# Development and validation of a tool to select patients for admission to medical short stay units

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ABSTRACT

**Medical short stay units help to increase patient flow and decrease length of stay, but selecting appropriate patients for admission to such units is difficult. The selection tool used in our unit was effective but cumbersome to apply. We collected prospective data on 297 unselected emergency medical admissions and developed a new scoring system based on four key variables using regression analysis. The model predicted a length of stay of <72 h with an area under the receiver operating characteristic curve of 0.68. The model was then used to select patients for admission to the short stay unit in our trust. Length of stay on the short stay unit had decreased by an average of 2.73 days with our original selection tool, but remained unchanged at an average of 3.02 days using the new simpler tool (p>0.05). This model could now be adopted by other units.**

**KEYWORDS:** Length of stay, prediction tool, acute admission, patient selection, short stay unit

## Introduction

Many hospitals have introduced medical short stay units (MSSUs) in an attempt to improve patient flow, without compromising quality of care, in response to increasing emergency medical admissions and a decreasing bed base,[1] as well as the need for efficiency savings. There are also clinical needs, primarily to get the right person in the right setting at the first attempt.[2] The definition of a 'short stay' varies, but is usually taken to be a hospital stay of <72 h.[3,4] These units have been shown to reduce length of stay without increasing readmission rates,[3] and to reduce in-hospital complications and readmissions within 30 days.[5] However, appropriate patient selection remains problematic, yet is essential to the smooth running of MSSUs. Predicting length of stay is difficult; for example, in one study, predictions by doctors were correct 45.5% of the time, regardless of grade,[6] whereas nurses, the patients themselves and their relatives accurately predicted length of stay 30% of the time.[6] In other research, consultants had a tendency to underestimate length of stay by 1.7 days per patient.[7]

No scoring systems to predict the length of stay accurately could be found on reviewing the literature (PubMed; 18 May 2013). A scoring system was previously designed in our hospital based on variables thought to affect length of stay. When using this tool for patient selection to our MSSU, patient flow increased by 0.82 patients per bed per week, and the mean length of stay on MSSU was reduced by 2.73 days.[8] When applied to unselected emergency medical admissions, the original MSSU score predicted a length of stay of 72 h or less with a sensitivity of 70% and a specificity of 82.5%.[8]

This scoring system included eight variables with a maximum score of 35 and, although simple to use, was relatively time consuming and not used consistently.[9] To streamline the score, data were collected on multiple variables in consecutive emergency medical admissions, and a new scoring system was designed for comparison with the original scoring system.

## Methods

Data were prospectively collected from all unselected medical emergency admissions over a 2-week period from 12 July 2010 to 26 July 2010 from medical and nursing notes. Data were collected on 14 different variables (Table 1) using a data collection proforma. These variables were chosen because they had either previously been shown to affect length of stay[4,7,10,11] or were thought to be relevant after discussion with the multidisciplinary team.

Discharge date and time information was collected retrospectively from the patient notes or the computerised hospital admissions system for up to 24 weeks after the admission date.

## Statistical analysis

Chi-squared testing was used to identify variables that predicted length of stay. Six variables were found to be significantly associated with length of stay (highlighted in Table 1) and these were included in a logistic regression model. Data were analysed using backwards stepwise logistic regression, with length of stay <72 h as the dependent variable,

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**Table 1. Patient characteristics.**

| Variable | Overall (n=301) | Length of stay | | p value |
|---|---|---|---|---|
| | | <72 h (n=150) | >72 h (n=151) | |
| Median length of stay (h) | 73 | 22 | 190 | <0.01 |
| Mean length of stay (h) (SD) | 164 (258) | 26 (19) | 301 (307) | <0.01 |
| Age (years) (SD)* | 63.8 (19.7) | 57.0 (19.3) | 70.4 (17.8) | <0.01 |
| Cognition (% orientated)* | 82.8 | 87.5 | 78.0 | 0.04 |
| Home situation (% with family member) | 44.5 | 45.9 | 43.1 | 0.72 |
| Occupation therapy required (%) | 84.2 | 88.6 | 79.7 | 0.05 |
| Independently mobile (%)* | 70.4 | 80.3 | 60.7 | <0.01 |
| Low falls risk (%)* | 63.8 | 70.5 | 57.1 | 0.02 |
| Continent of urine and/or faeces (%) | 86.3 | 89.1 | 83.4 | 0.18 |
| Number of medications (% <5)* | 44.9 | 55.6 | 34.7 | <0.01 |
| Hospital admissions within previous 4 weeks (%)* | 29.2 | 22.4 | 36.1 | 0.02 |
| Modified early warning score <4 (%) | 90.0 | 90.6 | 89.4 | 0.85 |
| Need for translator (%) | 2.4 | 0.7 | 4.0 | 0.12 |
| Specialist referral made (%) | 62.1 | 60.7 | 63.6 | 0.64 |
| Psychiatric comorbidity (%) | 39.6 | 30.6 | 25.5 | 0.30 |
| Medical comorbidities <3 (%) | 60.1 | 65.3 | 55.1 | 0.09 |

