NICE National Institute for Health and Care Excellence

HIGHLY CONFIDENTIAL

HealthTech Programme

Medical Technologies Advisory Committee (MTAC)

GID-HTE10050 Bed frames for adults in acute settings: Late-Stage Assessment (LSA) – 2nd meeting

Thursday 20 March 2025

Technical analyst:	Sophie Harrison
Technical adviser:	Frances Nixon
Committee lead:	Avril McCarthy
Specialist Committee member lead:	Evelyn Otunbade Ria Betteridge
EAG leads:	Robert Malcolm (YHEC) Mary Chappell (YHEC)
Link to SCM list for this topic	specialist-committee-members-2.pdf

The following documents are made available to the Committee:

1. Cover sheet
2. Addendum to User Preference Report [NoACIC] – March 2025
3. Addendum to External Assessment report [NoACIC] – March 2025

NICE National Institute for Health and Care Excellence

Late-stage assessment

GID-HTE10050 Bed frames for adults in acute settings

User preference report addendum

Produced by: **NICE**

Authors: **Sophie Harrison**, Analyst, NICE

Frances Nixon, Adviser, NICE

Date completed: March 2025

Contains confidential information: No

Number of attached appendices: 4

This user preference report addendum summarises additional user preference information gathered following the first committee meeting and sets out points for discussion in the committee meeting. This addendum summarises user preferences from a sample of 4 porters, a key user group whose preferences were not captured in the original user preference assessment. This addendum also reports the results of 2 additional user preference tasks that were completed by 7 users with experience in clinical roles. These tasks were a ranking exercise and a weighting exercise, focused on the 8 features that had some evidence identified in the external assessment group's literature review. The purpose of these tasks was to provide a deeper understanding of user preferences for the 8 features that had some evidence identified, by indicating which features may be most and least important, and their importance relative to the other features. This addendum should be read together with the user preference report.

1. Porter user preferences

In the initial user preference survey that was circulated, porter opinions were sought, however no responses were received from this user group. A shorter version of the original survey was shared, specifically targeting porters. Contacts from 20 portering departments were shared with NICE by specialist committee members and other experts. Each contact was sent a request by NICE, containing all the relevant information for survey completion. In this survey, porters were asked to rate the importance of several innovative bed frame features that can potentially reduce musculoskeletal injuries when they are carrying out their tasks. Users were asked to use the following scoring scale when considering feature importance/desirability:

- 1 – not at all important
- 2 – not very important
- 3 – neither important or unimportant
- 4 – quite important
- 5 – very important.

Results

A total of 4 responses were received, representing users from 2 Trusts (1 response from Trust 1, and 3 responses from Trust 2). The breakdown of the porter survey results is shown in Table 1. Of the features rated by porters in the survey, those that have related evidence identified by the external assessment group are:

- Wheel systems to reduce the force required to move the bed and to facilitate transport (such as double castors or a fifth wheel to aid steering). All porters rated this as “very important”.
- Ergonomic brake system that is easy to operate with the foot. Three porters rated this feature as “very important”, and 1 porter rated it as “quite important”.
- Electric power-assisted steering. Three porters rated this feature as being “neither important nor unimportant”, and 1 porter rated it as “very important”

Table 1: Results of the porter survey.

Feature	Porter 1	Porter 2	Porter 3	Porter 4	Average
Wheel systems to reduce the force required to move the bed and to facilitate transport (such as double castors or a fifth wheel to aid steering)	5	5	5	5	5
Ergonomic brake system that is easy to operate with the foot	5	5	5	4	4.75
Headboard and footboard design (for example, they are lightweight and easy to remove)	5	5	5	2	4.25
Electric power-assisted steering	3	5	3	3	3.5
Gyro movement technology	3	5	3	1	3

A free-text question was included asking whether there are any other features that were not included in the first question that porters would consider to be very important (with a score of 5) in their role. Some responses to this question were related to features that were found to have relevant evidence:

- Low beds for patients that could possibly fall
- The steer mechanism.

The other features that were mentioned as being very important to porters were x-ray trays and oxygen cylinder holders.

2. Ranking and weighting of bed frame features

In the original user preference assessment report, user and patient surveys captured preferences on a large number of features that were identified at the user preference workshop. Only a small number of the innovative features identified at the user preference workshop have evidence (reporting the impact on incidents, or reporting technical outcomes) that was identified in the external assessment report (EAR):

- Bed frame designs for preventing patient migration (to reduce the risk of pressure ulcer formation. For example, back rest designed to translate backwards when using a profiling bed to prevent patient sliding down bed)
- Mechanism to enable bed to be adjusted to a low height (to reduce the occurrence of patient falls)
- Brake location (for minimising the risk of caregiver musculoskeletal injuries when operating the brakes)
- Turn-assist (to reduce the risk of caregiver musculoskeletal injuries sustained during the manual task of turning patients)
- Steering assistance (to reduce the risk of caregiver musculoskeletal injuries from steering the bed, such as a fifth wheel or double bogey caster configuration)
- Bed exit alarms

- Power-drive (motorised bed to reduce the risk of caregiver musculoskeletal injuries sustained during patient transportation)
- Inbuilt weighing scales

The 8 features with evidence may be able to impact 3 key incidents: patient falls, caregiver musculoskeletal injuries and pressure ulcer formation. Most of the evidence that was identified reported technical outcomes, demonstrating proof of concept. Evidence showing a direct impact of a feature on an incident was only available for bed exit alarms (reporting the impact on the incidence of falls). For these features with evidence, user preferences may be particularly useful for decision making by providing another type of evidence for consideration.

Methods

To understand more about user preferences for the innovative features with evidence in the EAR (evidence related to incidents or reporting technical outcomes), 2 exercises were shared with and completed by a group of experts with experience in clinical roles. These exercises were as follows:

- Exercise 1: ranking features with evidence in order of importance
- Exercise 2: weighting of features with evidence.

