

Abbreviations

AHSN	Academic Health Science Network
CI	Confidence interval
ISD	Information Services Division
IT	Information Technology
LOS	Length of stay
m	Million
NICE	National Institute for Health and Care Excellence
PSH	Patient Safety Huddles
RoI	Return on investment
YHEC	York Health Economics Consortium

Section 1: Return on investment

INTRODUCTION

The earlier sections of this evaluation have described patient safety huddles (PSHs) and considered their impact on reducing patient harm, ward-level patient safety climate/culture and their wider impact at trust level. This section estimates the return on investment (RoI) to the trusts from undertaking PSHs. It was conducted by York Health Economics Consortium (YHEC).

This work was undertaken in order to provide an independent, informed view on:

- The financial value of undertaking PSHs by systematically measuring the resources required and those saved as a result of their implementation;
- To inform future decision making by sharing the findings so others can generalise these to their own settings.

These aims are consistent with those set out in the Health Foundation's 'Guide to Evaluation'¹.

The primary audiences are:

- The Health Foundation as the main funder of the project, providing feedback on the stewardship of the financial resources received;
- Local implementation teams to show the financial consequences of the huddles;
- Trust managers to inform future decisions on the sustainability of the huddles.

The research questions addressed in this section are:

- What is the RoI from implementing PSHs to reduce falls?
- What is the RoI from implementing PSHs to reduce cardiac arrest calls emergency calls?

The RoI only considers costs and benefits associated with adopting PSHs on wards seeking to reduce the risk of falls and/or cardiac arrest calls. These harms were selected because:

- Falls - this is the most frequently selected harm across the wards.
- Cardiac arrest calls - a literature search identified there are no publications reporting clinical and cost effectiveness of interventions to reduce these. Such calls are often made as a patient approaches end of life, indicating an emergency has arisen at this critical juncture. Calls are thus indicative of unexpected harm arising which will often have adverse consequences for patients and family/carers.

The rate of change in other emergency calls made to summon an emergency team using a 2222 number² has also been measured and the RoI provided for the impact of PSHs on all

¹ Health Foundation. Evaluation: what to consider? London 2016.

calls. However it is important to note the huddles were aimed at reducing cardiac arrest calls only.

Financial consequences from other activities which are being addressed concurrently with huddles, for example to reduce risks from pressure ulcers, or hospital acquired infections (HAI) or to improve nutrition are not quantified as part of this analysis.

An interim evaluation was undertaken in September 2016 and the report shared with the Health Foundation. This was able to demonstrate that all the data required for this final RoI were being collected in an appropriate format. The final evaluation builds on this work.

METHODOLOGY

Return on investment formula

A summative evaluation methodology was used, with the comparator being baseline resources used and patient harms experienced prior to the introduction of PSHs. Some resource use data, for example, the composition and duration of huddles have been collected to inform the RoI. However, where possible RoI calculations have used routine data collected to inform the daily huddles, such as time since last harm.

The National Institute for Health and Care Excellence (NICE) has consulted on various approaches to estimate RoI and its recommended approach is adopted. This requires all key costs and consequences be estimated, with units of benefits expressed in monetary terms. A RoI is calculated by subtracting incremental costs from value of the incremental benefits and dividing the result by the incremental costs. This is expressed by the formula:

$$\frac{\text{Total incremental benefits minus total incremental costs}}{\text{Total incremental costs}}$$

For example, if an intervention has a one-year life, costs £10,000 and yields benefits of £25,000, the RoI is: $\frac{£25,000 - £10,000}{£10,000} = 1.5$ times

This is usually expressed as a percentage: 150%.

In this evaluation the incremental costs and benefits are expressed as a cost or benefit per ward per week. Where possible, accounting principles were adopted including:

- Using a fair value to measure inputs and outputs, adopting objective evidence where that exists;
- Expenses are matched with revenues across time periods;
- Estimates have adopted the conservatism principle to avoid overstating RoIs.

A recent literature review conducted for the Department for Business, Innovation and Skills estimated private sector rates of return to research and development investments of around

² 2222 is the internal hospital telephone number dialled to summon an emergency team, for example following a cardiac arrest in hospital.

30% (mean) or 20 to 25% (median)³. The social returns to the public sector were estimated to be slightly lower at 20%. These provide external benchmarks to compare the calculated Rols with.

Estimates of resource use and costs

The main resource required to implement PSH are the huddles themselves. Staff members, by grade, attend a huddle on each ward; their duration and frequency were observed by Kate Crosswaite, an Evaluation Team member. 2016/17 annual staff costs, including national insurance and superannuation, for each staff grade were provided by Claire Hewitt, Senior Finance Business Partner, Leeds Teaching Hospital NHS Trust and increased by 1.5% for pay rise and annual increments to 2017/18 prices. These were combined with information on whole time equivalent staff numbers for each grade to calculate the annual average cost of each grade and then expressed as a cost per minute. The resulting cost was applied to the staff attending each huddle.

Each ward was assumed to focus on three harms and thus the annual cost for each harm was the total cost of a huddle, divided by three. The evidence on three harms was informed by various snapshots of the harms that wards were addressing. At the most recent time point (August 2017), the mean recorded harms being addressed was 2.4 per ward. However, observation of the huddles noted some wards were addressing other unrecorded harms, particularly HAIs, whilst some of the early adopter wards had addressed different harms than their current focus. Hence the number was rounded up to three.

