Pictorial outcome measures for the hospital care of older patients—a suggested toolkit

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Abstract

Objective: to propose three pictorial methods of presenting hospital outcome data, suitable for use in older patients entering medical specialties (including rehabilitation).

Patients: 224 patients (mean age 80.6 years, 56% female, 75% emergencies) admitted to a department of medicine for the elderly.

Presentational techniques: the methods we propose for the presentation of outcome data are (i) place of discharge, using a two-dimensional diagram; (ii) ‘survival’ analyses, but using discharge from hospital rather than death as the endpoint; and (iii) ‘phase diagrams’, a novel method of charting the progress of a cohort of patients. To illustrate these methods, the relationship between admission case-mix (with patients put into tertiles on the basis of their Barthel index score) and outcome is shown graphically.

Result: each of the three techniques has different relative strengths, but their pictorial nature allows for rapid interpretation of data, showing, for example, the marked influence of case-mix. Separate analyses of subgroups of patients (such as those who die in hospital and those who survive) are also readily attainable by the three methods.

Conclusions: the three methods of presenting outcome should be of benefit in comparing the performance of different units, particularly when case-mix is taken into account. The pictorial methods are complementary both to more conventional patient-based methods (mean duration of stay, median duration of stay, percentile duration of stay, regression analyses etc) and to modelling techniques using ‘census’ data from large numbers of patients.

Keywords: aged, Barthel index, case-mix, geriatrics, length of stay, outcome assessment

Introduction

The most common routine method of measuring hospital outcome is mean duration of stay. However, the mean duration of stay, like other commonly-used methods of measuring bed usage, can be very misleading in geriatric assessment and rehabilitation settings [1, 2]. It can be greatly influenced by a small number of patients with very long durations of stay, who skew the distribution to the right, and, in contrast to the situation in acute short-stay medical specialties, a two- or even three-compartment model may be needed to model patterns of hospital stay in geriatric medicine [2–6]. While parametric methods of analysis (including t-tests, analysis of variance and multiple linear regression [7]) can still be performed on the logarithm of the duration of stay [8], mean duration of stay is an imperfect outcome measure, especially in the absence of information about patient case-mix.

Non-parametric measurements, such as percentiles of the duration of stay (including the 50th percentile, or median) offer an alternative, being much less affected by outlying values [1]. However, while non-parametric statistical tests are available [7], they are less versatile than parametric tests, particularly if multiple factors affect duration of stay and place of discharge.

A recent study of elderly patients admitted to assessment and rehabilitation beds in a department of medicine for the elderly has given new insight into factors affecting duration of stay and place of discharge [9, 10]. A major aim of the study was to devise novel pictorial methods of presenting outcome data which might be suitable for routine use among older patients in a busy care of the elderly, rehabilitation or general
medical unit. It is these pictorial techniques that we describe in this paper. They are intended to be complementary both to traditional methods [1] and to large-sample 'census' or other modelling approaches [5, 6, 11–16].

Patients and methods

We have used data from a series of 223 patients (mean age 80.6 years, 56% women) admitted to the assessment wards of the department of medicine for the elderly at Woodend Hospital, Aberdeen, UK, to illustrate three pictorial methods of presenting data. This unit admits over 3000 patients a year, most of them directly from general practitioners who also have the option of sending patients to the nearby Aberdeen Royal Infirmary. Of the study sample, only 8% were admitted electively, 75% were admitted as emergencies (either directly from their general practitioner or via the accident and emergency department at Aberdeen Royal Infirmary) and the rest were inter-hospital transfers (predominantly for rehabilitation).

The Barthel index score, a well-recognized measure of disability [17], was one of several patient characteristics recorded in the larger study from which our data are taken [9, 10]. It is used in this report as a broad indicator of case-mix, with low scores indicating high levels of physical disability. Patients were divided into tertiles based on their scores 5–7 days after admission. Seventy-four patients scored 0–9 (indicating severe physical disability), 77 scored 10–15 (indicating moderate disability) and 72 scored 16–20 (indicating mild disability).

We used SPSS for Windows version 8.0, Microsoft Excel 1997 and Microsoft PowerPoint 1997 on a personal computer to analyse and display the data.

Results

Three pictorial methods of describing patient outcome are presented: place of discharge (two-dimensional representation), 'survival' analysis using day of discharge as the endpoint and 'phase' diagrams. In each case the data are presented separately for each tertile of disability (Barthel score), demonstrating the value of the methods in comparing groups in which some type of case-mix adjustment has been made.

Place of discharge
(two-dimensional representation)

We classified place of discharge into four categories:

(i) returning home or to the same level of care,
(ii) discharge to a more dependent level of care than on admission,
(iii) still in hospital at 90 days, and
(iv) death in hospital.

