279 (61%)
	Total costs	129 (57%)	133 (57%)	262 (57%)
12 months	Inpatient care	168 (74%)	186 (79%)	354 (77%)
	Outpatient care	162 (72%)	180 (77%)	342 (74%)
	Community care	161 (71%)	180 (77%)	341 (74%)
	Medications	159 (70%)	179 (76%)	338 (73%)
	Personal social services	163 (72%)	182 (78%)	345 (75%)
	Aids and adaptations	163 (72%)	180 (77%)	343 (75%)
	Total costs	152 (67%)	170 (73%)	322 (70%)
Complete cases	EQ-5D and Economic costs	65 (29%)	79 (34%)	144 (31%)

Appendix II: Primary initial procedures by trial arm

Primary initial procedure name	Number (%) of procedures NPWT	Mean (95% CI) length of stay NPWT (days)	Number (%) of procedures Standard	Mean (95% CI) length of stay Standard (days)	*P*-value difference in percentage of procedures	*P*-value difference in length of stay
Microvascular free tissue transfer of flap of muscle of shoulder	70 (40.0%)	18.5 (15.9, 21.1)	60 (25.6%)	20 (16.1, 24.0)	0.204	0.512
Primary open reduction of fracture of bone and external fixation however further qualified (HFQ) of knee	53 (23.5%)	22.7 (18.3, 27.2)	60 (25.6%)	18.3 (14.9, 21.8)	0.585	0.12
Primary open reduction of fracture of long bone and fixation using rigid nail not elsewhere classified (NEC) of knee	28 (12.4%)	17.0 (9.7, 24.3)	33 (14.1%)	15.2 (11.4, 18.9)	0.588	0.654
Primary open reduction of fracture of long bone and extramedullary fixation using plate NEC of knee	17 (7.5%)	15.2 (10.7, 19.8)	17 (7.3%)	15.2 (8.4, 22.0)	0.916	0.988
Microvascular free tissue transfer of flap of muscle of hip	18 (8.0%)	16.9 (10.7, 23.1)	14 (6.0%)	28.2 (13.4, 43.0)	0.404	0.148
Primary open reduction of fracture of long bone and fixation using rigid nail NEC of hip	5 (2.2%)	7.4 (1.2, 13.7)	9 (3.8%)	14.1 (7.4, 20.8)	0.308	0.094
Primary open reduction of fracture of bone and external fixation HFQ of hip	9 (4.0%)	18.2 (12.9, 23.6)	4 (1.7%)	23.8 (0, 58.5)	0.141	0.652
Primary open reduction of fracture of long bone and extramedullary fixation using plate NEC of hip	0 (0%)	-	8 (3.4%)	31.5 (12.2, 50.8)	0.005	-
Primary open reduction of fracture dislocation of joint and internal fixation NEC of foot	4 (1.8%)	7.5 (4.2, 10.8)	2 (0.9%)	12.5 (0, 133.2)	0.387	0.691
Amputation of leg below knee	4 (1.8%)	33.0 (5.4, 60.7)	2 (0.9%)	21.0 (0, 148.1)	0.387	0.441
Primary open reduction of fracture of bone and external fixation HFQ of foot	3 (1.3%)	19.0 (5.9, 32.1)	2 (0.9%)	15.5 (0, 47.3)	0.625	0.442
Primary open reduction of fragment of bone and fixation using wire system of foot	3 (1.3%)	5.7 (0, 15.1)	2 (0.9%)	20.5 (0, 115.8)	0.625	0.279
Unspecified split autograft of skin	3 (1.3%)	17.0 (6.2, 27.8)	1 (0.4%)	8 .0 (-)	0.299	-