Conference calls between ward staff, Project Team members, other Evaluation Team members and YHEC, identified activities used in addition to the huddles to reduce each harm. Local costs for consumables used were provided by Ms Hewitt (Senior Finance Business Partner, Leeds Teaching Hospital NHS Trust), call participants and where necessary by assumption. All assumptions were tested by peer review (process for which is discussed later in this section).

Project costs were provided by Vicky Padgett, Project Manager, Improvement Academy. A total of £375,600 was included in the RoI calculation. This comprised the £510,000 funded by the Health Foundation less monies allocated for band 5 backfill (£97,500), cost of dissemination related events (£23,300) and cost of printing, IT plus other consumables (£13,600) which have been charged against the harms directly. Dr A Cracknell, Project Lead, judged the backfill monies would not be required to encourage take-up of huddles across other NHS sites; similarly dissemination costs would not be repeated should PSHs be implemented across other NHS sites. The costs of printing, IT and other consumables were added to costs at a ward level and thus removed from these costs to avoid a double count.

Number and value of reduced harms

³ Frontier Economics. Rates of return to investment in science and innovation. A Report Prepared for the Department for Business, Innovation and Skills (BIS). July 2014. Available at <https://www.gov.uk/.../bis-14-990-rates-of-return-to-investment-in-science-and-innovation>

The numbers of reduced harms attributable to PSHs were provided by Professor M Mohammed, University of Bradford, and lead evaluator. These were informed by data provided by statistical control run charts using data provided by each ward to staff at the Improvement Academy.

The financial value of each fall avoided was informed by a targeted literature search to identify the cost of hospital falls in the NHS. This identified a highly relevant report from NHS Improvement (July 2017) which had calculated this cost using a robust methodology.⁴

The value of a cardiac arrest call avoided was calculated from information on staffing required to attend each call, their grades and duration, plus information on the subsequent placement of patients in critical care settings. Local staff costs were then applied. The value of other emergency calls was assumed to be similar. The most common reason for these call is respiratory arrest and the same team attend these.

Peer review process and quality assurance

In August 2106, a draft of the Interim report containing values for each parameter and draft results was circulated to Operational Group members, the Evaluation Advisory Group, Ms C Hewitt and NHS staff members who had provided inputs to inform the assumptions on each harm. Comments were invited, particularly where the author's assumptions were used to determine costs or the value of benefits. In light of comments received, the draft report was revised to inform the Interim report. This was shared with the Health Foundation and comments were invited on its contents.

A further consultation with key members of the Operational Group was conducted in summer 2017 to identify changes in practice since the Interim report to inform the Final report. At each stage YHEC also undertook its own internal quality assurance processes, with independent checking of the model inputs, calculations and outputs, together with a detailed 'slow read' of the final draft of the Final report.

⁴ NHS Improvement. The incidence and costs of inpatient falls in hospitals. London. July 2017

Section 2: ROI FOR PSH TO REDUCE FALLS

The final evaluation includes costs for 54 wards which are focused on reducing harm from falls within their PSHs. These wards have a complete dataset relating to the huddles so no assumptions were needed. However, they are a subset of the 76 wards addressing falls as a harm (source excel workbook 'RoI HUSH Evaluation Data, worksheet 'Evaluation Wards'), with incomplete datasets being the cause of the reduction.

This section sets out the incremental cost of huddles, other activities accompanying these to reduce falls, the reduced rate of falls against the base line rate and their value. Incremental costs and benefits are combined to provide an RoI, with various sensitivity analyses conducted.

PARAMETERS

Resources and cost of PSHs

Observational data from each ward provided the number and mix of staff attending PSHs, their duration and frequency. Across the 54 wards, mean staff numbers attending a huddle were 10.8, with Table 1 providing an analysis by grade.

Table 1: Analysis of staff attending huddles

Grade	Number
Nurses	4.4
Clinical support workers	2.2
Doctors	1.2
Therapists	1.3
Pharmacists	0.1
Other (e.g. student nurse, clerk, domestics)	1.6
Total	10.8

Mean duration of a huddle was 9.3 minutes and frequency was 6.2 times per week.

Data on staff costs comprising salary, all additional pay related payments (e.g. overtime and shift allowances) plus national insurance and superannuation for each staff grade and the number of whole time equivalents, by grade, at Leeds Teaching Hospital NHS Trust, for the first quarter of 2016/17 were provided by Claire Hewitt, Senior Finance Business Partner at the Trust. These were converted to annual costs per grade and updated by 1.5% to 2017/18 prices. Trainees, students or apprentices were not costed.

The average working week for each grade was obtained from a [national dataset](#) providing unit cost data (Curtis and Burns, 2017).⁵ The cost for doctors was calculated for each grade,

⁵ Curtis L, Burns A. Unit Costs of Health and Social Care 2015. PSSRU. 2017. Available at <http://www.pssru.ac.uk/project-pages/unit-costs/2015/>

using the relevant salary and average working hours, with the total weighted by the number of whole time equivalents in each grade. These were used to estimate cost per minute of each grade. The staff costs per minute are shown in See Table 2.