Exercise 1: ranking criteria in order of importance

Users were asked to rank the features in order of importance to them via email. Ranked lists from all respondents were collated, averaged and ordered from most important to least important, creating a final ranked list of features (using the SMART ranking technique; see Appendix C for a detailed definition). The final ranks were taken as the average of the ranks of all responders. Standard deviation (SD) was used to measure the level of agreement between responders.

Exercise 2: weighting of criteria

Users were asked to weight the ranked features to show how much more important 1 feature was compared with the feature ranked below (using the swing weighted technique, see Appendix C for a detailed definition) via email.

To weight the criteria, users were asked to give each feature a score from 0 to 100%. For example, a score of 0% meant that there was no difference in importance between a feature and the feature ranked below, and a score of 100% meant that it was considered twice as important. Weighted lists for all respondents were collated, averaged and weights were calculated. SD was used to measure the level of agreement between responders.

Results

In total, 7 experts with experience in clinical roles completed both the ranking and weighting exercises. The results are presented in Table 2.

Table 2: Results from ranking and weighting exercises

Rank	Feature	Weight
1	Bed frame designs for preventing patient migration (to reduce the risk of pressure ulcer formation. For example, back rest designed to translate backwards when using a profiling bed to prevent patient sliding down bed)	26.4%
2	Mechanism to enable bed to be adjusted to a low height (to reduce the occurrence of patient falls)	20.4%
3	Brake location (for minimising the risk of caregiver musculoskeletal injuries when operating the brakes)	14.9%
4	Turn-assist (to reduce the risk of caregiver musculoskeletal injuries sustained during the manual task of turning patients)	11.2%
5	Steering assistance (to reduce the risk of caregiver musculoskeletal injuries from steering the bed, such as a fifth wheel or double bogey caster configuration)	10.1%
6	Bed exit alarms	7.3%
7	Power-drive (motorised bed to reduce the risk of caregiver musculoskeletal injuries sustained during patient transportation/portering)	5.5%
8	Inbuilt weighing scales	4.2%

3. Interpretation of results

In the ranking task, there was most consensus around the features that were ranked in first (SD=0.79), seventh (SD=1.07) and eighth place (SD=0.1.13) in the final order. There was lower agreement on the features ranked second to sixth. In the weighting exercise, there was most consensus around the weight of the feature ranked fourth (SD=19.7), and least agreement around the weight of the features ranked third (SD=46.7) and sixth (SD=46.9).

Bed frame designs for preventing patient migration (to reduce the risk of pressure ulcer formation) were ranked in first place overall by clinical users. Individual ranks ranged from first place to third place, and there was a relatively small standard deviation (=0.79) indicating good overall agreement on the importance ranking of this feature. This feature had an overall weight of 26.4%, with individual weights ranging from 0% to 80% (SD=31.7).

The feature ranked second was “mechanism to enable bed to be adjusted to a low height (to reduce the occurrence of patient falls)”. This feature had the lowest level of agreement (SD=2.67) in the ranking exercise, with 3 users ranking this feature first (most important) whilst another user ranked this feature eighth (least important). This feature had an overall weight of 20.4%, with individual weights ranging from 0% to 75% (SD=26.4). This feature was noted in the free-text question of the porter survey as being very important in the role of one of the porters. In the patient survey for this assessment, height settings were the joint most important feature (see the user preference report). Most types of users involved across various stages of the user preference activities appear to have valued the importance of low bed height for reducing patient falls highly.

Brake location (for minimising the risk of caregiver musculoskeletal injuries when operating the brakes) was ranked in third place. Individual ranks ranged from first place to sixth place. This feature had an overall weight of 14.9%, with individual weights ranging from 0% to 100% (SD=46.7), indicating poor levels of agreement on the relative importance of this feature. An ergonomic brake system that is easy to operate with the foot had the second highest average importance score in the porter survey. Overall, user preferences demonstrate that brake location and ergonomics may be considered as being of relatively high importance to some users.

Turn-assist (to reduce the risk of caregiver musculoskeletal injuries sustained during the manual task of turning patients) was ranked in fourth place overall by clinical users. Individual responses for this feature ranged from second place to sixth place. This feature had an overall weight of 11.2%, with individual weights ranging from 0% to 50% (SD=19.7). Five out of 7 users gave this feature a weight of 0% relative to the feature ranked fifth.

Features related to steering assistance (such as double castors or a fifth wheel to aid steering) were ranked fifth overall by clinical users. Individual responses ranged from second place to seventh place. This feature had an overall weight of 10.1%, with individual weights ranging from 0% to 100% (SD=36.4). All 4 porters responded that such features are very important to them in their role. These results show that some user groups may perceive the importance of these features to be greater than other user groups would.

Bed exit alarms were ranked sixth place. Individual responses ranged from fourth place to eighth place. This feature had an overall weight of 7.3%, with individual weights ranging from 0% to 100% (SD=46.9), indicating poor levels of agreement. The results suggest that bed exit alarms may not be a highly important feature to bed frame users. Bed exit alarms were the only feature identified as having directly relevant evidence (on the impact on patient falls) in the external assessment report (EAR), however there were concerns with the risk of bias in the study and as such the effectiveness of bed exit alarms is unclear.

Power-drive had a ranking of seventh place, with individual responses ranging from fourth place to seventh place. This feature had an overall weight of 5.5%, with individual weights ranging from 0% to 50% (SD=23.6). In the porter survey, the average importance score of this feature was second from lowest (=3.5, in between “neither important or unimportant” and “quite important”). These results suggest that this feature may be considered less important by users when considering bed frame features.

