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# BMJ Open Lack of weight recording in patients being administered narrow therapeutic index antibiotics: a prospective cross-sectional study

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## ABSTRACT

**Objectives:** Patient weight is a key measure for safe medication management and monitoring of patients. Here we report the recording of patient's body weight on admission in three hospitals in West London and its relationship with the prescription of antibiotic drugs where it is essential to have the body weight of the patient.

**Methods:** A prospective cross-sectional study was conducted in three teaching hospitals in West London. Data were collected during March 2011–September 2011 and July 2012–August 2012, from adult admissions units, medical and surgical wards. Data from each ward were collected on a single day to provide a point prevalence data on weight recording. Patient medication charts, nursing and medical notes were reviewed for evidence of weight and height recording together with all the medication prescribed for the patients. An observational study collecting data on the weight recording process was conducted on two randomly selected wards to add context to the data.

**Results:** Data were collected on 1012 patients. Weight was not recorded for 46% (474) of patients. Eighty-nine patients were prescribed a narrow therapeutic antibiotic, in 39% (35/89) of these weight was not recorded for the patient. Intravenous vancomycin was the most commonly prescribed antibiotic requiring therapeutic monitoring. In total 61 patients were receiving intravenous vancomycin and of these 44% (27/61) did not have their weight recorded. In the observational study, the most frequently identified barrier to weight not being recorded was interruptions to the admission process.

**Conclusions:** Despite the clinical importance of body weight measurement it is poorly recorded in hospitalised patients, due to interruptions to the workflow and heavy staff workloads. In antibiotics a correct, recent patient weight is required for accurate dosing and to keep drugs within the narrow therapeutic index, to ensure efficacy of prescribing and reduce toxicity.

## Strengths and limitations of this study

- Our study is conducted across three hospitals to investigate the relationship between measuring patient body weight and antibiotic dosing.
- In this study we found that nearly 50% of patients admitted to hospital do not have their weight measured.
- In patients receiving narrow therapeutic index antibiotics, where an accurate weight is essential for safe dose calculations, 4 in every 10 patients did not have a weight recorded.
- Part of this gap in practice is due to systems and pathways which need to be simplified and streamlined to minimise workflow disruptions.
- At present, despite the simplicity of body weight measurement there are no simple interventions to improve the rate of patient weight recording in hospitals.

nutritional status (which is independently linked to morbidity and mortality) and for the prescription of a large number of drugs. Measuring and recording patient weight at admission to hospital is necessary as part of the initial nutritional assessment and is a recognised recommendation in many national guidelines in the majority of health-care systems globally.<sup>1–5</sup> The Care Quality Commission now has documentation of weight for hospitalised patients as one of its quality indicators for assessing hospitals.<sup>1</sup> Patient weight needs to be recorded and monitored during hospitalisation for (1) accurate drug dosing, especially for medicines with a narrow therapeutic index, for example, gentamicin and vancomycin, or low-molecular-weight heparins; (2) assessment of response to therapy for example, diuretics; and (3) as an indicator of organ function. Failing to record patient weight is a medication safety issue, especially for patients on multiple medications, narrow therapeutic agents and those



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## INTRODUCTION

For patients admitted into acute hospitals body weight is an important measure of

patients with impaired renal function.<sup>6–8</sup> Furthermore, it is estimated that between 20% and 50% of patients admitted to hospital are malnourished,<sup>9–10</sup> and malnutrition is known to have adverse impact on length of stay and readmission to hospital as well as mortality.<sup>11</sup> Here we examine the practice of weighing and recording of patient body weight on admission to three teaching hospitals in West London. We also examine the relationship between body weight recorded and the prescription of antibiotics where it is necessary to have the body weight of the patient for safe prescribing.

## METHODS

A prospective cross-sectional study was conducted in three hospitals which between them have 1500 beds and are part of a National Health Service Trust. The study investigated the impact of obesity in hospital-acquired infections (manuscript under review).<sup>12</sup> Here we report the findings relevant to weight recording. Data were collected in two episodes during March 2011–September 2011 and July 2012–August 2012. The two episodes of data collection provided point prevalence data on weight recording.<sup>13</sup> Data were collected from all adult admissions units, medical and surgical wards on three hospital sites. Haematology, oncology, obstetrics and paediatric wards were excluded from data collection. This was because the main study was investigating obesity in adult patients, excluding cancer, haematology and obstetrics.<sup>12</sup> All designated wards were included in both episodes of data collection. Data from each ward were collected on a single day to provide a point prevalence snapshot of the practice of weight recording for hospitalised patients. All patients present on the ward at the time of data collection were eligible to be included in the study. Patient medication charts, nursing and medical notes were reviewed for evidence of weight and height records during current admission to hospital. The hospital did not have electronic prescribing in the wards at the time of the study and all records that were used to collect data were paper records. The recorded height and weight were extracted together with the source of information, that is, where they were recorded. Patient medication charts were reviewed and information collected on all medications prescribed at the time of the study. The medical notes were reviewed to collect information on patient demographics, such as age and gender, comorbidities and reason for admission. Patients not present on the ward during data collection, for example, were away for an investigation such as an X-ray would have had their medication/nursing-notes and drug charts taken away with them. These patients' records were not accessible on the ward by the study investigators and were therefore excluded from the study.