Developing a technique used by one of us in a previous study [8], in Figure 1 we have split the four discharge categories into two dimensions—a vertical 'north–south' axis for categories (ii) and (iii) and a longitudinal 'east–west' axis for categories (i) and (iv).

This simple method of presentation is very informative. For example, if large numbers of patients are being discharged to residential/nursing homes or are still in hospital at 90 days, the vertical line gets longer (and the horizontal line gets proportionately shorter). Furthermore, where there is ready availability of nursing- or residential-home places, the vertical line will tend to move 'north', while in situations where prolonged

![Barthel score 0 - 9](image)

![Barthel score 10 - 15](image)

![Barthel score 16 - 20](image)

**Figure 1.** Two-dimensional representation of place of discharge over a 90-day period for 223 patients admitted to the assessment wards with initial Barthel scores of 0–9 (indicating severe physical disability), 10–15 (indicating moderate disability) and 16–20 (indicating mild disability). (Readmissions within 90 days are not recorded.)

The length of each line from the origin of the cross represents the percentage of patients in that category. The vertical line gets longer (and the horizontal line gets proportionately shorter) if large numbers of patients are being discharged to residential/nursing homes or are still in hospital at 90 days. Where nursing- or residential-home places are readily available, the vertical line will tend to move 'north'; where prolonged hospital stay is the norm, the line will tend to move 'south'. High mortality rates shift the horizontal line 'east', while high discharge rates shift the horizontal line 'west'.

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hospital stay is the norm, the line will tend to move ‘south’. High mortality rates shift the horizontal line ‘east’, while high discharge rates shift the horizontal line ‘west’.

Simple visual inspection of data of the type shown in Figure 1, supplemented by χ² analysis [7], is an important preliminary step to the other pictorial methods of analysis described below. For instance, the relationship between Barthel index and duration of stay in patients who survive to leave hospital shows that patients with low Barthel scores have a much higher in-hospital mortality rate, as well as a longer duration of stay.

‘Survival’ analysis using day of discharge as the endpoint
As indicated by the name, ‘survival’ analyses usually use death as an endpoint [18, 19]. However, they are equally suitable for examining other types of endpoint, such as discharge from hospital or the date that a patient becomes medically fit for discharge (which is not always the same thing). This is demonstrated in Figure 2, where the outcome of interest is the proportion of patients remaining in hospital at different times, and where an adjustment for case-mix has been made by dividing patients into three groups on the basis of their Barthel scores. One of the great advantages of survival techniques is that they can accommodate ‘censored’ data, where the event of interest has not yet happened. This means that an investigation into factors affecting length of stay does not have to be delayed until the very last member of a cohort of patients has been discharged from hospital.

As our ‘survival’ techniques use hospital discharge rather than death as an endpoint, consideration must be given as to the correct statistical approach in the case of patients who die during the admission. There are three possible approaches to this problem (although they yield similar results on the particular data set being analysed here). The first and simplest approach, as used in Figure 2, is to exclude from the analysis those patients who die in hospital [8], the second is to include all patients in the analysis regardless of whether their stay ended in discharge or death and the third (see Baillie et al. [20]) is to regard patients who have died as having ‘censored’ durations of stay (as they have not reached the endpoint of interest, which is discharge from hospital).

Figure 2 suggests that there are major differences in the pattern of stay between patients with Barthel scores of ≥ 16 (who have a much shorter duration of stay) and patients with poorer scores. The groups of patients with Barthel scores of 10–15 and 0–9 show similar patterns of duration of stay (although Figure 2 excludes those who died in hospital, an event which Figure 1 shows to be much more likely in those with a low Barthel score). Thus, Figure 2 indicates the likely existence of a relatively homogeneous subgroup of patients with low levels of dependency (Barthel score ≥ 16) who normally progress rapidly through the hospital system, and who might be selected out for audit. Other investigators might want to focus on patients with poorer scores, depending on the purpose of a particular investigation or audit.

The survival package in SPSS [19] calculates the Wilcoxon (Gehan) or log-rank statistic to estimate the probability that the curves in the diagram could be drawn from the same population (P<0.001 for the three curves in Figure 2). Cox regression [18, 19] allows the relative contribution of more than one risk factor (e.g. age and Barthel index) to be estimated, but statistical advice should be sought before using this method [18].

‘Phase’ diagrams
Many older patients go through several phases during a hospital admission. Thus, a patient with a severe stroke might need acute medical management initially, then rehabilitation, and may spend additional time in hospital because there is a delay in obtaining necessary social services support. If there is a single endpoint of interest (such as the length of stay in hospital up to the time that the patient became medically fit to leave), then many of the techniques listed above can be used. We have, however, been exploring the use of ‘phase diagrams’ to give a pictorial representation of inpatient progress and also to look at patterns of readmission. To our knowledge, this method has not been used previously to describe elderly medical inpatients. However,
Thorngren has used similar pictorial methods, which he refers to as 'state diagrams', in long-term follow-up studies of hip fracture patients (C. Currie, personal communication).