SD = standard deviation.
*Variables found to be significantly associated with length of stay.

and by inspecting the changes in the receiver operating characteristic (ROC) curves as the model was reduced to only those terms that remained statistically significant at the 5% level. This left four terms that were given equal weight to allow the score to be easily implemented in the clinical environment without the need for calculating aids or software. In assessing the effectiveness, the difference in length of stay was calculated using a Mann-Whitney U test. All statistical analyses were carried out using IBM SPSS statistics version 19 (IBM corporation, New York, NY, USA).

## Implementation

The four-point tool was used to select patients for admission to our short stay unit from 27 February 2012. This was achieved by the nurses on the medical admissions unit calculating the score for patients and transferring suitable patients to MSSU, and the nursing staff on MSSU ensuring that the patient had a suitable score (less than or equal to 1) before accepting the patient on to MSSU. Length of stay data on MSSU and the medical division as a whole were collected from the hospital performance and information team for the 12-week period from 27 February 2012 to 21 May 2012 and the same period 1 year earlier for comparison, when the original scoring system was being used.

## Results

In total, 308 unselected emergency patients were admitted to the medical take over the study period, for which 297 records were analysed: 144 patients (48%) had a length of stay of <72 h, 153 (52%) had a length of stay of >72 h. Five patients' records could not be found and six contained insufficient data and were not analysed. Four patients had died and one patient was still an inpatient when the discharge data were collected, 24 weeks after the end of the admission period.

The mean patient age was 64 years (range 17 to 99 years). The most common presenting complaint was chest pain, followed by shortness of breath and then collapse (Fig 1).

Data were collected and statistically analysed as detailed above. There were four independent terms that were significant when predicting a length of stay of <72 h. These were: age over 80 years, confusion (regardless of whether new or old), five or more regular medications and any hospital admission over the previous 4 weeks. Although independent mobility was associated with a length of stay of <72 h with high significance ($p<0.0002$), this failed to be an independent predictor and, therefore, was not included in the model. The four terms were developed into a new scoring system (Box 1) based on complete data from 247 patients. Using different age cut-offs did not significantly predict length of stay until the age of 80 years was reached.

Using the weighting suggested in the model would enable a more accurate prediction of length of stay but is cumbersome and requires software (the full model is shown in Table 2); therefore, the terms were given equal weighting to enable easy manual calculation on the ward, and a score developed (Box 1). When applied to this data set, the four-point tool had an area under the ROC curve (AUROC or c-statistic) of 0.68 at predicting a length of stay of <72 h in unselected medical emergency admissions (sensitivity 0.62, specificity 0.60, positive predictive value 0.60 and negative predictive value 0.61). Patients

**Box 1. MSSU score.**

**Variable**

- Medication: ≥5 regular medications on admission
- Age: ≥80-years old
- Short-term memory loss: any confusion (new or old)
- Unplanned previous admission: hospital admission over the previous 4 weeks

MSSU = medical short stay unit.

Score 1 point for each variable: MSSU score ≤1: admit to MSSU; MSSU score ≥2: not suitable for MSSU, admit to specialist ward.

**Table 2. The coefficients and 95% confidence intervals for each variable as determined by the logistic regression model.**

| Variable | Coefficient | 95% confidence interval |
|---|---|---|
| Age > 80 years | 0.22 | 0.08–0.36 |
| Medications ≥5 | 0.11 | 0.01–0.23 |
| Admissions within previous 4 weeks | 0.16 | 0.02–0.29 |
| Confusion | 0.17 | 0.01–0.37 |

with a score of 0 or 1 had a median length of stay of 46 h (mean 114, standard deviation [SD] 191), whereas those with a score of 2–4 had a median length of stay of 120 h (mean 251, SD 346; p<0.001). Full details of length of stay for each score are detailed in Table 3. The average length of stay for scores of 0 and 1 was skewed by patients younger than 80 years with multiple comorbidities for which the model failed to predict a >72-h length of stay. This explains the discrepancy between median and means and the large variation indicated by the SD.

The most common variable in patients with a score of 1, 2 or 3 was 'over five regular medications' (52%, 88% and 100%, respectively), whereas in those with a score of 3, age was the second most common variable (93.3%; Table 4).