Table 2: Staff costs per minute

Grade	
Nurses	£0.42
Clinical support workers	£0.24
Doctors	£1.11
Therapists	£0.45
Pharmacists	£0.45
Other (e.g. student nurse, clerk, domestics)	Various

The average cost per ward per week for PSH activity was estimated at £286.16, (calculated by totalling the minutes of staff time deployed across all wards and applying the cost per minute for those staff attending). Given wards focus on more than one harm, with almost all selecting three harms, this cost was divided by three to give the cost of a PSH at £95.39 attributable to reducing harms from falls.

Incremental cost of other activities to reduce falls

Five activities have been introduced into wards with the aim of reducing falls:

- Footwear;
- Post falls review;
- Visual display, documentation and IT;
- Rounding;
- Cohorting.

Footwear

Now, double tread slipper socks are provided for 60% of patients at a 20p premium price per pair (Source: Claire Hewitt, Senior Finance Business Partner) compared to previous practice. The average number of patients per week per ward receiving slipper socks was estimated at 30. This was calculated by multiplying the average number of beds in a ward of 24.3 by the number of days in a year to give the maximum occupancy in a year. This was multiplied by the average bed occupancy level of 95% to give the mean number of bed-days used a year. This was then divided by 52 to give weekly occupancy and by 5.38 days, being the mean length of stay per patient of, based on the England and Wales average.^{6,7} Additional weekly cost per ward was £3.60.

Post falls review

⁶ Department of Health. NHS Reference Costs 2015/16. November 2016. Available at <https://www.gov.uk/government/collections/nhs-reference-costs>

⁷ Calculation is $(24.3 \times 365 \times .95) / (5.38 \times 52)$

Following a fall, a post falls review is undertaken. These activities require 45 minutes from a nurse, with 75% of fallers being reviewed for 15 minutes by a physiotherapist, occupational therapist or pharmacist and all receiving a medical review of an average duration of 15 minutes. Some patients may be referred to community services such as a falls clinic as part of the discharge process but this aspect has not been included in the ward costs. The associated costs are £40.39 per fall.

The mean falls per week per ward before the introduction of PSHs was 0.905 (see Section 4.5.2 in the main report). The additional cost of the falls review was thus £36.56 per ward per week (£40.39*0.905). However, not all of these costs are incremental to the baseline costs as many wards were undertaking a structured fall review prior to the introduction of PSH. Hence sensitivity analyses are provided assuming a nil incremental cost and an increase of 50% (£18.28) from the cost base for this aspect.

Visual display, stickers, other documentation and IT costs per ward

Clinical staff advise that on the wards undertaking huddles, a nurse spends less than five minutes per week setting up a template for the visual display of results for each harm being addressed. This has an estimated weekly cost of £1.56 per harm (assuming four minutes).

A key aspect of huddles is providing documentation, including certificates of achievement, ward level reports, laminated charts to display progress etc. Vicky Padgett, Project Manager, advised the project's printing budget is about £9,000 over its three year life. Assuming an annual cost of one third of this i.e. £3,000 and that this meets the needs of 130 wards, each focusing on three harms, provides a weekly cost of £0.15 per ward per harm. Project management staff prepare the documentation themselves and these costs are part of the Project Management costs (see Project costs). Thus each ward was estimated to incur £0.15 per week for documentation related costs.

Stickers and/or magnets are used around patient headboards to identify those who require monitoring for reasons such as poor mobility. Ten percent of patients are assumed to require two each at a unit cost of £0.005. This is the cost of a sticker. Magnetic labels cost more, possibly up to £1 per magnet but are re-usable, hence the same unit cost has been applied. Assuming the same length of stay and ward occupancy as adopted for the footwear calculation, this gives a weekly cost per ward of £0.03.

Minimal additional IT costs have been incurred because data on each harm were already collected at ward level. The main additional cost has been incurred in exporting data from the trusts to the Improvement Academy. The analyst (M Rooney) advised of the initial set-up time and time per week per grade at each site to generate the falls data. These costs equate to a weekly cost of £0.10 per ward seeking to reduce the harm from falls (assuming 130 wards and three harms per ward).

Rounding

Intentional rounding is a structured process whereby, typically, nurses, with the support of healthcare assistants, carry out regular checks of individual patients at set intervals, often hourly. During these checks, they carry out scheduled or required tasks such as addressing

patients' pain, positioning and toilet needs, plus checking the environment for any risks to the patient's comfort or safety. A recent report from King's College London found there was little evidence about the impact of rounding on staff time. The report suggested that time taken to carry out rounds is offset by time savings from improved patient management⁸. This assumption of no net increase in ward staff for rounding is used in this report.

Other related projects

Some wards are also participating in a pilot, which is subject to a separate evaluation, to cohort patients. This requires ward staff to identify patients at the highest risk of falling e.g. elderly, confused patients and place them together in one high risk bay where they are monitored.

Leeds Teaching Hospital recently introduced a standardised risk assessment process to identify potential fallers and others at high risk of harm. Where a patient at high risk is identified, ward staff use a decision support tool to identify the appropriate action. This initiative was informed by a pilot exercise which used a qualitative evaluation methodology; no measure of the falls avoided attributable to this project or its costs are available.