For patients included in the study, their records were prospectively scanned 1 year after data collection and data on mortality during the admission period included in this study was collected. The variable 'number of

comorbidities' were used to estimate severity of illness for individual patients.

To assess participants for obesity, in addition to height and weight information, a prevalidated Figure Rating Scale (FRS) was used.<sup>14</sup> To measure obesity using the FRS, each participant who was at their bedside when the investigators were collecting data was independently assessed by at least one of the study investigators and the result recorded. To validate the assessors for rating of obesity using the FRS, wherever it was possible two investigators independently of each other assessed the study participants using the scale. A data collection form was designed and piloted prior to the study. All data were anonymised after full data collection to remove dates of birth and hospital numbers. All data entered into the database were double checked for accuracy and cleaning by one of the researchers.

## Observational study

Additionally, an observation study was conducted to clarify the issues on why body weight is not recorded despite the simplicity of the measurement. The observational study was designed to collect an in-depth assessment on the practice of weighing patients on admission to a hospital ward. Admissions to two randomly selected wards were observed by a medically trained researcher acting as a non-participatory observer. The researcher attended the ward whenever she was notified of an admission and stayed in the ward until the admission process was completed. She documented the observations made during the admission process in a piloted form. In this paper we will report on the observations relevant to weighing patients as part of the admission procedure.

## Data analysis

For analysis of the data a two-part analysis was conducted using STATA V.12 (STATA Corp, College Station, Texas, USA). Univariate associations between patient weight recording and demographic information, comorbidity obesity and status were analysed using  $\chi^2$ , Fisher's exact test and ANOVA tests where appropriate. After preliminary exploration of the data, multivariable logistic regression was used to investigate the association between patient weight recorded and predictors such as demographics, number of comorbidities, hospital site and reason for admission. All the covariates found to have a p value <0.20 in univariate analyses were included into a stepwise multivariate regression model to test predictors for 'weight recording'. The final model included covariates found to be significant in our regression model ( $p < 0.05$ ) and was controlled for confounding factors identified in the literature.

## RESULTS

In each episode of the cross-sectional study 34 wards were visited. These wards represent 1/3 of the available

### Box 1 A summary of the dedicated sections for documenting weight on hospitalised patient records

#### Medical Notes

- ▶ Anaesthetics Notes
- ▶ Admission Documentation

#### Medication Chart

#### Nursing Notes

- ▶ Early Warning Observation Chart
- ▶ In-patient Risk Assessment Booklet
- ▶ Weight Monitoring Chart
- ▶ Nursing inpatient Care Plan Booklet

bed capacity across the hospitals included in this study. Over the two episodes a total of 1338 (741 in 2011, 597 in 2012) patients were admitted to a hospital bed on the wards selected in the study. Of these, 1012 patients (76% of all patients admitted to the wards under study) were included in the study. There were three major sources in which the data on weight and height could be recorded: the nursing notes, medical notes and medication charts with a total of over five different pieces of documentation for each patient where the weight was a requirement (box 1). Of the patients included in the analysis, 46% did not have their weight recorded on any hospital documentation. This gap in weight recording was consistent across the different patient age groups with only a maximum difference of 2% between the groups (table 1).

In total 236 patients were receiving at least one intravenous antibiotic, with 89 (38%) on at least one agent that required therapeutic monitoring and dosing based on weight (table 2). Of the number of courses of narrow therapeutic agents prescribed 35/89 (39%) did not have weight recorded for the patient. Intravenous vancomycin was the most commonly occurring antibiotic requiring therapeutic monitoring that was prescribed. In total 61 patients were receiving intravenous vancomycin and of these 27 (44%) did not have their weight recorded. A number were also receiving one or more other narrow therapeutic antibiotic.

