■ CHILDREN'S ORTHOPAEDICS

# Cost-effectiveness analysis of soft bandage and immediate discharge versus rigid immobilization in children with distal radius torus fractures

THE FORCE TRIAL

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## Aims

**The aim of this trial was to assess the cost-effectiveness of a soft bandage and immediate discharge, compared with rigid immobilization, in children aged four to 15 years with a torus fracture of the distal radius.**

## Methods

**A within-trial economic evaluation was conducted from the UK NHS and personal social services (PSS) perspective, as well as a broader societal point of view. Health resources and quality of life (the youth version of the EuroQol five-dimension questionnaire (EQ-5D-Y)) data were collected, as part of the Forearm Recovery in Children Evaluation (FORCE) multicentre randomized controlled trial over a six-week period, using trial case report forms and patient-completed questionnaires. Costs and health gains (quality-adjusted life years (QALYs)) were estimated for the two trial treatment groups. Regression was used to estimate the probability of the new treatment being cost-effective at a range of 'willingness-to-pay' thresholds, which reflect a range of costs per QALY at which governments are typically prepared to reimburse for treatment.**

## Results

**The offer of a soft bandage significantly reduced cost per patient (saving £12.55 (95% confidence interval (CI) -£5.30 to £19.80)) while QALYs were similar (QALY difference between groups: 0.0013 (95% CI -0.0004 to 0.003)). The high probability (95%) that offering a bandage is a cost-effective option was consistent when examining the data in a range of sensitivity analyses.**

## Conclusion

**In addition to the known clinical equivalence, this study found that the offer of a bandage reduced cost compared with rigid immobilization among children with a torus fracture of the distal radius. While the cost saving was small for each patient, the high frequency of these injuries indicates a significant saving across the healthcare system.**

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## Introduction

Torus (buckle) fractures of the distal radius are the most common fractures in children. They result from trauma to growing bones and account for two-thirds of all wrist fractures in children, which equates to approximately 60,000 UK emergency department (ED) attendances annually.[1–4] There is widespread agreement that these fractures universally heal well. There has been a longstanding doctrine of rigid immobilization in cast for wrist fractures,[5] tempered by newer evidence to suggest that simpler treatment methods (e.g. use of a removable rigid splint) are as effective for these fractures.[6–9] While rigid forms of immobilization (i.e. cast or splint) may maximize pain relief and minimize refracture, they may unduly restrict function and delay discharge from follow-up.

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The National Institute for Health and Care Excellence (NICE) non-complex fracture guidelines made recommendations for the management of these injuries.[10] The NICE review group concluded that bandaging was probably the optimal treatment approach, due to the convenience, likely adequate pain control, and the ability to promote early function. NICE concluded that torus fractures of the distal radius should not be immobilized in a rigid cast, and advocated discharge from the ED without the subsequent need for outpatient follow-up. While NICE recommended that bandaging or soft casts should be the mainstay of treatment for torus fractures, they questioned whether any intervention was necessary at all.

In response to the NICE guideline, we performed the Forearm Fracture Recovery in Children Evaluation (FORCE) study.[11–14] The FORCE study randomized 965 children from 23 UK hospitals between either the offer of a soft bandage (which families could choose to wear) and immediate discharge, or rigid immobilization (cast or splint) and routine follow-up for the treating centre. The study identified equivalence in the primary outcome (child-reported pain at three days) between the intervention groups, with no between-group difference in pain or function at any point during the six weeks of follow-up, nor any difference in complications. In this linked economic evaluation, we have sought to determine the cost-effectiveness of the interventions from the UK NHS and personal social services (PSS) perspective, as well as a broader societal point of view.