Inbuilt weighing scales were ranked in eighth place. Five of 7 users in the ranking exercise ranked inbuilt weighing scales as being in last place. This level of agreement indicates that this feature was perceived to be the least important of the features with evidence in the EAR. This feature had an overall weight of 4.2%. The user preference assessment methods allow for the list of criteria/features to be truncated by removing the criteria whose relative weight is lower than 5%. However, in this case the ranking and weighting exercises were done to capture preferences of the bed frame features that had some evidence available (relating to incidents or technical outcomes). For that reason, the list of features has not been truncated at 5% weight and the results for all features are considered relevant.

4. Conclusion

The exercises in this addendum collected user preferences for bed frame features from 4 porters, along with 7 experts who have experience in clinical roles. Eight types of bed frame features were found to have some evidence available (evidence related to incidents or technical outcomes). These 8 features were the focus of the ranking and weighting exercises. Bed frame designs for preventing patient migration were ranked as the most important feature overall by the 7 users with clinical experience, with a weight of 26.4%. The feature ranked as least important by these users were inbuilt weighing scales, with a weight of 4.2%.

The process of selecting a bed frame within a Trust will involve users across different bed frame user groups. It is acknowledged that each bed frame user group will have their own priorities for the bed frame features that are important to them in their role. It was therefore anticipated that there would be a range of views on the ranking and weighting of bed frame features. The user preference exercises are intended to give an idea of trends in user preferences for bed frame features, to support committee decision making. Individual Trusts may find that the experience of their staff means that value is placed on bed frame features differently to the findings of this user preference assessment.

5. Appendix A. Uncertainty in the user preference ranking and weighting exercises

A source of uncertainty in the ranking and weighting exercises and the porter survey is the sample size of users. However, the assessment benefitted from high levels of engagement throughout all stages.

Porter survey

Four porters responded to the porter survey, with responses from individuals from University College London Hospitals NHS Foundation and North West Anglia NHS Foundation Trust. While this number is low relative to the number of porters in the NHS, this number is larger than the number of representatives from other bed frame user groups in this assessment.

Ranking exercise

Seven users with experience in clinical roles contributed to the ranking exercise. There were 8 features, therefore responses could have ranged from 1 to 8 meaning the maximum SD was approximately 4. The SD ranged from 0.40 for feature 8 (inbuilt weighing scales) to 2.89 for feature 2 (mechanism to enable bed to be adjusted to a low height (to reduce the occurrence of patient falls).

Weighting exercise

Seven users with experience in clinical roles contributed to the weighting exercise. Responses could range from 0-100 meaning the maximum SD was approximately 50. The SD ranged from 19.7 (turn-assist) to 46.9 (bed exit alarms).

6. Appendix B. Data from ranking and weighting stages

Table 3: Raw data from ranking exercise

Feature	User 1	User 2	User 3	User 4	User 5	User 6	User 7	Mean	SD
Bed frame designs for preventing patient migration	1	2	2	1	1	3	1	1.57	0.79
Mechanism to enable bed to be adjusted to a low height	1	1	1	5	8	2	2	2.86	2.67
Brake location	1	3	4	6	4	1	5	3.43	1.90
Turn-assist	6	5	2	3	3	5	3	3.86	1.46
Steering assistance	4	4	6	2	2	7	4	4.14	1.86
Bed exit alarms	5	7	5	6	5	4	8	5.71	1.38
Power-drive	7	6	7	4	6	6	7	6.14	1.07
Inbuilt weighing scales	8	8	8	8	7	8	5	7.43	1.13

Table 4: Raw data from weighting exercise

Rank	Feature	User 1	User 2	User 3	User 4	User 5	User 6	User 7	Mean	SD	Overall weight*
1	Bed frame designs for preventing patient migration	50	0	25	0	80	50	0	29.3	31.7	26.4%
2	Mechanism to enable bed to be adjusted to a low height	50	50	50	75	10	0	25	37.1	26.4	20.4%
3	Brake location	100	0	0	0	5	100	25	32.9	46.7	14.9%
4	Turn-assist	0	0	0	0	25	50	0	10.7	19.7	11.2%
5	Steering assistance	75	25	10	40	20	0	100	38.6	36.4	10.1%
6	Bed exit alarms	100	0	20	0	5	100	0	32.1	46.9	7.3%
7	Power-drive	50	50	0	50	30	0	50	32.9	23.6	5.5%
8	Inbuilt weighing scales	-	-	-	-	-	-	-	-	-	4.2%

*points are attributed to the feature based on the mean importance relative to the feature below. These are used to calculate the final weight

7. Appendix C. Glossary

Term	Definition
SMART ranking technique	Simple Multi-Attribute Rating Technique is a process mainly used in Multi Criteria Decision Analysis. It allows a group of alternatives to be ordered by importance. Individual responses from each member of the sample are collated and then meaned ensuring equal say among the group (Von Winterfeldt D, Edwards W. (1993) Decision analysis and behavioral research. Cambridge: Cambridge University Press).
Swing weighting technique	Swing weighting is also a process often used in Multi Criteria Decision Analysis. It is a method used for calculating and reporting the relative importance (weight) of each of the alternatives from a ranked group. Each member of the provides individual answers to questions asking them to decide (on a scale of 0-100%) how important each criterion is over the criterion below it. All of the responses from each member of the sample are then collated and meaned. After this, weights are calculated (Von Winterfeldt D, Edwards W. (1993) Decision analysis and behavioral research. Cambridge: Cambridge University Press).