Application of external ring fixation to bone NEC of knee	0 (0%)	-	3 (1.3%)	30.0 (10.3, 49.7)	0.088	-
Revision of microvascular vessel anastomosis of blood vessel of lower limb	0 (0%)	-	3 (1.3%)	33.0 (0, 83.2)	0.088	-
Primary open reduction of fragment of bone and fixation using screw of knee	0 (0%)	-	2 (0.9%)	7.0 (0, 57.8)	0.164	-
Amputation of leg above knee	0 (0%)	-	2 (0.9%)	40.5 (0, 428.0)	0.164	-
Primary open reduction of fracture of ankle and extramedullary fixation NEC	1 (0.4%)	0 (-)	1 (0.4%)	9.0 (-)	0.98	-
Amputation of leg through knee	0 (0%)	-	2 (0.9%)	37.0 (0, 164.1)	0.164	-
Primary open reduction of fragment of bone and fixation using wire system of knee	1 (0.4%)	14.0 (-)	1 (0.4%)	18.0 (-)	0.98	-
Application of skeletal traction to bone NEC of hip	0 (0%)	-	1 (0.4%)	62.0 (-)	0.325	-
Debridement of soft tissue NEC of knee	1 (0.4%)	15.0 (-)	0 (0%)	-	0.308	-
Application of external fixation to bone NEC of knee	0 (0%)	-	1 (0.4%)	1.0 (-)	0.325	-
Unspecified local flap of skin and muscle	1 (0.4%)	12.0 (-)	0 (0%)	-	0.308	-
Application of external fixation to bone NEC of foot	0 (0%)	-	1 (0.4%)	4.0 (-)	0.325	-
Debridement of soft tissue NEC of foot	1 (0.4%)	1.0 (-)	0 (0%)	-	0.308	-
Other specified transplantation of muscle of hip	1 (0.4%)	50.0 (-)	0 (0%)	-	0.308	-
Primary open reduction of fragment of bone and fixation using screw of foot	1 (0.4%)	7.0 (-)	0 (0%)	-	0.308	-
Microvascular free tissue transfer of flap of muscle of knee	0 (0%)	-	1 (0.4%)	18.0 (-)	0.325	-

Remanipulation of fracture of bone and external fixation HFQ of knee	0 (0%)	-	1 (0.4%)	25.0 (-)	0.325	-
Remanipulation of fragment of bone and fixation using screw of knee	0 (0%)	-	1 (0.4%)	2.0 (-)	0.325	-
Primary open reduction of fracture of long bone and extramedullary fixation using plate NEC of foot	1 (0.4%)	8.0 (-)	0 (0%)	-	0.308	-
Primary simple repair of tendon of foot	1 (0.4%)	41.0 (-)	0 (0%)	-	0.308	-
Total	226 (100.0%)	18.5 (16.7, 20.3)	234 (100.0%)	19.5 (17.5, 21.6)	NA	0.437

Appendix III: Resource use values by trial allocation, follow-up period and resource category; complete cases

	NPWT Mean (95% CI)	Standard dressing Mean (95% CI)	*P*-value difference between means	NPWT Mean (95% CI)	Standard dressing Mean (95% CI)	*P*-value difference between means	NPWT Mean (95% CI)	Standard dressing Mean (95% CI)	*P*-value difference between means	NPWT Mean (95% CI)	Standard dressing Mean (95% CI)	*P*-value difference between means
		3 months			**6 months**			**9 months**			**12 months**	
Inpatient resource use	n = 157	n = 174		n = 145	n = 164		n = 145	n = 150		n = 168	n = 186	
Readmissions related to WOLLF wound	0.22 (0.16, 0.28)	0.22 (0.16, 0.28)	0.869	0.22 (0.16, 0.28)	0.26 (0.20, 0.32)	0.467	0.21 (0.15, 0.27)	0.17 (0.11, 0.23)	0.305	0.11 (0.07, 0.15)	0.11 (0.07, 0.15)	0.991
Outpatient resource use	n = 148	n = 164		n = 142	n = 157		n = 140	n = 143		n = 162	n = 180	
Orthopaedics	2.36 (1.83, 2.89)	2.55 (2.14, 2.96)	0.576	1.97 (1.62, 2.32)	2.12 (1.69, 2.55)	0.593	1.16 (0.89, 1.43)	1.34 (1.05, 1.63)	0.388	1.05 (0.80, 1.30)	0.98 (0.74, 1.22)	0.715
Pathology	0.16 (0.00, 0.34)	0.20 (0.08, 0.32)	0.766	0.32 (0.10, 0.54)	0.21 (0.07, 0.35)	0.383	0.17 (0.07, 0.27)	0.15 (0.07, 0.23)	0.803	0.15 (0.05, 0.25)	0.14 (0.02, 0.26)	0.894
Radiology	1.16 (0.85, 1.47)	1.28 (1.06, 1.50)	0.552	1.27 (0.96, 1.58)	1.29 (1.05, 1.53)	0.898	0.62 (0.42, 0.82)	0.76 (0.54, 0.98)	0.368	0.66 (0.44, 0.88)	0.75 (0.48, 1.02)	0.608
Physiotherapy (NHS)	1.85 (1.36, 2.34)	2.07 (1.44, 2.70)	0.588	3.72 (2.84, 4.60)	3.99 (2,77, 5.21)	0.726	1.64 (1.13, 2.15)	3.21 (1.80, 4.62)	0.040	1.05 (0.66, 1.44)	1.24 (0.79, 1.69)	0.539
Physiotherapy (Private)	0.33 (0.02, 0.64)	0.59 (0.12, 1.06)	0.358	0.84 (0.10, 1.58)	0.60 (0.21, 0.99)	0.576	0.41 (0.08, 0.74)	0.78 (0.23, 1.33)	0.265	0.34 (0.05, 0.63)	0.28 (0.06, 0.50)	0.768
Emergency Department - injury related	0.04 (0.00, 0.08)	0.06 (0.00, 0.12)	0.596	0.07 (0.00, 0.19)	0.04 (0.00, 0.08)	0.668	0.07 (0.01, 0.13)	0.04 (0.00, 0.08)	0.364	0.02 (0.00, 0.06)	0.03 (0.01, 0.05)	0.874
Other	0.94 (0.29, 1.59)	1.46 (0.58, 2.34)	0.347	0.41 (0.08, 0.74)	0.38 (0.14, 0.62)	0.900	0.10 (0.02, 0.18)	0.20 (0.06, 0.34)	0.226	0.19 (0.01, 0.37)	0.11 (0.01, 0.21)	0.393
Community care resource use	n = 148	n = 162		n = 138	n = 156		n = 138	n = 138		n = 161	n = 180	