## Methods

**Background of the FORCE study.** FORCE was a multicentre randomized controlled equivalence trial, with patients recruited between 16 January 2019 and 13 July 2020, with follow-up until 27 August 2020.[11–14] Children aged four to 15 years inclusive with a radiologically confirmed torus fracture of the distal radius were eligible to enter the study. Further details on eligibility can be found in the protocol.[11] The FORCE study was approved by the UK National Research Ethics Committee (18/WM/0324). A detailed statistical and health economic analysis plan was published prior to the completion of data collection.[12]

**Trial recruitment and demographics.** FORCE recruited 965 children with a distal radius torus fracture from 23 UK centres assigned to either offer of soft bandage and immediate discharge (n = 489) or rigid immobilization (n = 476). Baseline demographics of recruited participants were similar, comparing treatment groups and comparing those screened and recruited. Approximately twice as many children were screened for inclusion and recruited in the eight to 15 years group than in the four to seven years group. The injury involved the dominant hand in 426 (44%) participants.

**Resource use data.** Data were recorded using proxy-completed health resource questionnaires, capturing the resource use associated with the injury from both an NHS and social services perspective. Items included inpatient care, outpatient care, and community/social care services input. For a broader societal perspective, additional questions considered private medical care (e.g. physiotherapy, out-of-pocket medication), non-medical care (e.g. help with childcare), and indirect costs (e.g. carer absenteeism) associated with the injury.

**Table I.** Amount of missing Youth version of the EuroQol five-dimension questionnaire data by treatment group.

| Variable | Offer of bandage (n = 489), missing (%) | Rigid immobilization (n = 476), missing (%) |
|---|---|---|
| Baseline | 0 | 0 |
| Day 3 | 6.13 | 7.35 |
| Day 7 | 6.75 | 8.61 |
| Week 3 | 12.07 | 10.50 |
| Week 6 | 11.25 | 10.08 |
| QALY (AUC) | 16.36 | 15.76 |

AUC, area under the curve; QALY, quality-adjusted life-year.

**Valuation of resource use.** We used the health economic methods recommended by the NICE Guide to Methods of Technology Appraisal.[15] Costs for each NHS resource within the trial (i.e. ED attendance) were obtained from the most recent national sources. The cost of the different forms of immobilization applied (futura-type splint, back-slab, soft cast, and hard cast) or non-immobilization (i.e. soft bandage) were sourced from the latest NHS Supply Chain catalogue.[16]

Inpatient, ED, and outpatient use were valued using NHS Reference Costs.[17] Community care unit costs were acquired from Personal Social Services Research Unit (PSSRU).[18] The unit cost of any relevant medications was acquired from British National Formulary (BNF),[19] assuming daily doses using BNF recommendations. Non-medical childcare costs were obtained directly from the participant questionnaire. Costs associated with lost productivity (i.e. days off work) were estimated using the 'human capital approach', whereby the median daily wage was multiplied by number of days off work due to injury. The cost of health resource use per patient was calculated by multiplying the health resource use by its unit cost. Costs were evaluated in the most recent year for which unit cost data were available and expressed in British pounds (GBP). Health economic models often adjust future costs to place greater value on short-term health gains, through a process called 'discounting', although this was not done in this study owing to the short follow-up timeframe.

**Health outcomes.** Following NICE guidelines, the primary health outcome for the economic evaluation was the quality-adjusted life year (QALY).[15] The health-related quality of life (HRQoL) of study participants was estimated using the Youth version of the EuroQol five-dimension questionnaire (EQ-5D-Y), a child-friendly version of the EQ-5D.[20] EQ-5D-Y is widely used in economic analyses and consists of five health dimensions (mobility, self-care, usual activity, pain/discomfort, and anxiety/depression), each with three responses: no problems, some problems, and a lot of problems. Each child (or their proxy) reported the participant's present health at baseline, three days, seven days, three weeks, and six weeks post-randomization. Additionally, they completed a visual analogue scale (VAS), providing the participant's self-rated health at the time of survey completion. The EQ-5D is converted into a 'utility score' between -0.148 and 1.0, the conversion for which slightly differs between populations, whereby 1.0 is the best health, 0 represents death, and negative numbers are considered a state worse than death. There is currently no validated utility conversion for the EQ-5D-Y, therefore we used the UK tariff