8. Appendix D. Participants of the ranking and weighing exercises

Anna Skipper, Falls Prevention & Management Lead, Norfolk & Norwich University Hospital

Francis Quinon, Site Nurse Practitioner, Guys and St Thomas NHS Foundation Trust

Heather Bertasius, Patient Moving and Handling Service Lead, The Royal Wolverhampton NHS Trust

Michael Fray, Physiotherapist / Safety Adviser, Reader Ergonomics and Assisted performance SDCA, Loughborough University; Director, Ergonomics and Rehabilitation Services Ltd, Nottingham

Muhammed Tunkara, Staff nurse, OneCall24

Olawale Olanrewaju, Physiotherapist / Head of Intermediate Care transformation, North Cambridgeshire and Peterborough Partnership

Ria Betteridge, Nurse Consultant, Tissue Viability, Oxford University Hospitals NHS Foundation Trust

Document cover sheet

Assessment report: Bed frames for adults in acute settings (addendum)

EAG team: Hayden Holmes, Lavinia Ferrante Di Ruffano, Mary Chappell, Robert Malcolm, Laura Kelly, Luc Curtis-Gretton, Alice Sanderson, Paul Miller, Maisie Green, Katie Reddish

Project lead(s): Hayden Holmes and Lavinia Ferrante di Ruffano

Information specialist: Paul Miller

Clinical evidence reviewers: Lavinia Ferrante di Ruffano, Mary Chappell, Alice Sanderson, Katie Reddish

Economic evidence reviewer: Hayden Holmes, Robert Malcolm, Laura Kelly, Luc Curtis-Gretton, Maisie Green

EAG sign-off: Matthew Taylor

Version number	Brief description of changes	Author/reviewer (e.g. J Smith)	Date (DD/MM/YY)	Date sent to NICE (if applicable)
1.0	Draft addendum report submitted to NICE	YHEC	21.02.2025	21.02.2025
2.0	Updated addendum addressing NICE comments	YHEC	03.03.2025	03.03.2025
3.0	Final QA checks and altering CiC marking	YHEC	05.03.2025	05.03.2025

NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

Late Stage Assessment

[GID-HTE10050] - Bed frames for adults in acute settings

External Assessment Group report

Produced by: York Health Economics Consortium (YHEC)

Authors:

Hayden Holmes, Associate Director, YHEC

Lavinia Ferrante di Ruffano, Project Director, YHEC

Mary Chappell, Senior Research Consultant, YHEC

Robert Malcolm, Senior Research Consultant, YHEC

Luc Curtis-Gretton, Research Consultant, YHEC

Laura Kelly, Research Consultant, YHEC

Alice Sanderson, Research Consultant, YHEC

Paul Miller, Information Specialist, YHEC

Maisie Green, Research Assistant, YHEC

Katie Reddish, Research Assistant, YHEC

Correspondence to: Hayden Holmes, York Health Economics Consortium, Enterprise House, University of York, YORK, YO10 5NQ.

Date completed: 05.03.2025

Contains confidential information: Yes

Number of attached appendices: 2

Declared interests of the authors

Description of any declared interests with related companies, and the matter under consideration. See NICE's Policy on managing interests for board members and employees.

Responsibly for report

The views expressed in report are those of the authors and not those of NICE. Any errors are the responsibility of the authors.

Contents

Abbreviations

Term	Definition
CPR	Cardiopulmonary resuscitation
DF	Disabled feature
EAG	External Assessment Group
NA	Not available
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
QALY	Quality-adjusted life year
YHEC	York Health Economics Consortium

1 Background to the addendum

The Late Stage Assessment of 'GID-HTE10050 Bed frames for adults in acute settings' evaluated the cost-effectiveness of different bed frames and their innovative features, described further in the NICE final scope, and external assessment report. Following the first committee meeting for this topic, further information was requested by the committee including exploration of feature-based repair costs and the likely impact this could have on the results. In the full assessment report, only the reported repair costs from companies were included in the analysis, given a lack of evidence.

In response to the committee's suggestion, NICE sent a questionnaire to clinical engineers to collect data on bed frame feature repair costs. We planned to use the data from that questionnaire for this addendum, presenting additional analysis. Furthermore, the committee discussed whether alternative analysis, such as regression-based analysis, could be conducted to estimate the cost-effectiveness of features.

We prepared an addendum:

- Summarising the repair data received from clinical engineers.
- Conducting additional analysis of the total monetary burden of different incidents associated with acute bed frames (previously defined as falls, entrapments, pressure ulcers, infections and caregiver injuries).
- Plotting the relationship between number of innovative features and bed frame costs and further exploring the relationships between specific innovative features and the cost of bed frames.

As part of this additional analysis, we have not summarised or repeated information contained in the full assessment report. Please see the full assessment report for further details on the clinical and economic evidence.

2 Methods

2.1 Repair costs analysis

Appendix A contains the data collection survey developed by NICE, with input from individuals from Sheffield Teaching Hospitals NHS Foundation Trust and the Institute of Physics and Engineering in Medicine (IPEM). The survey was shared with clinical engineering departments across Trusts nationally. NICE received 1 completed response to the questionnaire, as well as 2 email responses to the questionnaire, which has been qualitatively summarised. The 1 completed response to the questionnaire is also listed in Appendix A.

No model adaptations and scenarios were conducted to capture the survey response because there was limited useful data to populate the additional parameters, and given the data only contains 1 response, the generalisability of this information may be limited. Therefore, if incorporated into the analysis, the final output may not be helpful for supporting a recommendation.

Furthermore, given the lack of engagement from clinical staff, there was no starting point for what a sensible assumption of the repair costs, the time taken to repair, and how long the bed frame was out of service would be. The single survey response on repair costs indicated minimal cost differences, suggesting that incorporating this data would not alter the results of the full assessment report.

2.2 Regression analysis

Regression analysis to determine the cost-effectiveness of different innovative features was not conducted for this addendum. We acknowledge this analysis was requested by the committee. However, we do not believe this analysis would be useful to support a recommendation on this late stage assessment. To conduct regression analysis to estimate the cost-effectiveness of different innovative bed frame features, it would require a substantial number of assumptions, producing results with a very high degree of uncertainty. This is because:

- There is no efficacy data to understand the impact of innovative features, other than for bed exit alarms.
- There are likely a range of unobservable factors which impact the bed frame costs, which are independent of features. Therefore, any statistical model conducted to estimate the cost of features is likely to have wide or overlapping confidence intervals or may even present negative cost of features.
- As discussed in section 3, there is a relationship between certain innovative features, where if a bedframe has one feature, it is likely to have the other. Hence, this will make disentangling the true cost of a specific feature challenging, and we will not have confidence in the accuracy of the results produced, even if interaction terms are included within the statistical analysis, due to small sample sizes for certain features (N<5).