GP surgery	0.48 (0.30, 0.66)	0.72 (0.41, 1.03)	0.185	1.37 (0.66, 2.08)	0.65 (0.40, 0.90)	0.063	0.72 (0.45, 0.99)	0.56 (0.30, 0.82)	0.422	0.42 (0.17, 0.67)	0.34 (0.22, 0.46)	0.599
GP home	0.23 (0.11, 0.35)	0.18 (0.08, 0.28)	0.531	0.14 (0.04, 0.24)	0.10 (0.04, 0.16)	0.579	0.05 (0.00, 0.11)	0.08 (0.00, 0.16)	0.572	0.04 (0.00, 0.10)	0.02 (0.00, 0.06)	0.525
GP phone	0.43 (0.14, 0.72)	0.51 (0.33, 0.69)	0.633	0.28 (0.10, 0.46)	0.44 (0.22, 0.66)	0.265	0.25 (0.07, 0.43)	0.30 (0.14, 0.46)	0.664	0.11 (0.01, 0.21)	0.17 (0.07, 0.27)	0.427
Practice nurse	2.07 (1.11, 3.03)	1.12 (0.51, 1.73)	0.099	0.86 (0.31, 1.41)	0.75 (0.26, 1.24)	0.758	0.40 (0.05, 0.75)	0.51 (0.00, 1.06)	0.727	0.43 (0.00, 0.94)	0.09 (0.01, 0.17)	0.190
District nurse	4.74 (2.92, 6.56)	4.24 (3.01, 5.47)	0.66	2.75 (0.79, 4.71)	1.50 (0.74, 2.26)	0.243	0.54 (0.01, 1.07)	1.25 (0.37, 2.13)	0.173	0.38 (0.03, 0.73)	0.47 (0.04, 0.90)	0.740
Community physiotherapist	0.67 (0.26, 1.08)	0.59 (0.34, 0.84)	0.736	1.93 (0.46, 3.40)	1.72 (0.88, 2.56)	0.808	0.33 (0.09, 0.57)	0.60 (0.19, 1.01)	0.260	0.18 (0.00, 0.38)	0.64 (0.09, 1.19)	0.125
NHS direct call	0.10 (0.00, 0.30)	0.07 (0.01, 0.13)	0.696	0.04 (0.00, 0.10)	0.03 (0.01, 0.05)	0.715	0.10 (0.00, 0.24)	0.02 (0.00, 0.06)	0.238	0.01 (0.00, 0.03)	0.07 (0.00, 0.19)	0.314
Ambulance or paramedic	0.04 (0.00, 0.08)	0.06 (0.00, 0.12)	0.659	0.15 (0.00, 0.31)	0.04 (0.00, 0.08)	0.149	0.03 (0.00, 0.07)	0.00 (0.00, 0.00)	0.207	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-
Occupational therapy	0.26 (0.06, 0.46)	0.27 (0.13, 0.41)	0.945	0.12 (0.00, 0.28)	0.17 (0.05, 0.29)	0.665	0.12 (0.00, 0.30)	0.05 (0.00, 0.11)	0.499	0.01 (0.00, 0.03)	0.02 (0.00, 0.06)	0.838
Other	0.25 (0.00, 0.56)	0.32 (0.00, 0.65)	0.759	0.16 (0.00, 0.36)	0.16 (0.00, 0.34)	0.995	0.12 (0.00, 0.30)	0.02 (0.00, 0.06)	0.266	0.13 (0.00, 0.35)	0.01 (0.00, 0.03)	0.296
Personal social services resource use	n = 144	n = 158		n = 141	n = 157		n = 141	n = 142		n = 163	n = 182	
Meals on wheels (hot)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.46 (0.00, 1.36)	0.319
Laundry	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.10 (0.00, 0.24)	0.180