**Table II.** Number of additional episodes of NHS service use per participant.

| Variable | Bandage, mean (SE) | Rigid immobilization, mean (SE) | Mean difference (95% CI) |
|---|---|---|---|
| **Hospital care (0 to 3 wks)** | | | |
| Orthopaedic clinic | 0.037 (0.009) | 0.085 (0.015) | -0.048 (-0.084 to -0.012) |
| Radiology | 0.011 (0.005) | 0.009 (0.006) | 0.002 (-0.013 to 0.016) |
| Physiotherapy | 0 (0) | 0 (0) | 0 |
| Emergency Department | 0.048 (0.011) | 0.032 (0.010) | 0.015 (-0.014 to 0.044) |
| **Community care (0 to 3 wks)** | | | |
| GP (surgery) | 0.016 (0.006) | 0.009 (0.005) | 0.007 (-0.001 to 0.021) |
| GP (phone/email contact) | 0.002 (0.002) | 0.007 (0.005) | -0.005 (-0.015 to 0.007) |
| Practice nurse | 0.002 (0.002) | 0 (0) | 0.002 (-0.002 to 0.007) |
| District nurse | 0 (0) | 0 (0) | 0 |
| Physiotherapist | 0 (0) | 0 (0) | 0 |
| 111 advice | 0.002 (0.002) | 0.005 (0.003) | -0.002 (-0.010 to 0.005) |
| **Hospital care (4 to 6 wks)** | | | |
| Orthopaedic clinic | 0.021 (0.008) | 0.014 (0.007) | 0.007 (-0.015 to 0.028) |
| Radiology | 0.002 (0.002) | 0.004 (0.004) | -0.002 (-0.012 to 0.007) |
| Physiotherapy | 0.002 (0.002) | 0 (0) | 0.002 (-0.002 to 0.006) |
| Emergency Department | 0.006 (0.003) | 0.002 (0.002) | 0.004 (-0.004 to 0.003) |
| **Community care (4 to 6 wks)** | | | |
| GP (surgery) | 0 (0) | 0.011 (0.006) | -0.011 (-0.023 to 0.000) |
| GP (phone/email contact) | 0.002 (0.002) | 0 (0) | 0.002 (-0.002 to 0.007) |
| Practice nurse | 0 (0) | 0 (0) | 0 |
| District nurse | 0 (0) | 0 (0) | 0 |
| Physiotherapist | 0.002 (0.0022) | 0.004 (0.003) | -0.002 (-0.009 to 0.005) |
| GP (surgery) | 0.002 (0.002) | 0 (0) | 0.002 (-0.002 to 0.006) |

CI, confidence interval; GP, general practitioner; N/A, not applicable; SE, standard error.

for the adult version of the EQ-5D questionnaire,[21] which is the approach taken by many other similar studies, pending a more appropriate country and age-specific conversion.[22] QALYs were calculated for each participant as the area under the utility curve of the EQ-5D utility scores from baseline to six weeks post-randomization, using the trapezoidal rule.[23]

**Data analysis**. Analysis followed intention-to-treat (ITT) principles, providing summaries and estimates of effects based on allocated (as per randomization) treatment groups. Any 'free text' responses concerning resource use were reassigned within cost categories where possible, or removed if they were deemed not relevant to the trial treatments by clinical experts. Resource use categories, costs, and utilities were summarized by trial arm, and differences were reported including bootstrapped confidence intervals.

**Cost-utility analysis**. Cost-effectiveness is defined here as the ratio between the average difference in costs, and the average difference in QALYs, which is also called the 'incremental cost-effectiveness ratio (ICER)' or sometimes referred to as cost-utility analysis. Within the ICER the offer of a soft bandage and immediate discharge was considered the 'new' treatment and rigid immobilization 'current' practice.