These projects are separate from the introduction of PSHs.

Project costs

A total of £375,593 was included in the RoI calculation for project costs, with analysis provided in Table 3. These elements were judged as likely to be incurred across other hospitals seeking to implement PSH, with fidelity, at scale.

Table 3: Analysis of project costs 2015 to 2017

Activity	Cost
Clinical Lead, Project director, Project manager and admin	£224,854
Technical skills (e.g. run charts, organisational development, quality improvement skills)	£42,215
Project evaluation	£108,524
Total	£375,593

These were assumed to give benefit over a five year period, and divided across 130 wards, each focusing on three harms, to give a weekly cost per harm per ward of £3.70. The actual number of wards participating according to the Organisational Plan is 136, but this has been rounded down slightly as a few have had little active engagement.

Total incremental cost of activities accompanying PSH

The total incremental cost per ward per week is estimated at £45.70 of which £42.00 relates to the activities introduced to prevent initial or further falls and the balance (£3.70) is for

⁸ King's College London. Intentional Rounding: What is the evidence? Policy plus. Issue 35 April 2012.

project implementation costs (see Table 4). Of the activities costs excluding project costs (£42.00), staff costs account for £38.12 (91%) of the total.

Table 4: Weekly cost per ward focusing on falls

Activity	Weekly cost per ward
Footwear	£3.60
Falls review	£36.56
Visual display, documentation and IT	£1.84
Project costs	£3.70
Total	£45.70

Change in frequency of inpatient falls per ward per week.

Clinical benefit of PSHs were measured using monthly data provided by the wards focusing on falls. Two approaches were adopted. The first measured the rate of change in the number of falls from baseline to date when PSHs were embedded; the second compared the rate of change from baseline to the date of the first huddle. Statistical modelling established that under the first measure there was a reduction in the number of falls per ward from 0.894 (95%CI 0.743 to 1.044) per week per ward before PSHs were embedded to 0.773 (95%CI 0.640 to 0.906) after PSHs were embedded. This is a reduction of 0.121 falls per week (or 1.21 in 10 weeks).

Under the second measure there was a reduction in the number of falls per ward from 0.9 (95%CI 0.747 to 1.053) per week per ward at baseline to 0.796 (95%CI 0.662 to 0.929) after PSHs were introduced. This is a reduction of 0.104 falls per week. The mean reduction was 0.1125 falls per week.

Cost of falls avoided

A literature review conducted to inform this final analysis identified a cost per inpatient fall of £2,600 (NHS Improvement, July 2017)⁹. This value was estimated by using data by age group (up to and including 65 years and over 65 years) and reported severity of harm. The classifications used and the percentage of patients in each are compared to local data used in the Interim evaluation in Table 5. The local data reported 5% more falls resulted in no harms with a similar reduction in low harms. This could be due to slightly different definitions being applied. However, the overall data are sufficiently similar, that for the RoI, a mean cost of £2,600 per fall will be used. This cost does not include social care costs for those experiencing severe harm and likely to be discharged to a nursing home facility and thus omit this material cost for albeit a small sub-group.

Table 5: Inpatient fall severity national versus local data

Classification	NHS Improvement	Leeds and Bradford weighted average
No harm	71.9%	76.9%
Low harm	25.5%	20.7%
Moderate harm	2.0%	1.7%

⁹ NHS Improvement. The incidence and costs of inpatient falls in hospitals. London. July 2017.

Severe harm	0.5%	0.3%
Death	0.1%	0.4%

Sensitivity analyses were provided by NHS Improvement assuming length of stay was overestimated by 50% and 25%. Not all the costs were related to length of stay and hence this assumption reduced the cost of falls by rather less than the 50% and 25% assumed for length of stay reductions. The figures provided by NHS Improvement were the cost of falls reduced from £2,600 per fall by 44% to £1,456 and by 22% to £2,028 respectively.

Applying the mean reduction of 0.1125 falls per week per ward suggests, on average, wards are reducing costs to manage patients who fall by about £292 per week (0.1125*£2,600), (sensitivity analyses range of £164 to £228 per week, with a cost per fall of £1,456 and £2,028 respectively). These are the savings to offset against costs.

Costs and savings assumed in sensitivity analysis

Cost analyses estimated total costs of £141.08 per ward focusing on falls per week, comprising:

- Mean cost of huddles £95.39 (67%)
- Cost of activities to support huddles £42.00 (30%)
- Project costs £3.70 (3%)

The cost base relevant to the RoI calculation is that which captures the incremental costs associated with PSHs and related activities to reduce falls, that is the additional cost to wards following implementation of the PSH and related activities. The comparator is the costs before the intervention. Given some wards were already doing falls reviews, sensitivity analyses are provided assuming a nil increase in costs for this component (total costs £104.52) and a 50% increase in the cost of the effort now devoted to the review compared to baseline (total cost £122.80).