Therefore, conducting a regression analysis is likely to be harmful and potentially misleading to inform evidence-based recommendations, rather than informative. Although a regression analysis may produce precise results, the degree of uncertainty within the results would diminish the usefulness of this approach.

2.3 Additional analysis

2.3.1 Net monetary benefit

Additional analysis was conducted to estimate the net monetary benefit of avoiding each of the 5 key modeled incidents: falls, entrapments, infections, pressure ulcers, and caregiver injuries. Additional analysis was conducted to present the results in the full assessment report in an alternative way, to highlight the potential value of reducing different types of incidents. This includes graphical breakdowns of the results, as well as presenting the number of incidents per bed frame per year for additional context.

In the full assessment report each incident had an associated cost and quality-adjusted life year (QALY) loss. Costs were accounted for either directly through identified treatment costs or indirectly via the additional hospital bed days required for treatment. Proportions, split by severity level, were reported for 3 of the incidents: falls, pressure ulcers, and entrapment. Where severity stratification was applied, events were grouped, and the total costs and QALYs were calculated as a weighted average based on the distribution of severity.

To estimate the net monetary benefit of avoiding each incident, the following formula was used:

$$Net\ monetary\ benefit = Total\ cost + \ (QALY\ loss\ avoided\ x\ willingness\ to\ pay\ threshold)$$

The net monetary benefit accounts for the direct cost savings and the monetary value of additional QALYs gained. A cost-effectiveness threshold of £20,000 per QALY was applied, in line with the NICE reference case.

2.3.2 Features analysis

Additional analysis was conducted to determine which features may drive the cost of bed frames. The bed frames and their innovative features were reviewed, and statistical analysis was conducted to determine which features were likely to be impacting the price of bed frames. Descriptives of the data were produced to initially identify differences in costs and related features. We then conducted Mann Whitney U tests in R programming software to compare the cost of bed frames with and without a given feature. The Mann Whitney U test was selected because the data was non-normally distributed, making it unsuitable for a standard t-test. The statistical testing was exploratory, and was used as a starting point to explore which features drive the cost of bed frames. Hence, the presence of cofounding factors was not considered.

For the features that were identified as being likely cost-drivers, the average cost with and without that feature was calculated. Line graphs were then produced to display the relationship between the costs and the number of features of each bed frame.

3 Results

3.1 Repair costs

1 survey response was received by NICE from a clinical engineer on behalf of an NHS Trust, where the NHS Trust repairs are conducted in-house rather than externally. In the response 9 of the 13 features asked about were given responses, the other 4 were labeled as NA or DF (disabled feature by the Trust). The NA features were the autoregression backrest, power-drive and turn-assist. The Trust required bed-exit alarms to be disabled.

6 of the 13 features had data on repair time. The repair time of the 6 features was listed as 30 minutes (handset, siderails, CPR system, double bogie castors, front castor lock, fifth wheel). The cost to repair these features were either listed as £0 plus labour costs, unknown, or a cost-plus labour (£90.79 for CPR system and £7.46 for the handset). The frequency of repairing these features were listed either as very rarely, once per year (fifth wheel) or less than 5% of beds with that feature requiring repair on an annual basis. Notably, it is not possible to gain a sufficient understanding of how frequently bed frames are repaired for those listed as being repaired ‘very rarely’.

Damage to the bed frame itself was also identified in the survey as a routine repair cost, suggesting that any damage to the frame would require a full replacement. In-built weighing scales and the mechanism enabling the bed to be adjusted to a low height were answered as not experiencing a fault, therefore, neither a cost nor time to repair was provided.

4 of the features were listed as requiring the whole bed frame to be out of service while it is repaired. These were the double bogie castors, CPR system, siderails and repairs to the bed frame itself.

NICE also received further information from two clinical engineers on behalf of their Trusts via email. Both email responses stated that the bed frames they use rarely require repair, with one response from a Trust stating they have a fleet of over 1,000 beds. One of the email responses outlined 6 major failure modes that they have seen occur. These were: Damage to the main cable or plug, depletion of the bed frames batteries due to not being plugged in, damage to handsets, damage to safety side rails due to fire doors not on detents, failed actuators, and twisted frames. The other response outlined 17 repairs required for their fleet of over 1,000 beds, the repairs were dated from 2022 to 2024. The repairs included bent frames, a faulty control box, replacement batteries needed, damage to the main cable and electrical faults.

3.2 Total monetary burden

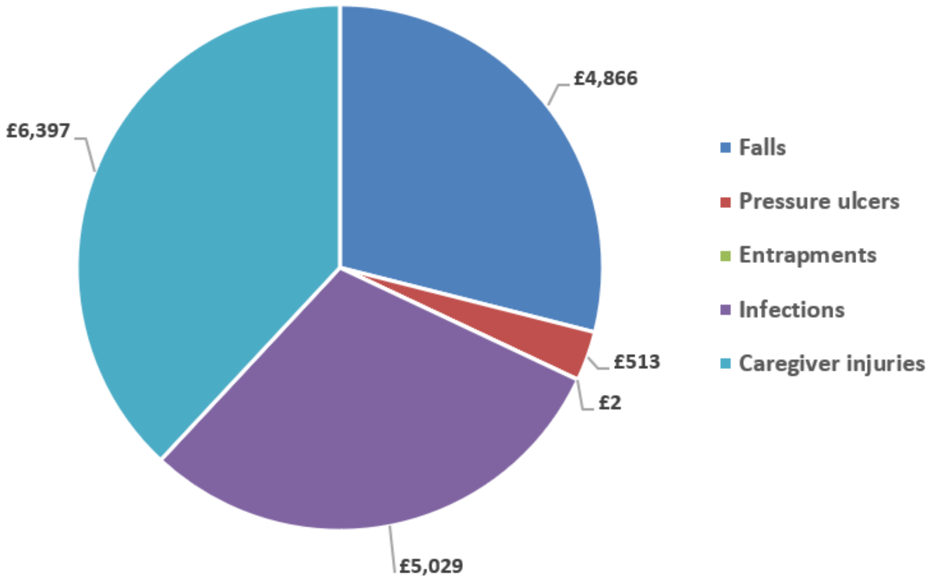
Table 3.1 displays the total number of incidents per bed per year, the cost of each event, and the QALY benefit of eliminating each incident. This information was used to calculate the net monetary benefit of stopping all incidents. See the full assessment report for the assumptions and sources for the number of incidents.