Social worker	0.13 (0.00, 0.31)	0.01 (0.00, 0.03)	0.178	0.04 (0.00, 0.08)	0.00 (0.00, 0.00)	0.319	0.06 (0.00, 0.18)	0.03 (0.00, 0.09)	0.652	0.02 (0.00, 0.06)	0.00 (0.00, 0.00)	0.207
Care worker	1.52 (0.00, 3.05)	4.26 (0.85, 7.67)	0.151	2.44 (0.00, 6.12)	2.39 (0.00, 5.02)	0.985	0.71 (0.00, 1.63)	1.37 (0.00, 3.04)	0.493	1.41 (0.00, 3.00)	1.39 (0.00, 3.29)	0.988
Other	0.08 (0.00, 0.18)	1.19 (0.00, 3.29)	0.300	0.02 (0.00, 0.04)	0.11 (0.00, 0.33)	0.426	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	-	0.00 (0.00, 0.00)	0.02 (0.00, 0.06)	0.319
Aids and adaptations resource use	n = 144	n = 162		n = 138	n = 156		n = 139	n = 140		n = 163	n = 180	
Crutches	0.83 (0.67, 0.99)	0.80 (0.64, 0.96)	0.743	0.38 (0.24, 0.52)	0.40 (0.28, 0.52)	0.824	0.23 (0.13, 0.33)	0.13 (0.05, 0.21)	0.121	0.16 (0.08, 0.24)	0.09 (0.03, 0.15)	0.201
Sticks	0.03 (0.00, 0.07)	0.08 (0.04, 0.12)	0.102	0.13 (0.05, 0.21)	0.21 (0.11, 0.31)	0.201	0.09 (0.03, 0.15)	0.14 (0.06, 0.22)	0.399	0.08 (0.04, 0.12)	0.12 (0.06, 0.18)	0.253
Zimmer frames	0.31 (0.21, 0.41)	0.40 (0.30, 0.50)	0.217	0.09 (0.03, 0.15)	0.15 (0.09, 0.21)	0.172	0.03 (0.01, 0.05)	0.01 (0.00, 0.03)	0.407	0.02 (0.00, 0.04)	0.03 (0.01, 0.05)	0.563
Grab rails	0.06 (0.00, 0.14)	0.14 (0.08, 0.20)	0.088	0.01 (0.00, 0.03)	0.12 (0.04, 0.20)	0.008	0.06 (0.00, 0.12)	0.06 (0.00, 0.12)	0.856	0.01 (0.00, 0.03)	0.02 (0.00, 0.04)	0.280
Dressing aids	0.25 (0.00, 0.50)	0.20 (0.00, 0.40)	0.749	0.01 (0.00, 0.03)	0.04 (0.00, 0.08)	0.195	0.79 (0.00, 2.20)	0.14 (0.00, 0.42)	0.375	0.00 (0.00, 0.00)	0.03 (0.00, 0.09)	0.319
Long-handle shoe horns	0.04 (0.00, 0.08)	0.04 (0.02, 0.06)	0.836	0.02 (0.00, 0.04)	0.03 (0.00, 0.07)	0.845	0.02 (0.00, 0.04)	0.01 (0.00, 0.03)	0.313	0.01 (0.00, 0.03)	0.00 (0.00, 0.00)	0.158
Other	0.47 (0.37, 0.57)	0.52 (0.44, 0.60)	0.463	0.16 (0.10, 0.22)	0.22 (0.14, 0.30)	0.215	0.05 (0.01, 0.09)	0.10 (0.00, 0.20)	0.335	0.10 (0.04, 0.16)	0.04 (0.02, 0.06)	0.027
	NPWT n (%)	Standard n (%)	All n (%)	NPWT n (%)	Standard n (%)		NPWT n (%)	Standard n (%)		NPWT n (%)	Standard n (%)	
Medications resource use	n = 142	n = 159		n = 136	n = 155		n = 139	n = 143		n = 159	n = 179	
Prescription medication	76 (54%)	85 (53%)	0.991	49 (36%)	74 (48%)	0.044	41 (29%)	47 (33%)	0.541	44 (28%)	67 (37%)	0.057