There is also an argument to support excluding the cost of the huddles and the front-line staff element of the activities supporting huddles. The rationale is that no additional ward time is required for the huddle, rather this activity displaces other, more dis-jointed, activities and hence is more efficient than previous working practices. This is consistent with the qualitative feedback which suggests huddles are not seen by ward staff to add to workload but rather are an effective use of time. Thus one costing option excludes all front-line staff costs. The incremental cost of this case is £7.58, comprising:

- Non-staff cost of activities to support huddles £3.87
- Plus project costs £3.70

In total, six cost options for incremental costs were used being:

- a) No staff costs of activities or huddles plus project costs £7.58;
 - b) Activities plus project costs but no huddle costs £45.70;
 - c) Cost of activities less fall review costs plus project and huddles £104.52;
 - d) Cost of activities less 50% of review costs plus project and huddles £122.80;
 - e) Cost of activities including reviews plus project and huddles £141.08;
 - f) Cost of activities including reviews plus project and huddles plus 20% costs £169.30.
-

Three estimated weekly savings from reduced falls per ward of £292.50 (base case), £228.15 (25% reduced length of stay) and £163.80 (50% reduced length of stay) will be applied to each cost.

The results using the mean number of falls avoided (0.1125 per week) informed the base case, with sensitivity analysis using the rates measured by the two different approaches. These were a reduction of 0.121 when measured to date huddles were embedded and 0.104 when the date of the first huddle was used.

Results

Applying the RoI formula:
$$\frac{\text{Total incremental benefits minus total incremental costs}}{\text{Total incremental costs}}$$

to each potential cost and savings option gives results as shown in Table 6.

Table 6: RoI for cost options and value of falls scenarios per ward focusing on falls; assumes 0.1125 falls avoided per week.

Cost option per week	RoI		
	Central cost per fall £2,600	25% reduction in LoS £2,028	50% reduction in LoS £1,456
A) £7.58	3,560%	2,911%	2,062%
B) £45.70	540%	399%	258%
C) £104.52	180%	118%	57%
D) £122.80	138%	86%	33%
E) £141.08	107%	62%	16%
F) £169.30	73%	35%	-3%

If one accepts the cost of falls calculated by NHS Improvement (£2,600 per inpatient fall) then the return on investment ranges from over 70% with the highest estimated cost per week (£169.30) to over 3,500% if only the non-staff costs plus project costs (£7.58 per week) are included in the cost base. The latter assumes no additional staff time is required to support huddles but rather huddles displace time spent on existing, but less effective activities, and communications.

All the options show returns well above the private sector norm of 30%¹⁰ except when one assumes:

- A 50% lower length of stay for an inpatient fall from that measured by the NHS Improvement and the incremental costs exceed £123 per week. Such a cost is only generated if one assumes all staff functions are undertaken by new staff rather than displacing existing activities and if 50% of wards currently undertake no falls reviews.

¹⁰ Frontier Economics. Rates of return to investment in science and innovation. A Report Prepared for the Department for Business, Innovation and Skills (BIS). July 2014. Available at <https://www.gov.uk/.../bis-14-990-rates-of-return-to-investment-in-science-and-innovation>

- A 25% lower length of stay for an inpatient fall from that measured by the NHS Improvement and that costs are 20% higher than the cost of the PSH intervention assuming all staff functions are undertaken by new staff rather than displacing existing activities.

Applying the lower estimate of falls avoided per week of 0.104 (calculated by comparing base line to date of first huddle), reduced the associated saving to £270.40 per ward per week. Assuming costs for the non-staff element of the intervention only (£7.58) gave an RoI of over 3,400%, falling to 92% when the total cost including huddles of £141.08 is used.

Applying the higher estimate of falls avoided per week of 0.121 (calculated by comparing base line to date huddles were embedded), increased the associated saving to £314.60 per ward per week. Assuming costs for the non-staff element of the intervention only (£7.58) gave an RoI of over 4,000%, falling to 123% when the total cost including huddles of £141.08 is used.

Sensitivity analyses show the RoI is most sensitive to changes in the value of the savings per fall; changes in cost for the intervention also have an impact but variances from the change in falls from the mean values used in the base case have little impact..

Uncertainty and Limitations

The two key uncertainties in this analysis are:

- Whether the introduction of PSH has increased workload on wards. There is no evidence that it has in wards which were adequately staffed when the PSH was implemented or subsequently. This will continue to be monitored.
- Whether the national cost per inpatient fall generalises to these settings. The analysis of falls severity gives no reason to suggest it does not apply.

Limitations of the work include failure to measure and value the improved quality of life for patients who may avoid a fall, including avoidance of anxiety associated with fear of falling. Other benefits not quantified include those stemming from factors such as improving team work, communication and staff morale.

Benefit from avoided falls may be understated because the savings per fall avoided excluded all social care costs incurred when a patient who has fallen returns home or possibly to a non-NHS care setting. For the relatively few patients experiencing severe falls these costs may be high.

The recent introduction of an enhanced care pathway in adult wards at Leeds Teaching Hospital may be a confounder as one of its objectives is to reduce the risk of falls. However, its impact on the observed reduction in rate of falls is judged to be marginal because it was so recently embedded.

The main strength of the work is parameter values were informed by results from implementing the intervention across 54 wards. The project has been supported by good data analyses support, giving confidence in reported outcomes. A second strength is the use of local staff cost data which reflects the mix of grades in post across the Leeds Trust and

the local element of premia payments. Thirdly uncertainty on the cost of falls has been reduced with the publication of these costs by NHS Improvement.