The results of the logistic regression are presented in table 3. The study site, the reason of admission and the presence of comorbidities were the factors associated with weight being recorded. Each additional comorbidity increased the likelihood of patient weight being recorded by 5%. Patients who were recorded as having died during admission to hospital were also significantly

more likely to have had their weight recorded during their stay. These last two factors can be proxy markers for severity of illness. Planned surgery as a reason for admission significantly increased the likelihood of weight being recorded. Obese patients were more likely to have their weight recorded in comparison to the other weight categories, with 56% of the obese having a recorded weight versus 52% for normal/overweight and 53% for underweight (table 4). However, the observed difference did not reach significant levels. Age was not a significant factor in the model although patients in the 65–79 age range the most likely group to have their weight recorded.

In the observation study a total of 18 admissions were observed, the weight of the patients was not measured in 11 of these admissions. Three issues most frequently identified as a barrier to weight being measured were:

1. High workload and/or low staffing level resulting in the body weight being missed out of the admission process (n=6)
2. Interruption in the admission process leading to weight not being recorded (n=9)
3. The complexity of the admission forms led to body weight measurement being missed (n=6).

In the case of eight of these patients body weight was taken from previous hospital records rather than weighing the patient for an accurate current weight.

## DISCUSSION

Patient weight is an essential parameter for medication safety and infection management. Drugs where body weight is important in the dose assessment are often prescribed without a recorded weight. Our study showed that large numbers of patients are not weighed on admission. The reasons for this omission are complex and may result in inaccurate dosing of certain narrow therapeutic index drugs, which could have serious consequences. From a medication safety perspective recording of patient weight is an essential step for the safe administration of many medicines with a narrow therapeutic index. In the case of antibiotics the need to keep drugs within the narrow therapeutic index during therapy, in addition to ensure efficacy and reduce toxicity is of significant importance for mitigating the emergence of resistance. If the antibiotic concentrations fall short of the minimum inhibitory concentrations there is a risk of resistance being developed to the antibiotic

**Table 1** Source of weight information of patients by age category

Source	Age			Total
	17–34 (%)	35–64 (%)	65> (%)	
Drug charts	22 (29)	98 (30)	174 (29)	294 (29)
Medical/nursing notes	16 (22)	75 (23)	153 (25)	244 (24)
Weight not recorded	37 (49)	157 (47)	280 (46)	474 (46)
Total	75 (7)	330 (33)	607 (60)	1012

**Table 2** Proportion of patients with no documentation of weight on intravenous antibiotics that require therapeutic monitoring

Antibiotics (n)	Percentage of episodes of each drug prescribed in class with no weight recorded (n)
Vancomycin (61)	44 (27)
Amikacin (10)	30 (3)
Gentamicin (12)	25 (3)
Teicoplanin (6)	33 (2)
Total=89	39 (35)

being used.<sup>6 7</sup> Using the correct patient weight to accurately dose antibiotics is therefore not only potentially an important patient safety parameter for the patient being treated but is also important considering the need to reduce the risk of the emergence of antibiotic prescribing.

Despite accurate weights being critical for appropriate drug dosing in some patients, the main thrust of government guidelines is that weight is measured for nutritional screening purposes. National Institute for Health and Care Excellence (NICE) guidance on nutritional support in adults recommends that 'all hospital

**Table 4** Recorded weight using the Figure Rating Scale (FRS; n=1012)

N	No recorded weight	Recorded weight	Total
Normal/overweight	333 (47.9%)	362 (52.1%)	695
Obese	98 (43.75%)	126 (56.3%)	224
Underweight	43 (46.2%)	50 (53.8%)	93
Total	474 (46.8%)	538 (53.2%)	1012

Pearson  $\chi^2$  (2)=1.19, p=0.55.

inpatients on admission and all outpatients at their first clinic appointment should be screened. Screening should be repeated weekly for inpatients and when there is clinical concern for outpatients'.<sup>3</sup> Body weight is central to this screening process. The fact that 46% of patients' do not have a recorded body weight suggests that adequate nutritional monitoring is not been carried out and appropriate dosage calculations cannot be made. This particularly important for the elderly cohort who were 60% of the patients hospitalised during this study (table 1). We found no significant difference in the rate of weight recording for different age groups or for different weight categories. In particular the elderly for whom adequate nutrition and nutritional assessment

**Table 3** Multiple Logistic regression analysis examining predictors of for recorded weight among patients from point prevalence audits (n=1012)