## Internal verification

The four-point tool was then used for patient selection to MSSU with the aim of comparing it with the original tool that had decreased mean length of stay by 2.73 days.[8] Length of stay data on MSSU were analysed over a 12-week period after the introduction of the new scoring system (27 February 2012–20 May 2012) and compared with data from the same period from the previous year when the original scoring system had been used. Mean length of stay was 2.90 days (SD 3.4) using the original scoring system and 3.02 (SD 3.6) days using the new scoring system (median length of stay was 2 for both time points). This compared with a mean length of stay in the whole medical division of 4.73 days (SD 10.6) for the first period and 4.27 (SD 9.6) days for the second period (median of 1 for both time points). There was no significant change to the length of stay on MSSU (p=0.65) or in the medical division as a whole (p=0.38).

## Conclusion

These data suggest that a four-point scoring system based on age (over 80 years), cognition (any confusion), number of medications on admission (five or more) and previous hospital admissions (over the previous 4 weeks) can predict a length of stay of <72 h with an AUROC of 0.68 and, therefore, can be used to determine the suitability of patients for transfer to a MSSU. We propose an easy-to-remember acronym to help with the scoring: MSSU; medications (5 or more = 1 point), senior (age over 80 = 1 point), short-term memory loss (any confusion, new or old = 1 point), unplanned previous admission (hospital admission in the last 4 weeks = 1 point). All medical patients admitted as an emergency can be scored on admission by any member of staff, usually the admitting nurse, and before full medical clerking. Patients with a score of 1 or less can be admitted to MSSU (if not being discharged directly from the medical admissions unit), whereas patients with a score of over 1 should be admitted to the appropriate specialty ward. Use of this scoring system will help to select appropriate patients for a MSSU to improve patient flow.

## Study limitations and discussion

Although the MSSU score demonstrates equivalence to our previous eight-point score in length of stay, the intermediate AUROC value of 0.68 reflects the difficulties of using a simple score to predict outcome of such a heterogeneous patient population. We made a decision to sacrifice a higher degree of accuracy to produce an easy-to-apply score that can be used by all healthcare professionals. Therefore, we emphasise that the score should not replace clinical judgement but be used as an additional tool to guide patient management. Furthermore, the data available during the internal verification were not sufficiently detailed to provide individual model variables for each patient and the length of stay was only accurate to the nearest 24-h period. From these data, we can only demonstrate that there was no large difference in length of stay in MSSU on implementation of the new score. Although this provides a useful indication that the patient outcome was not altered by the score, a true validation of the full model is lacking.

**Table 3. Median and mean length of stay with standard deviations separated by model score.**

| Score | Number of patients | Median length of stay (h) | Mean length of stay (h) | Standard deviation |
|---|---|---|---|---|
| 0–1 | 154 | 46 | 115 | 191 |
| 2–4 | 93 | 120 | 251 | 346 |
| 0 | 69 | 32 | 91 | 160 |
| 1 | 85 | 54 | 133 | 212 |
| 2 | 69 | 108 | 207 | 342 |
| 3 | 17 | 220 | 279 | 210 |
| 4 | 7 | 554 | 618 | 456 |
| **Total** | **247** | **73** | **166** | **268** |