Many trials suffer from some incompleteness of data. This reduces statistical power and may bias the analysis, as there may be confounding reasons why data are missing. Multiple imputation allows a number of complete datasets to be drawn probabilistically from the original data, informed by the reasons for missingness. These complete datasets are then regressed and their findings combined in a principled manner. A bivariate regression was used to estimate group costs and QALYs, as this maintained the correlation between the two outcomes.

The trial data give a point estimate of the ICER (i.e. the incremental cost divided by incremental QALY). However, exploring uncertainty around an ICER value is difficult using traditional statistical methods as it is a ratio quantity. Bootstrapping is a statistical technique where study participants are randomly chosen to form new datasets, which simulate running the trial many times, with each new estimate providing a statistically plausible alternative ICER. The distribution of bootstrapped ICERs is plotted on a graph showing the cost-effectiveness plane and used to derive confidence intervals (CIs). The bootstrapped output informs several other health economic measures.

The incremental net monetary benefit (NMB) is the financial benefit that would be achieved from implementing an intervention. It is calculated at each willingness-to-pay (WTP) threshold by: NMB = (QALY × WTP threshold) – cost of the intervention.

If the incremental NMB is positive there is a gain from the new treatment and, in principle, it should be adopted. The value of the intervention is determined at several different WTP thresholds used by governments – the upper threshold of £30,000/QALY used by NICE for 'regular' approvals,[24] a central value of £20,000/QALY, and a lower value of £15,000/QALY – this reflects uncertainty about the true value appropriate within the NHS.[25] Derived from the NMB, the cost-effectiveness acceptability curve indicates the probability that the new treatment is cost-effective as the WTP threshold varies.

The expected value of perfect information (EVPI) gives the monetary value of further research to remove all uncertainty from the cost-effectiveness findings. If the EVPI is greater than the cost of further research, then further research may

**Table III.** Cost summary (£GBP) per participant.

| Variable | Bandage, mean cost (SE) | Rigid immobilization, mean cost (SE) | Difference (95% CI) |
|---|---|---|---|
| NHS services (0 to 3 wks) | 3.378 (0.168) | 12.461 (0.030) | -9.082 (-9.213 to -8.982) |
| Drug cost (1 to 7 days) | 2.985 (0.159) | 3.165 (0.165) | -0.179 (-0.627 to 0.267) |
| NHS services (4 to 6 wks) | 14.716 (2.914) | 17.085 (2.741) | -2.369 (-10.101 to 5.363) |
| Total cost, NHS and PSS | 21.131 (2.923) | 32.653 (2.722) | -11.522 (-19.558 to 3.486) |
| Total cost, non-NHS | 0.187 (0.042) | 0.262 (0.078) | -0.075 (-0.099 to 0.251) |
| Total societal cost* | 20.171 (2.787) | 33.619 (2.742) | -13.448 (-21.158 to -5.737) |

*Denominators vary between items, making them non-additive.
CI, confidence interval; PSS, Personal Social Services; SE, standard error.

**Table IV.** Utility score and quality-adjusted life-year estimates (1 = perfect health, 0 = death).

| Variable | Bandage (mean (SE)) | Rigid immobilization (mean (SE)) | Mean difference (95% CI) |
|---|---|---|---|
| **EQ-5D-Y** | | | |
| Baseline | 0.537 (0.016) | 0.557 (0.629) | -0.019 (-0.064 to 0.025) |
| 3 days | 0.563 (0.012) | 0.548 (0.013) | 0.015 (-0.021 to 0.052) |
| 7 days | 0.706 (0.011) | 0.695 (0.011) | 0.011 (-0.018 to 0.044) |
| 3 wks | 0.895 (0.007) | 0.885 (0.007) | 0.009 (-0.012 to 0.032) |
| 6 wks | 0.975 (0.004) | 0.972 (0.004) | 0.003 (-0.008 to 0.014) |
| QALY (AUC) | 0.095 (0.001) | 0.094 (0.001) | 0.001 (-0.001 to 0.002) |
| **EQ-5D-VAS** | | | |
| Baseline | 72.728 (1.024) | 73.288 (1.029) | -0.560 (-2.226 to 3.347) |
| 3 days | 76.969 (0.895) | 75.862 (0.916) | 1.107 (-3.559 to 1.345) |
| 7 days | 83.064 (0.901) | 83.540 (0.807) | -0.476 (-1.922 to 2.874) |
| 3 wks | 92.577 (0.589) | 90.699 (0.732) | 1.878 (-3.694 to -0.061) |
| 6 wks | 94.744 (0.629) | 96.129 (0.448) | -1.385 (-0.119 to 2.889) |