The main cost driver is the decision on whether or not to include staff costs. There is a strong case to exclude all staff related costs. This is because huddles seem to be displacing other fragmented and unstructured activities and replacing these by more effective and efficient communication. Indeed some observations suggest huddles are being used as handovers rather than additional to these. On this basis, PSHs addressing falls are likely to generate a highly positive rate of return.

Overall, if the number of inpatient falls avoided with huddles are about one every 10 weeks, and adopting the national published cost per inpatient fall avoided of £2,600 suggests wards can incur expenditure of up to £225 a week and still achieve an RoI of 30%. This is much higher than the costs associated with introducing huddles, making these a cost-effective intervention to address this harm

Section 3: ROI FOR PSH TO REDUCE CARDIAC ARREST CALLS

The final evaluation includes costs for 32 wards which are focused on reducing cardiac arrest calls within their PSHs. These wards have a complete dataset relating to the huddles so no assumptions were needed. However, they are a subset of the 42 wards addressing this harm (source excel workbook 'RoI HUSH Evaluation Data, worksheet 'Evaluation Wards'), with incomplete datasets being the cause of the reduction.

This section sets out the incremental cost of huddles, other activities accompanying these to reduce cardiac arrest calls, the reduced rate of calls against the base line rate and their value. Incremental costs and benefits are combined to provide an RoI, with various sensitivity analyses conducted.

This intervention relates to improving patient management such that avoidable deterioration is managed before it becomes critical. This avoids the trauma of cardio-pulmonary resuscitation and the need to call the internal telephone number '2222' to summon the emergency team. Not all '2222' calls are for a cardiac arrest, with respiratory arrest also being a common cause. The RoI measures the impact of the intervention on cardiac arrest calls only and on all '2222' calls. The latter is included for completeness. The intervention was not designed to reduce all 2222 calls; only those for cardiac arrest.

PARAMETERS

Resources and cost of PSHs.

Observational data from each ward informed the number and mix of staff attending PSHs, their duration and frequency. Across the 32 wards, mean staff numbers attending a huddle were 11.6; Table 7 provides an analysis by grade.

Table 7: Analysis of staff attending huddles

Grade	Number
Nurses	4.2
Clinical support workers	2.3
Doctors	1.6
Therapists	1.7
Pharmacists	0.2
Other (e.g. student nurse, clerk, domestics)	1.6
Total	11.6

Mean duration of a huddle was 9.1 minutes and frequency 6.7 times per week. These values are similar to wards focusing on falls, with the main difference being on average 7% more staff attend and a slightly higher proportion of wards operate huddles 7 days a week.

The same approach to estimating cost of huddles was applied as for falls reduction, giving a mean cost per ward per week of £280.68, equivalent to a cost per harm of £93.56. This is slightly lower than the cost of the huddles on wards focusing on fall (£95.39) due to their slightly shorter duration

Cost of other activities to reduce cardiac arrest calls

The activities supporting deteriorating patients and hence avoiding cardiac arrest calls are:

- Education and support;
- Visual display, documentation and IT.

Education and support

A band 6/7 nurse from Critical Care Outreach provides one hour per week of support across wards with this focus each week. Applying local salary rates gives a weekly cost per ward of £0.91.

Visual display, stickers and other documentation and IT costs

Weekly costs for visual display (£1.56), documentation (£0.15) and IT (£0.10) are the same across wards focusing on deteriorating patients and falls. Those addressing deteriorating patients are assumed to use two stickers per day per ward (Personal communication Dr Ali Cracknell) giving a weekly cost of £0.07. Hence the total cost for these activities is £1.87.

The total cost of all activities related to huddles is therefore £2.78 per ward per week. In addition the same weekly project costs per ward of £3.70 were applied (see falls section above for derivation of this figure).

Total cost of PSH and other activities

Table 8 summarises the weekly cost per ward focusing on reducing cardiac arrest calls of £100.04. Huddles comprise 93% of the costs, with other activities adding 3%, and 4% accounted for by project-related costs.

Table 8: Weekly cost per ward focusing on reducing cardiac arrest calls

Activity	Weekly cost per ward	%
PSH	£93.56	93
Other activities	£2.78	3
Project cost	£3.70	4
Total	£100.04	100

Change in frequency of cardiac arrest calls and all 2222 calls per ward per week

Clinical benefit of PSHs were measured using monthly data provided by the wards focusing on cardiac arrest calls. Two approaches were adopted. The first measured the rate of change in the number of such calls from baseline to date when PSHs were embedded; the second compared the rate of change from baseline to the date of the first huddle. Statistical modelling established that, under the first measure, there was a reduction in the number of cardiac calls per ward from 0.084 (95%CI 0.048 to 0.119) per week per ward before PSHs were embedded to 0.061 (95%CI 0.0.043 to 0.079) after PSHs were embedded, a reduction of 0.023 cardiac calls per week. Using the same measure there was an increase in all 2222 calls per week of 0.029 from 0.167 to 0.196 calls per week.