Figure 3 shows a set of phase diagrams of patients in the present data set sub-divided on the basis of their initial Barthel scores. A time of 90 days from the time of the admission has been taken, but patients who have been readmitted to the care of the elderly service during that period are also included. To produce a phase diagram of this type, it is necessary to follow patients prospectively to identify when they have passed from one phase to another. In the present study, the team in charge of the patient was asked to state once a week what were the predominant needs of the patient at that point (acute care, rehabilitation, waiting for nursing-home place, etc.). The 'summary' function of SPSS [7] was then used to compile frequency tables for each week of admission, and the 'area' graph facility of Excel was used to draw Figure 3. Minor adjustments to the figure were made using the PowerPoint package.

This format gives an instant visual impression of the phases and of the contrast between the different groups of patients. In this data set, the least disabled group (data for whom are shown in Figure 3c), many of whom are admitted for acute medical problems, spend most of their admission in an 'acute care' phase, with a small proportion entering a 'rehabilitation' phase; few die in hospital, the majority return home quickly and few are readmitted. Very few of this group enter a 'social' phase where the barrier to discharge is the setting up of social support in patients who are otherwise medically fit for discharge. In contrast, Figure 3a shows that patients in the most disabled tertile of patients are much less likely to return home, and tend to stay longer in hospital. Death rates are higher, and many enter phases of treatment where rehabilitation rather than acute care is the main reason for continued hospital admission. Alternatives to returning home ('discharge elsewhere') also feature much more in this group.

Patients with intermediate Barthel scores have a phase diagram (Figure 3b) which is in many ways intermediate between the two extremes, but there is an impression that this group has a greater proportion of readmissions, and that social barriers to discharge are also more important, particularly when deaths are excluded. One explanation is that patients who were previously self-caring but who are admitted as the result of a new moderately disabling illness tend to fall into this intermediate disability category. Home support often needs to be established for the first time in such patients, leading to 'social' delays in discharge and, in a proportion of patients, the failure of a 'trial of discharge' results in readmission.

The large number of possible phases mean that phase diagrams are best interpreted in colour. They appear to be a promising method for describing the progress of
older people in a general medical or geriatric service, and for making comparisons between different services—particularly if definitions of delayed discharge become standardized in the UK and elsewhere [21]. While care must be taken when interpreting phase diagrams based on small patient numbers, they can draw attention to phenomena (such as an apparent increase in the proportion of patients waiting for nursing-home care), which can then be explored in a quantitative and statistical fashion using the other methods described in this paper.

Discussion
A few years ago, the techniques of data analysis and presentation described in this paper would have required access to mainframe computers and specialized reprographics. Now they are available to anyone with a standard personal computer and a few widely-available computer packages, and can readily be used to examine and compare the patterns of outcome of older patients in different acute medical units, geriatric assessment units and rehabilitation units.

They are intended to be complementary to, rather than in competition with, other methods such as the examination of means, medians and percentiles [1, 6, 8], the use of regression [7, 19, 22] and the rapidly developing field of bed modelling [5, 6, 11–16]. While the ready availability of computers has allowed us to use novel analysis and presentation techniques, some of the basic clinical definitions are sanctioned by long use. The 90-day time horizon, for instance, was proposed as a study outcome in a geriatric unit as long ago as 1965 [23].

In common with other recent case-mix studies in older patients [24–33], our paper has shown that it is factors related to case-mix, rather than those related to age, sex and consultant style, that primarily affect the duration of stay and the place of discharge. However, the proposed pictorial methods are particularly good at focusing attention on subgroups of patients who have special characteristics, and can thus stimulate targeted audit studies or projects involving innovative methods of patient management. For example, the hospital trajectories of patients who die can be readily separated from and compared with those of patients who survive.

If, on the other hand, the purpose of an audit is to study the effect of admission case-mix on outcome, this can also be readily visualized. Thus, Figures 1–3 show that mortality is lowest and duration of stay shortest in patients who have an initial Barthel score of ≥16. In contrast, patients with a Barthel score of ≤9 tend to have a much higher mortality rate and a longer stay in hospital, and often have their discharge delayed because of non-medical factors (such as the wait for a nursing-home place).

We are now planning to use the toolkit described in this paper as part of the multicentre ACMEplus project to standardize case-mix and outcome measurement in units in different parts of the UK and the rest of Europe.

Key points

- We propose three pictorial methods for presenting outcome data in older patients admitted to hospital for medical assessment and/or rehabilitation.
- We have used graphical techniques that have recently become readily available through the use of personal computers.
- Together with more conventional measures, these techniques should prove useful to those who wish to evaluate their own performance and compare it with that of others.
- Using these techniques to look at the outcomes of patients admitted for assessment/rehabilitation reveals the great influence of case-mix on outcome in older hospital patients.

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References


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