AUC, area under the curve; CI, confidence interval; EQ-5D, EuroQol five-dimension questionnaire; EQ-5D-Y, Youth version of EuroQol five-dimension questionnaire; QALY, quality-adjusted life-year; SE, standard error; VAS, visual analogue scale.

be a worthwhile investment and further value-of-information analysis is warranted.

To assess the robustness of findings, the robustness of the primary analysis was explored using a range of supportive subgroup (sensitivity) analyses. Planned subgroup analyses included: exploring the interaction of age group (four to seven years or eight to 15 years) with treatment; a complete case analysis, which uses the original trial data (without imputation and assuming data are 'missing completely at random'); and a broader societal perspective (including productivity losses and loss of earnings). We previously demonstrated the rapid healing and resolution of symptoms in torus fractures,[26] therefore it was anticipated that any difference between treatments in cost or quality of life would occur within the first six weeks and there would be no need for further modelling. All analyses were undertaken in Stata v. 16 (StataCorp, USA). Reporting follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement.[27]

**Missing data.** Imputation (the statistical process of replacing missing data with alternative plausible values) and estimation were conducted according to good practice guidance using the multiple imputation framework within Stata,[28] the technical detail of which is described as follows: multiple imputation provides unbiased estimates of treatment effects if data in the imputation model are missing at random (i.e. systematic causes of missingness are explained by included variables). This assumption was explored in the data using logistic regression of the missingness of costs and QALYs against baseline variables.[29] Imputation models used fully conditional multiple imputation by chained equations methods, which are appropriate when correlation occurs between variables. Each multiple imputation 'draw' provided a complete dataset, which probabilistically reflected the distributions and correlations between variables. The imputation process was partitioned to run independently for the two treatment groups. Predictive mean matching drawn from the five nearest neighbours (knn = 5) was used to enhance the plausibility and robustness of imputed values, as normality may not be assumed. Analysis of multiple draws was conducted with Stata's multiple imputation framework providing estimation adjusted for Rubin's rule.[30] For each draw within the imputation, missing costs and EQ-5D-Y scores were imputed for each period of follow-up; overall patient costs and QALYs were passive variables calculated for each draw. All imputed variables acted as predictive variables, supplemented by trial baseline variables if significant and plausible predictors of missingness. Multiple imputation estimation models were bootstrapped to provide non-parametric estimates of costs and QALYs. Initially, the imputation model employed ten draws reflecting the proportion of missing data. To minimize the information loss of finite imputation sampling, the fraction of missing information (FMI) was assessed, ensuring that the number of draws exceeded the FMI percentage.

## Results

**Completeness of data.** The amount of missing data was low and was similar in each treatment arm – 5% or less in both groups and in both health economic collection periods (zero to three and three to six weeks). The extent of missing data

**Table V.** Incremental cost-effectiveness analysis: bandage (new treatment) versus rigid immobilization (current treatment).