Predictors	Unadjusted OR	(95% CI)	Crude p Value*	Adjusted OR	(95% CI)	Adjusted p Value*
Gender						
Female	1†					
Male	1.03	(0.81 to 1.32)	0.79	0.98	(0.76 to 1.27)	0.90
Age (year)	1.00	(0.99 to 1.01)	0.83	1.00	(0.99 to 1.01)	0.71
FRS results						
Normal/overweight	1†					
Obese	1.18	(0.87 to 1.60)	0.28			
Underweight	1.07	(0.69 to 1.65)	0.76			
Number of comorbidities	1.06	(1.01 to 1.12)	0.015	1.05	(1.00 to 1.11)	0.071
Diabetes						
No	1†					
Yes	1.21	(0.91 to 1.61)	0.20			
Hypertension						
No	1†					
Yes	1.06	(0.83 to 1.36)	0.62			
Site						
Hospital 1	1†			1†		
Hospital 2	2.21	(1.62 to 3.02)	<0.001	2.00	(1.45 to 2.75)	<0.001
Hospital 3	1.54	(1.14 to 2.08)	0.005	1.47	(1.08 to 2.00)	0.01
Reason for admission						
A&E admission	1†			1†		
Infection	1.57	(1.17 to 2.11)	0.003	1.50	(1.11 to 2.03)	0.008
Planned surgery	2.00	(1.40 to 2.86)	0.000	1.96	(1.36 to 2.82)	<0.001
Planned procedure	0.59	(0.30 to 1.15)	0.120	0.62	(0.31 to 1.22)	0.17
Other	0.78	(0.24 to 2.48)	0.671	0.86	(0.26 to 2.78)	0.80

\*Statistical significance is based on p value <0.05.

†Reference.



has been proven to make difference in length of hospital stay and mortality.<sup>11 15</sup> Patients, who were 'sicker', were more likely to have their weight recorded, though it is only an association. However, our finding does match a previous study that investigated the recording of weight in patient morbidity data where those defined as being sicker were more likely to have a recorded weight in hospital databases.<sup>16</sup>

Despite important clinical parameters necessitating an accurate assessment of patient weight there remains a gap in practice in the correct documentation of patient weight in hospitals.<sup>6 17-19</sup> The reasons for this gap in practice are manifold. Chief among them is prioritisation and the increasing demand on healthcare professional work loads, in particular the nursing profession.<sup>17 18</sup> Increasing conflicting priorities have resulted in the measurement and recording of hospitalised patients' weight to be given a lower priority in the initial assessment and screening and follow on care. Added to this is the potential that weighing scales and equipment are not universally available in all areas of hospitals and where available they may be faulty. Our observational study highlighted that during the admission process even when a weight is recorded it may have been taken from a previous admission episode rather than a current measured weight, resulting in inaccurate nutritional risk screening and potential for inaccurate drug dosages. Frequent disruptions to the admission process were a common reason given for the body weight recording being missed. Disruptions in the clinical environment and workflow interruptions have been reported as increasing work load of doctors in one observational study.<sup>20</sup> Interruptions to the workflow may increase the workload for all healthcare professionals and the increase in workflow may result in basic, routine activities such as recording patient weight will missed. The fragmentation of care in the admission pathway and the complexity of the paperwork were also important barriers to patients being weighed. That there are multiple pieces of documentation for the recording of weight (drug chart, medical notes, nursing assessment forms) which are not user friendly. However, the multiple use of weight measurements mean it is needed in multiple forms in the patient record. Perhaps if systems were simplified and integrated to ensure that patient weight is only recorded once then adherence to recording and documentation may increase. The use of electronic patient records may help achieve this aim. In addition, the decision architecture of existing systems may need to be adapted to provide fewer choices where weight should be recorded, to assist healthcare professionals in making the desired behaviour to become the routine behaviour.<sup>21</sup> Since weight is an important step in drug dosage and medication safety perhaps the responsibility to ensure patients are weighed and the weight recorded accurately should be with the pharmacy team who screen medication charts in hospitals. In addition the choice environment needs to be addressed to ensure that adequate scales both for measuring mobile and immobile

bed-bound patients are made available in all areas to ensure patients can be weighed accurately. Widespread use of beds which have digital scales will ensure the accurate and dignified weighing of patients who are immobile or bed bound due to severity of illness, for example, in intensive care settings.

## CONCLUSION

Patient weight is currently poorly documented for hospitalised patients, partly due to workflow interruptions and high workloads. There is fragmentation in the process of weighing patients which needs to be addressed by changing the choice environment to streamline how weight is measured and by shifting the responsibility for ensuring patients are weighed to different healthcare professionals. The lack of weight documentation may have adverse consequences in terms of medication safety and nutritional assessment of patients. In antibiotic dosing, for some of the most widely used agents, the need to keep plasma levels within a narrow therapeutic range necessitates accurate dosing. Having an accurate and recent patient weight is an important parameter.

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