Under the second measure, there was a reduction in the number of cardiac calls per ward from 0.081 (95%CI 0.048 to 0.114) per week per ward at baseline to 0.064 (95%CI 0.044 to 0.181) after PSHs were introduced, a reduction of 0.017 cardiac calls per week. The increase in total calls was 0.039 from 0.161 to 0.200 call per week.

The mean reduction was in 0.01975 cardiac calls per week and increase of 0.034 total calls per week.

The frequency of non-cardiac arrest calls has increased and now form 68% of all calls, an increase from 50% before the introduction of PSH. These calls include calls for other medical emergencies where an urgent response is required but the patient has not suffered a cardiac arrest, e.g. respiratory arrests¹¹ and false alarms.

Table 9: Changes in cardiac arrest and 2222 calls per ward per week

Calls	Change baseline to PSH embedded			Change baseline to first PSH		
	Baseline	PSH Embedded	Reduction/ increase	Baseline	First PSH	Reduction/ increase
Cardiac arrest	0.084	0.061	0.023	0.081	0.064	0.017
Other 2222	0.083	0.135	-0.052	0.08	0.136	-0.056
Total 2222	0.167	0.196	-0.029	0.161	0.200	-0.039

The reason for the increase in other calls is under investigation. Of note, across the Leeds hospitals, all 2222 calls have increased by about 10% this year. For the purposes of this evaluation it is assumed that the number of medical emergencies has increased, that is fewer patients are experiencing a cardiac arrest, where the heart stops beating, but more have a respiratory arrest or near arrest. It is not known if the introduction of initiatives to reduce cardiac arrests has impacted on calls for respiratory failure. For example, ward staff may call the crash team slightly earlier in the pathway before deterioration is so severe that the patient is in cardiac arrest. Alternatively, the change may be due to factors independent of PSHs.

¹¹ In both respiratory arrest and cardiac arrest, the patient will be unconscious and not breathing. However, respiratory arrest patients still have a beating heart. Without treatment, respiratory arrest always leads to cardiac arrest. Sometimes, however, it can take several minutes.

Value of cardiac arrest and other 2222 calls avoided

Benefits from improving the management of deteriorating patients accrue primarily to the patient and their family members. The financial benefits to the NHS are ancillary to the improved quality of the death. No value can be put on this. This section only values the NHS-related savings which include:

- Less disruption to ward staff during and immediately after a 2222 call;
- The emergency team is not required and can continue with normal duties;
- The avoided deterioration reduces patient transfers from these wards to critical care settings.

Ward related savings from avoided 2222 call

Clinical staff advise that when a 2222 call occurs, all ward staff are involved in the event. The huddles work reported that on average 11.6 staff attend a huddle. This has been increased to 15 staff involved with a 2222 call, as not all staff attend huddles, but all ward staff are reported to be involved in the 2222 event. The composition was assumed to be essentially the same as those attending huddles with the addition of three doctors.

Five percent of calls were assumed to be false alarms (Personal communication Dr Ali Cracknell) with the associated disruption taking five minutes. Ward staff are assumed to be involved for 25 minutes for true calls. This assumption is based on the crash team being on a ward at an arrest for an average of 15 minutes, with a range of five to 60 minutes (Personal communication Dr Ali Cracknell) plus time before arrival of the team, immediately after and later with the family. Applying the local staff costs to these measures gave an estimated cost per 2222 call of £195.

External team savings from avoided 2222 call

The emergency team's composition was agreed to comprise of six staff being:

- Anaesthetist 1
- Registrars 2
- Foundation Programme doctors 2
- Band 7 Resuscitation officer 1

False alarm calls were assumed to require five minutes, rising to 25 minutes for true 2222 calls. Applying the local staff costs to these measures gave an estimated cost per 2222 call of £99.

Other costs associated with 2222 calls

In addition to staff time, an average 2222 call is estimated to use £85 of consumables. This comprises cost of the medicines used on the call, primarily adrenaline, plus replacing medicines on each crash trolley when time expired (Personal communication Liz Mellor Leeds Teaching Hospitals NHS) plus cost of gel, pads, blood and other tubes, cannula,

syringe and a set of basic bloods and arterial blood gas analysis (Personal communication Dr Ali Cracknell).

Critical care costs for a cardiac arrest

Reviewing data on cardiac arrests identified that in the year to date, of all the cardiac arrests that occurred on inpatient wards (excluding critical care and catheterisation laboratory), 18% went to an intensive care unit (ICU) for an average length of stay of 130 hours; 1.5% went to coronary care (CCU), with an average length of stay of 72.5 hours and 1.5% went directly to a high dependency unit (HDU) directly, with a further 1% going to HDU after ICU (length of stay 130 hours) [2.5% in total]. The other 79% of patients either died or remained on the same ward.

No NHS England unit costs are available for these different types of wards, so Scottish costs¹² per day were adopted being:

- ICU £2,109
- CCU £944
- HDU £902.

These costs were for 2015/16 and increased by 1.5% a year to 2017 prices. The resulting cost per arrest are £2,288. The savings per cardiac arrest call avoided are shown in Table 10.

Table 10: Cost of a cardiac arrest call avoided

Activity	Cost
Ward team	£195
Emergency team	£99
Consumables	£85
Total cost excluding critical care	£379
Average cost of critical care bed for 21%	£2,288
Ward staff	£195
Emergency team	£99
Consumables	£85
Total cost including critical care for 21%	£2,667

This is potentially an underestimate of the savings. Having an urgent response team on hand before an arrest may increase the number of patients surviving. The NHS and social care services are likely to incur additional costs to manage these patients.