| Variable | Gain in cost with bandage use, £ (95% CI) | Gain in QALY with bandage use (95% CI) | ICER, £/QALY | Probability cost-effectiveness at WTP threshold | | |
|---|---|---|---|---|---|---|
| | | | | £15,000 | £20,000 | £30,000 |
| **Base case analysis** | | | | | | |
| NHS and PSS: imputed, covariate adjusted | -12.552 (-19.801 to -5.302) | 0.0013 (-0.0004 to 0.003) | -9,311 | 0.9845 | 0.9760 | 0.9655 |
| **Sensitivity analysis** | | | | | | |
| NHS and PSS perspective: complete case, covariate adjusted | -12.003 (-20.07 to 3.94) | 0.0012 (0.003 to -0.001) | -10,680 | 0.9625 | 0.9515 | 0.9320 |
| Societal perspective: imputed costs, covariate adjusted | -12.302 (-19.483 to -5.121) | 0.0012 (0.000 to 0.003) | -9,890 | 0.9800 | 0.9680 | 0.9555 |
| Subgroup analysis: 4 to 7 yrs (NHS and PSS perspective: imputed, covariate adjusted) | -17.00 (-34 to -3) | 0.0013 (-0.002 to 0.007) | -35,241 | 0.7695 | 0.7350 | 0.6985 |
| Subgroup analysis: 8 to 15 yrs (NHS and PSS perspective: imputed, covariate adjusted) | -11.00 (-18 to -3) | 0.0021 (0.004 to 0.000) | -6,442 | 0.9805 | 0.9730 | 0.9670 |

CI, confidence interval; ICER, incremental cost-effectiveness ratio; PSS, Personal and Social Services; QALY, quality-adjusted life-year; WTP, willingness-to-pay.

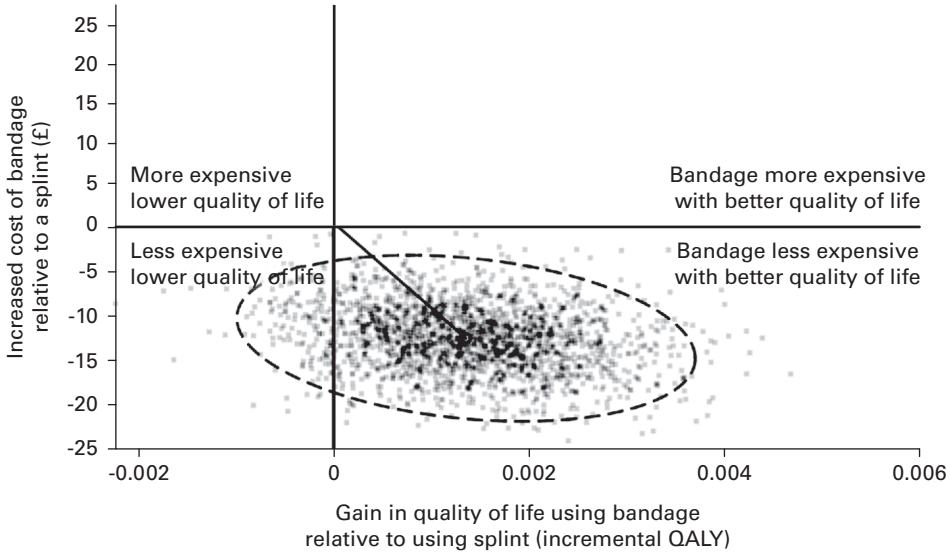


Fig. 1

The incremental cost-effectiveness ratio plane, which simultaneously considers cost and clinical effectiveness, illustrating the cost-effectiveness ratio mean and 95% credible region. QALY, quality-adjusted life-year.

in EQ-5D-Y scores was similar between groups, with complete data at all points available for 84% of patients (810/965) (Table I).

**Rigid immobilization.** The splints identified within the study were: Actimove Manus Wrist Brace (BSN Medical, Germany); Promedics Neoprene Wrist Thumb Splint (Promedics Orthopaedics, UK); Beagle Orthopaedic Paediatric D-ring Wrist Brace (Beagle Orthopaedic, UK); Promedics Wrist Brace; Promedics Standard Neobrace; Provectus Medical one size wrist brace (Nelson, UK); Deltaform Futuro splint (Promedics Orthopaedics); 3M soft cast (3M United Kingdom PLC, UK); BeneCare Universal Wrist Splint (BeneCare Direct, UK); and Neoprene wrist brace.