Table 3.1: Total number and cost of incidents (per bed per year)

Innovative feature impact	Total number of incidents	Total monetary burden	QALY benefit	Net monetary benefit
Falls	2.27	£4,392	0.024	£4,866
Pressure ulcers	0.09	£430	0.0042	£513
Entrapments	0.0002	£0.32	0.00008	£2
Infections	0.71	£2,797	0.11	£5,029
Caregiver injuries	2.13	£6,250	0.007	£6,397
Total	**5.21**	**£13,868**	**0.147**	**£16,708**

The maximum potential net monetary benefit of a bed frame which can prevent all incidents from happening is approximately £16,708. This was based on an assumption that the number of falls, pressure ulcers, entrapments, infections or caregiver injuries happening to the people using a particular bed frame over the year time horizon is reduced to zero. These results do not account for a range of other factors which will contribute to these incidents, such as (but not limited to) mattresses, staff processes, or patient characteristics. Eliminating caregiver injuries is shown to be the greatest contributor to the net monetary benefit (£6,397), whilst entrapments had the least impact (£2). This is displayed further in Figure 3.1.

Figure 3.1: Net monetary benefit of incidents, per bed per year



3.3 Features analysis

The Mann Whitney U test returned 7 significant results, of which 5 were significant due to an increase in the costs associated with the innovative feature. We excluded 2 significant results from the analysis, given they indicated that the bed frames were cheaper due to having a feature. We believe it is unrealistic that patient pendants and accessory sockets are reducing the cost of bed frames, and the relationship is therefore likely driven by unobservable factors and confounders. Appendix B presents the results of the Mann Whitney U tests. The 5 innovative features that were identified as being drivers of the cost of bed frames were:

- Bed exit alarms.
- In-built bed weighing scales.
- Bluetooth connectivity.
- Features that enable connection from the patient to the caregiver when assistance is required.
- Features that enable patient data to be sent to electronic medical records.

Table 3.2 displays the average cost and average total number of features for beds with and without these 5 features. The features available on the different bed frames were detailed in the full assessment report, Tables 2.1-2.7.

Of the bed frames that had bed exit alarms, 62% also had in-built weighing scales. Comparatively, of the bed frames without bed exit alarms, none had in-built weighing scales. Likewise, of the bed frames that had in-built weighing scales, 100% of them also had bed exit alarms. Hence, there is a relationship between these 2 innovative features, meaning that they are both likely impacting the increase in the cost of bed frames.

Considering the average cost of all the bed frames is [redacted] the 3 bed frames that [redacted] These 3 bed frames are the [redacted].

It is important to note that differences in costs between beds with Bluetooth connectivity and connectivity between patients and caregivers were all driven by [redacted]. Notably, one of these bed frames – the [redacted] – [redacted]. Therefore, it is difficult to disentangle what innovative feature, if any, is driving the cost of these bed frames.

Table 3.2: Average cost and features of beds with and without the 5 innovative features

	Number of beds	Average number of features	Average cost	Incremental cost difference
Beds with bed exit alarms	13	22.5	[redacted]	£3,831
Beds without bed exit alarms	17	21.9	[redacted]	
Beds with in-built weighing scales	8	23.0	[redacted]	£5,914
Beds without in-built weighing scales	22	21.1	[redacted]	
Beds with electronic medical records features	3	28.3	[redacted]	£7,492
Beds without electronic medical records features	27	20.9	[redacted]	
Beds with Bluetooth connectivity	5	25.4	[redacted]	£6,447
Beds without Bluetooth connectivity	25	20.8	[redacted]	
Beds that enable patient and caregiver connectivity	14	23.7	[redacted]	£3,437
Beds that do not enable patient and caregiver connectivity	16	19.8	[redacted]	

The total cost of each bed frame was plotted against the total number of features to display the relationship between costs and features. Figure 3.2 shows this relationship. [redacted]- were considerably more expensive compared with the other bed frames, with costs of over [redacted]. To determine the effect that these bed frames have on the regression line, these 3 outliers were removed, and the new plot is displayed in Figure 3.3. As shown in Figure 3.3, once these 3 outliers have been taken out, the regression line is flat. Hence, it is likely there is no correlation between the number of innovative features and bed frame costs. It is more likely that specific features are going to contribute to higher costs.

Figure 3.2: Plot of the costs and innovative features for each bed frame

[redacted]

Figure 3.3: Plot of the costs and innovative features for each bed frame excluding the 3 most expensive bed frames

[redacted]

4 Interpretation of additional evidence

4.1 Repair costs

The repair data collection questionnaire sent out by NICE only received 1 completed response, and 2 email responses to the questionnaire providing further context. The sample size of 1 completed response is likely not to be appropriate upon which to draw strong conclusions. The results of that completed response and the additional email were reported qualitatively.