¹² R040: Specialty Group Costs - Inpatients In All Specialties (Exc Long Stay). Available at: <http://www.isdscotland.org/Health-Topics/Finance/Costs/Detailed-Tables/Speciality-Costs/Acute-Medical.asp>

The savings, assuming £2,667 per call avoided, associated with the observed reduction of 0.01975 cardiac arrest calls per ward per week are £52.67.

If one assumes the cost of managing other medical emergencies are similar to those for a cardiac arrest then the weekly cost increase associated with the rise of 0.034 calls a week in total 2222 calls is £90.68.

A sensitivity analysis assumes the savings increase and decrease by an arbitrary 20%. Thus for the cardiac calls only, savings range from £43.89 to £63.21 per ward per week and for the all calls analyses, costs range from £75.57 to £108.81 per ward per week.

Results

The estimated incremental costs per ward per week focusing on reducing cardiac calls are £100 including huddles, which account for 93% (£93.56) of the cost (see Table 8). In addition to the base case results, costs and savings are changed by 20% to test the sensitivity of the results to these variables. The 20% is arbitrary as we have no known ranges to adopt.

Applying the RoI formula:
$$\frac{\sum \text{Total discounted benefits minus total discounted costs}}{\sum \text{Total discounted costs}}$$

to each potential cost base and for the reduction in cardiac calls gives the results shown in Table 11.

No RoI is presented for the change in 2222 calls. The increase in such calls results in an increase in costs and hence there is no financial saving to use as a benefit: the PSH intervention is always cost incurring. RoI is not applicable in such circumstances.

Table 11: Base case and sensitivity analyses of RoI for cardiac calls

Cost option	Cost per ward per week	Base case savings per week		
		£52.67	£43.89	£63.21
Activities + project	£6.48	712%	577%	875%
Activities + project + PSH	£100.04	-47%	-56%	-37%
20% lower activities + project + PSH	£83.37	-37%	-47%	-24%
20% higher activities + project + PSH	£120.05	-56%	-63%	-47%

Assuming savings from the avoided cardiac arrest 2222 calls only, the huddles show an excellent RoI ranging from 577% to 875%, with a base case of over 700% when the incremental costs of activities to support huddles and project costs are used. If one includes the cost of the time for staff to attend huddles then the returns are always negative. The savings from cardiac events avoided are lower than the cost of the activities needed to implement the huddle, project costs and staff cost of the huddle per ward per week.

If one assumes PSHs have had no impact on non-cardiac calls (that is the reason for the increase in non-cardiac calls is external to this intervention) then if the cost of activities per

ward per week related to reducing cardiac calls are £40, the RoI is 32%. This is similar to RoI rates recorded in the private sector.

These analyses adopted a mean reduction in cardiac calls of 0.01975 per week, with the individual changes from the two approaches to measure benefit being 0.0168 and 0.0227. Using the lower saving of 0.0168 cardiac calls per week and activities plus project costs only, reduced the RoI to about 600%, falling to -55% when the cost of huddles was also included. Using the higher saving of 0.0227 cardiac calls per week and activities plus project costs only, increased the RoI to about 830%, falling to -39% when the cost of huddles was also included.

The key uncertainty in this analysis is what is driving the change in non-cardiac calls and whether this factor is interacting with PSH.

LIMITATIONS AND CONCLUSION

Limitations of the work include failure to measure and value the key benefit of enhancing the quality of the end of life experience for patients and families. Managing that stage in an ordered way, avoiding the trauma of cardiac arrest and cardio-pulmonary resuscitation, is at the heart of the rationale to reduce avoidable deterioration. Hence while total deaths may not change, the patient experience is materially enhanced. Other related benefits include the avoidance of complaints; complaints relating to unexpected or bad end of life experiences are not uncommon and are expensive to investigate, requiring a lot of senior management time and can impact adversely on staff morale.

Other benefits which cannot be quantified include those stemming from factors such as improving team work, communication and staff morale.

The main strength of the work is that parameter values are informed by results from implementing PSHs across 32 wards. The project has been supported by good data analyses support, giving confidence in reported outcomes. We have also used local staff costs and grade mix and local costs for supplies where possible.

The main uncertainty is the factors influencing non-cardiac calls and how these have been moderated by PSHs. Similar arguments to those put forward for falls on whether to include the cost of huddles also apply, with the staff responses, suggesting huddles are an efficient way to improve communications and do not increase the staff time required to manage patients safely.

In conclusion, PSH to reduce the harm associated with cardiac arrest calls have an acceptable return of around 30% if the incremental cost of the activities supporting huddles and of the huddles themselves is about £40 per week compared to before huddles were introduced. If incremental costs are less than £40 per ward per week then the RoI will exceed 30%, rising to over 700% when the incremental costs are restricted to the cost of activities to support huddles plus a share of project costs (about £6.60 per ward per week). Higher costs reduce the RoI until financial break-even is reached (being a 0% RoI) with incremental costs of £52 per ward per week.