The application time for the splint was reported by clinicians to vary from 24 seconds to ten minutes (median two minutes), and time to explain the treatment to the child/parent from 30 seconds to ten minutes. The application time for the back slab was reported to vary from five to ten minutes, soft cast from four to ten minutes, hard cast ten minutes, and a split hard cast 15 minutes; the time to explain the treatment to the child/parent varied from two to 30 minutes. In the case of back slab, we assumed that patients had two bandage Plasters of Paris BP (either a 7.5 cm × 2.7 m roll or 5 cm × 2.7 m roll) and a synthetic undercast padding (either 5 cm × 2.7 m or 7.5 cm × 2.7 m). For full cast, we assumed that patients had two fibreglass casting tapes (either 7.5 cm × 3.6 m or 5 cm × 3.6 m) and a synthetic

undercast padding (either 5 cm × 2.7 m or 7.5 cm × 2.7 m). For the soft cast, we assumed that patients had a flexible casting tape (either 5 cm × 3.6 m or 7.5 cm × 3.6 m) and a synthetic undercast padding (either 5 cm × 2.7 m or 7.5 cm × 2.7 m). The unit consumable cost of the rigid immobilization was: Futura splint £6.05; Back-slab £1.50; Soft cast £4.97; and Full cast £5.82.

**Offer of bandage.** Participants randomized to receive the offer of a soft bandage were given either a K-band Urgo Type 1 conforming bandage in small or large, or Hospiform elastic conforming bandage, CE-Fix conforming bandage, URGO K-Lite, Molnylyke Tubigrip, or Hospicrepe 233 Type 2 Cotton crepe bandage. The application time for the soft bandage was reported by clinicians to vary from 30 seconds to ten minutes (median two minutes), and time to explain the treatment to the child/parent varied from 30 seconds to ten minutes. We based the cost of delivering the soft bandage treatment on the median delivery time of application (since the median is more robust against outliers) and the average cost per hour for each clinician delivering the treatment. The unit cost of the soft bandage was calculated as the median of the aforementioned types of soft bandage cost.[14] The total cost of soft bandage treatment to each participant was calculated by summing the mean administration and soft bandage costs. The unit consumable cost of a soft gauze bandage was £0.78.

**Other NHS resources.** Beyond differences in the frequency of orthopaedic outpatient clinic visits, there were no significant differences in resource use allocation between the treatment groups during the six weeks of follow-up (Table II). Consequently, the only significant cost item concerned clinic use (Table III). Use of medication was very low, with no significant cost differences, nor were there any significant differences in broader societal costs.

**Utility and quality-adjusted life-years.** Complete case data are reported in Table IV: consistent with clinical endpoints reported by the FORCE trial, there are no significant differences between treatment groups at any timepoint or in the unadjusted QALY estimates.

**Cost-effectiveness analysis.** Figure 1 shows the treatment cost and QALYs for the main analysis. Patients allocated to the offer of bandage experienced a small, although not statistically significant, increase in quality of life (0.0013 QALYs (95% CI -0.0004 to 0.003)) while incurring significantly lower costs (£-12.55 (95% CI -19.51 to -5.30)) (Table V). The probability of the offer of bandage being cost-effective was more than 95% at each of the willingness-to-pay thresholds of £15,000, £20,000, and £30,000 per QALY. The NMB associated with the offer of bandage was positive and increased with WTP. Sensitivity analyses supported the primary findings, with each sensitivity analysis demonstrating the offer of bandage to be the cost-effective strategy. In analysis by age group, the offer of bandage among participants aged four to seven years demonstrated more uncertain cost and quality-of-life gains than participants aged eight to 15 years, but the findings are qualitatively similar.