To summarise the questionnaire answers: for the 9 features that were provided with data, the repair times were listed as minimal (30 minutes), cost of repair largely reported as £0 and the frequency of repair being very rare. The bed frame itself, not related to a specific feature, was the only exception where a large cost of repair was reported as it would require a full replacement. With the understanding that this was data from only 1 response in which not all of the features were given answers, based on the given responses it would suggest that repair time for innovative features may not be a key driver of cost-effectiveness. Additionally, it is not possible to adequately interpret the frequency of repair for features that require repairments ‘very rarely’, given that no precise time period was specified. The two email responses also suggested that the bed frames very rarely require repairs.

However, in other NHS trusts, some features may be associated with significant repair costs or requiring the bed to be out of use for an extended period of time. Bed frames that are out of use will cost the NHS, as Trusts will be required to have additional beds to maintain a fixed capacity, or will faced reduced capacity. As previously indicated by clinical experts, a bed frame with a large number of features is more likely to have higher maintenance requirements than a bed frame with fewer features.

It is important to consider the potential additional costs that may be incurred if bed frames are regularly on repair, if an NHS trust aims to maintain a specific level of capacity. For example, a bed frame cost of £2,000, and a bed frame being out of use for 5 days in a year would result in an additional cost of £27.40 annually per bed per year to maintain a target capacity of beds, by having spare bed frames to replace any beds under repair. This demonstrates the impact that having to repair innovative features can have on the bed frame cost. However, in reality, it may not be an additional cost of spare bed frames, but a reduced capacity of available beds within the healthcare system. Therefore, it is important to consider the interaction between additional innovative features and the likelihood of more time spent on repairs.

4.2 Total monetary burden

The results of this analysis represent the maximum potential net monetary benefit if a bed frame resulted in completely eliminating incidents. This analysis demonstrated which features are likely to produce the greatest benefit from the NHS. Caregiver injuries and falls are associated with the greatest net monetary benefit (per bed per year), £6,397 and £4,866, respectively. A bed frame with features that impact these incidents are likely to produce greater benefit to the NHS. The total net monetary benefit of stopping all entrapments was £2. Features which are designed to reduce entrapments are therefore unlikely to produce much benefit, due to entrapments being so rare.

It is highly unlikely that the use of any one bed frame can eliminate 100% of the reported incidents. For example, the prevalence of pressure ulcers will be driven by patient characteristics, the mattress used, length of stay, and potentially other unobservable factors. The analysis does not take into consideration additional factors (such as clinical practice or patient characteristics) that may also impact the number of incidents. The results instead highlight how innovative features designed to prevent specific incidents, may be of less or more value to the NHS, depending on the relative burden of the incident.

4.3 Features analysis

For the medical records feature the average cost of the bed frames with this feature was substantially higher than beds without this feature [redacted]. Therefore, it is likely that the medical records feature may be driving up the cost of bed frames and would need to demonstrate measurable benefit to the health system to make them cost-effective. This feature may have limited value to the health system, as outlined in the user preference workshop, features that improve connectivity may be difficult to integrate to existing NHS IT infrastructure, in certain NHS trusts. It should be considered that there are only 3 bed frames that have this feature, whereas there are 27 bed frames that do not have this feature. Additionally, the bed frames with the medical records feature had an average of approximately 28 features in total, compared to only 21 total features for beds without this feature. Thus, there could be other additional features that are also increasing the price of bed frames that have the medical record feature.

Beds that enable connectivity when assistance is required were also on average more expensive than beds without this feature [redacted]. Therefore, this connectivity feature may be driving up the cost of bed frames. However, beds that enabled connectivity had 4 more features, on average, than beds that did not enable connectivity. Hence, other features are also likely to be driving up the cost of bed frames. The bed frames with Bluetooth connectivity ranged in price from [redacted]. Since the range of costs of beds with Bluetooth connectivity is large, it is unlikely that this innovative feature is driving up the cost of bed frames.

For in-build weighing scales and bed exit alarms, the average cost of bed frames with and without these features was compared. The average number of features for bed frames with bed exit alarms was 22 compared with 21 for bed frames without this feature. Hence, the cost difference between bed frames with and without bed exit alarms is more likely to represent the cost of that additional feature. The cost of bed exit alarms is approximately £3,831 when comparing the differences in average price. However, there may still be confounding factors which are driving the difference in price other than the bed exit alarm itself. In-built weighing scales resulted in a cost difference of £5,914 when comparing the difference in average price with and without the feature. This average considered 8 bed frames with a weighing scale and 22 bed frames without a weighing scale. It is worth noting that the estimated additional cost of a bed frame with a bed exit alarm was £3,831, lasting up to 10 years, whereas the estimated monetary benefit was £2,413 per year. This suggests that it may be a cost-effective feature; however, the effectiveness data for bed exit alarms is based on limited evidence, with concerns regarding the risk of bias.

The plots showing the relationship between number of features and cost of bed frames suggests there is no relationship between the cost of the bed frame and the total number of features. Therefore, it is likely the specific features outlined which are drivers in price different. However, there will be a range of other factors impacting price, including, but not limited to, materials used by bed frame providers, profit margins of the businesses and additional services covered when purchasing the bed frame, such as maintenance support.

However, it is also important to consider the limitations of the features analysis. Firstly, there is correlation between bed frames having different sets of features. For instance, of the 5 features identified that may increase costs, 2 features differences in average costs were driven by having 3 bed frames over [redacted] Therefore, it is not possible to determine which feature may actually be driving the cost, if any. Secondly, there are a range of confounding factors which are likely to also impact the cost of the bed frame. This may include profit margins or cost of production, or other unobservable factors. It is important to consider the limitations, when interpreting any analysis of the cost of features.

5 Conclusions

The cost of repairing features cannot be conclusively calculated from the evidence currently available. However, from the 1 complete response provided, the relative cost and time spent on repair may be small, compared with other factors such as the total cost of the bed frame, and the incidents associated with bed frames.

Further analysis of the results reported beyond what was reported in the full assessment report demonstrated that features preventing caregiver injuries and falls are associated with the greatest net monetary benefit. A bed frame with features that impact these incidents are likely to produce greater cost savings.