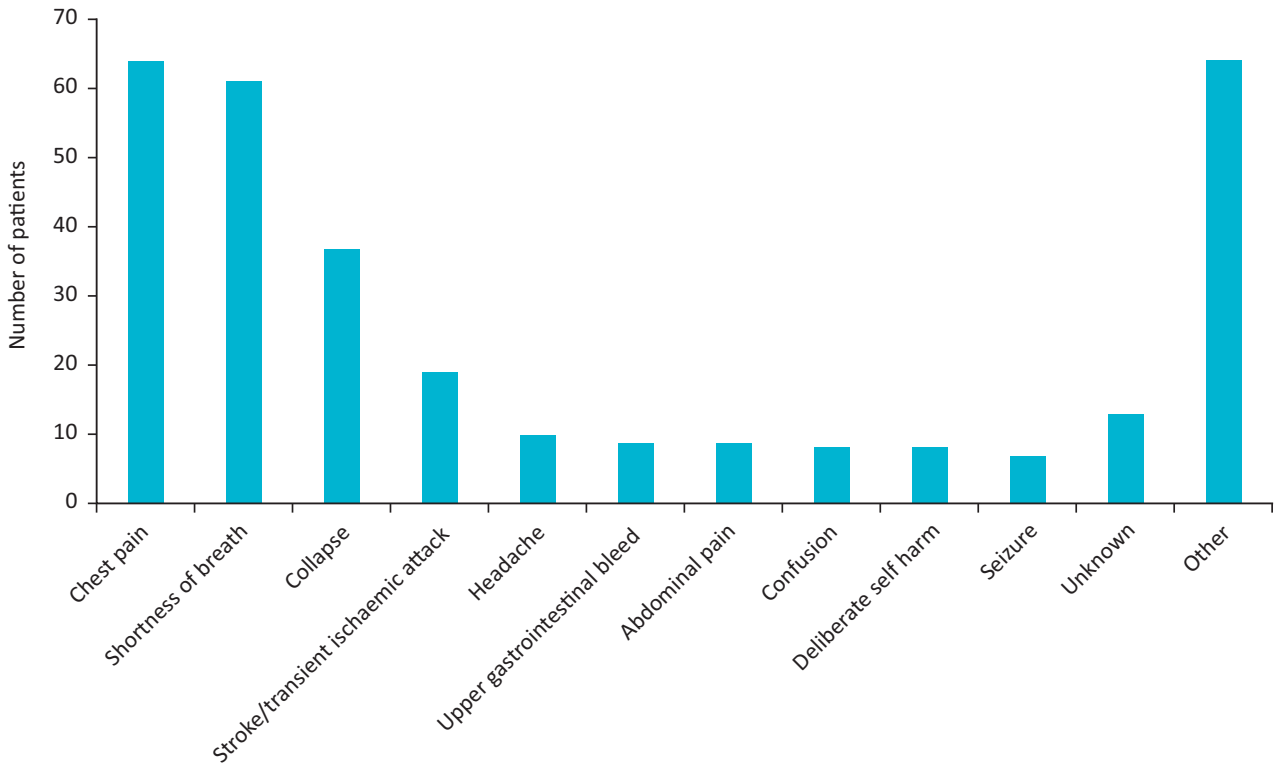


**Fig 1. Presenting complaint.**

**Table 4. Percentage of patients who scored for each variable of the model.**

| Model score | Number of patients | Age | Medication | Admissions | Confusion |
|---|---|---|---|---|---|
| 0 | 69 | 0 | 0 | 0 | 0 |
| 1 | 85 | 15 | 52 | 8 | 8 |
| 2 | 69 | 45 | 88 | 17 | 25 |
| 3 | 17 | 71 | 100 | 12 | 53 |
| 4 | 7 | 100 | 100 | 100 | 100 |

Both before and after the introduction of the new tool, the scoring system was not always used to admit patients to MSSU. This is likely to be a cultural issue because the scoring system is a relatively new tool that might be forgotten or side-lined on a busy ward, and some staff members might not see the benefit of using the score.[9] Some patients were admitted to MSSU with a high score who were not deemed suitable according to the score, because of bed pressures. There were also three 'high care' beds on MSSU where patients requiring cardiac monitoring and/or higher levels of care were admitted regardless of the score; these patients were included in the analysis and would probably have had a longer length of stay and, thus, might have influenced the results. However, these beds did not change before or after the introduction of the new scoring system and should not influence the comparison of the scoring systems.

The data collected on variables affecting length of stay on all medical admissions were collected over 2 weeks in July, typically a quiet time for the emergency department, and so might not have been representative of typical admissions over the winter months. However, this period did cover a wide variety of presenting complaints (Fig 1) that are expected throughout the year. Data were collected on 14 different variables that might have affected length of stay. Some variables have previously been shown to predict a 'failed' short stay, that is, admission for >72 h. These include: inability to independently mobilise, ongoing active treatment, need for specialty consultation, requirement of multidisciplinary assessment, inaccessibility of diagnostic tests, weekend admissions and transfer to intensive care units[4,10,11]. Increasing age has been shown by some to be associated with increased length of stay[4] but not others.[7] We did not include medical opinion on length of stay, which was included in our initial eight-point scoring system, because it was felt that a score that could be calculated by non-medical staff would be easier to achieve. We have shown that the new tool, which does not include a medical opinion, is equivalent to the old

tool at predicting length of stay. The four variables that are significant in predicting length of stay are not related to the current admission or the physiological status of the patient (as reflected by the modified early warning score), and rather reflect the chronic health status of the patient. We propose that this is because most patients who stay in hospital for longer than 3 days do so because of long-term chronic health needs that complicate otherwise simple diagnoses (eg a patient with Parkinson's disease who develops a urinary tract infection) or social needs that might only become apparent when the patient enters the hospital system or when there is a deterioration in their functioning because of an acute illness (eg an elderly patient with dementia who falls at home). Young patients with no comorbidities who become very unwell and need to stay in hospital for >72 h are not picked up by this score.

The Bristol Royal Infirmary is a large city-centre teaching hospital with an attached cardiac tertiary referral centre. We admit all medical patients referred from primary care or the emergency department to the medical admissions unit. Of these patients, 28% are discharged directly from the unit, others are transferred to our MSSU or specialty wards. The average length of stay on our medical admissions ward is 0.9 days. To ensure that this MSSU selection tool works for different patient populations and different systems in other trusts, it will need to be externally validated.

This tool clearly does not identify all patients who would benefit from a MSSU; however, it does identify some significant variables. It does not replace clinical judgment, but we propose that this easy-to-use scoring system (Box 1) can help to select appropriate patients for admission to MSSU with more accuracy than medical and nursing staff using clinical judgment alone, which is the method used to select patients in most units currently. ■

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