The expected value of perfect information per patient in the base case analysis was about £0.50 at a WTP threshold of £30,000/QALY. There are approximately 60,000 emergency attendances for torus fractures of the distal radius in children per year in the UK,[1,3] and assuming realistic time horizon for benefit of ten to 20 years, the population EVPI is approximately £280,000 to £460,000. This calculation assumes that future values are discounted at 3.5% per annum. Discounting is an adjustment for 'time preference' and all other things being equal, we would prefer benefits that occur sooner. However, given the costs involved, further research to reduce decision uncertainty is unlikely to be worthwhile.

## Discussion

The FORCE trial provided robust evidence of equivalence in reported pain at three days, and no difference in pain or functional recovery throughout the entire six-week follow-up period, when comparing torus fractures of the distal radius treated with the offer of a soft bandage to rigid immobilization. There were no safety concerns in either group, supporting the strategy of immediate discharge of children with this injury from the ED. This prospectively planned economic analysis provides complementary evidence that the offer of bandage is cost-effective with significant cost savings and minor improvements in quality of life, with a better than 95% probability of cost-effectiveness. The findings held true when analyzed in different ways to test their 'robustness'. Therefore, while the cost of the interventions is small, the frequency of the injury means that even small savings have relatively large cost savings across the healthcare system.

A key strength in this analysis was the level of data completeness. The level of missingness of cost and outcome data in the FORCE trial was low, enhancing the robustness of the findings and providing similarity between the imputed and complete case model estimates.

Recruiting to clinical trials in the context of emergencies is challenging, which is amplified when the patient group involves children. Prior to the study, there was concern whether clinicians and families would be prepared to participate. However, clinicians showed clear evidence of equipoise, with only 14 children not enrolled owing to clinician preference for treatment. Even so, families had a strong pre-existing preference for rigid immobilization, with 252 families declining to participate in the study for this reason. This preference continued after randomization, with seven patients immediately crossing over to rigid immobilization having first been randomized to the offer of bandage. Given the preference, and the inability to blind families to the treatment allocation, it is likely that there was some bias in the reporting of patient-reported outcomes. Such a bias is likely to amplify the magnitude of the treatment effect, to artificially improve outcomes in the splint group. This was potentially evident through the trial report of 'patient satisfaction', which was poorer on day 1 among participants randomized to the offer of bandage, despite a very small difference in pain well below the minimal clinically important difference.[13] This preference may also have biased the follow-up, leading to more frequent reattendance in the bandage group. Despite this potential bias, there was equivalence in the primary outcome, and all other clinical outcomes at every timepoint in the trial. We found that while there were slightly more emergency reattendances in the bandage group, reattendances occurred in both groups and the overall benefit in cost saving was clear.

While a selection bias could emerge through the initial patient preference in the trial, these numbers are small related to the size of the trial, and the demographic data of those declining to participate in the trial were broadly similar to those included within the trial. Any potential selection bias therefore appears unlikely to affect the external validity of the results.

In conclusion, the FORCE trial has demonstrated that when treating children with a torus fracture of the distal radius, offering a bandage and discharging the patient without any follow-up was the most cost-effective strategy, and clinically equivalent to treatment with rigid immobilization. A significant decrease in cost and small non-significant increase in quality of life combine to provide a positive NMB for the offer of a bandage and better than 95% probability of cost-effectiveness. This economic analysis therefore supports the main trial result, in recommending that torus fractures of the distal radius are treated with the offer of bandage and immediate discharge from the ED.

### Take home message

- The offer of bandage reduces costs of treatment in children with a torus fracture of the distal radius, when compared to rigid immobilization.
- Our findings support clinical results from the FORCE trial: equivalence in reported pain at three days through to six weeks, without safety issues.
- This study found that a strategy of soft bandage and immediate discharge from the Emergency Department is the most cost-effective treatment for children with this injury.

## Social media

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