The plots showing the relationship between number of features and cost of bed frames demonstrate no relationship between costs and features, once the 3 most expensive bed frames were removed. 5 innovative features were identified as being present on more expensive bed frames, 2 of which are driven primarily by [redacted]. The remaining 3 innovative features are likely impacting the cost of bed frames. These are: bed exit alarms, in-built bed weighing scales, and features that enable connectivity between the patient and the caregiver. However, evidence to support the effectiveness of the identified features having a higher impact on the cost is limited. An important proxy to consider the value for money of innovative features driving the cost of bed frames may be to consider user preferences.

6 Appendices

Appendix A – NICE Survey Questionnaire – Q4

Sheffield Teaching Hospital

1. Feature	2. Feature repaired/ maintained in-house or externally?	3. How often does this feature need to be repaired on a bed?	4. How often does this feature need to be replaced on a bed?	5. Has a fault with this feature ever resulted in the whole bed frame needing to be replaced?	6. Time taken to repair featur e	7. Is the whole bed frame out of service during repair? (Yes or No)	8. How much does this feature cost to repair if not covered under warranty?
Mechanism enabling bed to be adjusted to a low height	In - house	Very Rarely	Very Rarely	No	N/A	N/A	N/A
Autoregression backrest (i.e. rest designed to translate backwards when using a profiling bed to	N/A	N/A	N/A	N/A	N/A	N/A	N/A

prevent patient sliding down bed).							
Fifth wheel	In - house	Once a year	Very Rarely	No	30 minutes	No	£0
Front castor lock	In - house	Very Rarely	Very Rarely	No	30 minutes	No	£0
Double bogie castors	In -house	Very Rarely	Very Rarely	No	30 minutes	Yes	Unknown
Power-drive (motorised bed to aid patient transportation/portering)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In-built weighing scales	In - house	No experience of this fault	N/A	N/A	N/A	N/A	N/A
Bed exit alarms	D/F	D/F	D/F	D/F	D/F	D/F	D/F

Turn-assist to support caregivers with the manual task of turning patients	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Frame– durability/build quality/build material	In - house	N/A – if damage occurs, it is usually too severe.	Beyond economical repair	Yes	N/A - Bed is replaced with new	Yes	£1845.00 + Labour
Emergency/CPR system - functionality/reliability	In - house	12 repairs in 12 months out of 2050 beds in the Trust.	12 repairs in 12 months out of 2050 beds in the Trust.	No	30 Minutes	Yes	£90.79 + Labour
Siderails – design/build quality – patient safety, prevention of patient exiting bed, alarms	In - house	79 repairs in 12 months out of 2050 beds in the Trust.	79 repairs in 12 months out of 2050 beds in the Trust.	No	30 Minutes	Yes	£0 + Labour

Handset – durability/accidental damage	In-house	59 repairs in 12 months out of 2050 beds in the Trust.	59 repairs in 12 months out of 2050 beds in the Trust.	No	30 Minutes	No	£7.46 + Labour

Appendix B – Results from the Mann Whitney U tests (impact on costs)

Innovative feature	***p values***
Under bed light	*0.182*
Bed exit alarm	*0.000****
Anti-entrapment system	*0.355*
Innovative side rails	*0.771*
Bluetooth connectivity	*0.003***
Expanded range of heights	*0.383*
Corner bumpers	*0.072*
Side rail bumpers	*0.692*
Floor mounts	*0.228*
Features designed to reduce patient migration in bed	*0.419*
Angle indication	*0.298*
Caster design	*0.221*
5th wheel option	*0.062*
Electric power-assisted steering	*0.106*
Features that can help with the manual task of turning patients	*0.488*
In-built bed weighting scales	*0.000****
Collapsible frame for easy transport and storage	*0.170*
Variable bed width	*0.522*
Variable bed length	*0.616*
Removeable headboards/footboards	*0.938*
Battery power backup	*0.344*
Compatible with static, hybrid and dynamic mattresses	*NA*
Frame structures that have unrestricted access to all parts for cleaning	*0.429*
Bed controls that are in an accessible location and have an intuitive design - side rail control panel	*0.731*
Bed controls that are in an accessible location and have an intuitive design - patient pendant	*0.028**
Bed controls that are in an accessible location and have an intuitive design - nurse controls	*1.000*
Ease of use of accessories, accessory socket	*0.045**
Ease of use of accessories, x-ray compartment	*0.819*
Ease of use of accessories, oxygen cylinder holder	*0.371*
Ease of use of accessories, Foley bag basket	*0.055*
Ease of use of accessories, Catheter bag hooks	*0.817*
Ease of use of accessories, dual-sided drainage bag holder	*0.624*
Ease of use of accessories, Pull-out linen tray	*0.060*
Ease of use of accessories, crutches holder	*0.645*
One-push buttons for cardiopulmonary resuscitation (CPR) positioning	*0.562*
A handle for adjusting the height of the bed	*NA*
QR code that links to videos on bed functionality	*0.524*
Programmable custom height settings for when the patient is getting in or out of bed	*0.562*
Elements that are easy for patients to reach and use, such as handsets or controls	*0.190*
Side rail grip	*0.135*
Dual wheel castors	*0.586*
Castor configuration with low vibrations when the bed is moved	*NA*
Local sourcing of materials and bed frame production	*NA*
Recycling options and recyclable materials	*0.222*
Durable frame construction and integrated or semi-integrated components to reduce hospital-acquired damage	*0.613*
Access to all parts of the bed to facilitate easy repair	*0.730*
Features that enable connection between patients and caregivers when assistance is required	*0.005***
Features that enable patient data to be sent to electronic medical records, subject to national cyber security measures	*0.010***
Features to track and locate beds	*0.082*

Note: NA is in place of the p value statistic when the Mann Whitney U test was not able to be conducted due to either no bed frame having the feature, or all of the bed frames having the feature.