ORIGINAL ARTICLE

# Relationship between hospital length of stay and quality of care in patients with congestive heart failure

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**Objective:** To determine the relationship between hospital length of stay (LOS) and quality of care in patients admitted for congestive heart failure (CHF).

**Methods:** This observational study was conducted in the medical wards of the Geneva University Hospitals, Geneva, Switzerland. A random sample of 371 patients was drawn from the 1084 patients discharged alive with a principal diagnosis of CHF between January 1997 and December 1998. Explicit criteria grouped into three scores were used to assess the quality of processes of care: admission work-up (admission score); evaluation and treatment during the stay (treatment score); and readiness for discharge (discharge score). The association between LOS and quality of care was analysed using linear regression with adjustment for clinical characteristics.

**Results:** The mean proportion of criteria met were 80% for the admission score, 66% for the treatment score, and 76% for the discharge score. Mean (SD) LOS was 13.2 (8.8) days. The admission score was not associated with LOS, but the treatment score increased by 0.5% (95% CI 0.3 to 0.7; p<0.001) with each additional day in hospital and the discharge score increased by 2.5% (95% CI 1.6 to 3.3; p<0.001) per day from admission to day 10 but remained unchanged thereafter. Adjustment for potential confounders did not substantially modify these relationships.

**Conclusions:** In patients with CHF there is a significant association between LOS and the quality of the treatment provided, as well as with readiness for discharge. Appropriate reorganisation of processes of care should accompany attempts at reducing LOS to avoid detrimental effects on quality of care.

Congestive heart failure (CHF) is among the leading causes of hospitalisation in most developed countries.[1–4] Most of the costs of treating this disease are generated by hospital admissions, so reducing the length of stay (LOS) in hospital may yield significant savings.[2 5] However, understanding a patient's situation, performing investigations, and selecting the appropriate treatment requires time. Shortening the hospital LOS may therefore increase the risk of not completing the evaluations and treatments needed and of discharging insufficiently stabilised patients. On the other hand, once investigations and treatments have been completed, no additional benefit will accrue from extending the hospital stay. Keeping patients in hospital longer than necessary generates unnecessary costs and exposes patients to complications such as nosocomial infections. To understand better how quality of care relates to the duration of hospitalisation, we have examined the relationship between LOS and explicit quality of care criteria in patients with CHF.

## METHODS

### Setting and patients

The study was conducted in the general internal medicine wards of the University Hospitals of Geneva, Switzerland. This 1200 bed urban public hospital is the main community and teaching hospital for the area. A random sample of 371 patients was drawn from the 1084 patients discharged alive with a principal diagnosis of CHF between 1 January 1997 and 31 December 1998. Patients were identified in the hospital medical database using ICD9-CM codes 398-91, 402-01, 402-11, 402-91, 404-01, 404-03, 404-11, 404-13, 404-91, 404-93, and 428.[6]

### Outcome variables

The main outcome variable was the quality of in-hospital care measured by published explicit criteria developed by an expert panel from the Baylor College of Medicine, Houston, Texas in 1993.[7] The criteria were divided into three subgroups corresponding to successive hospitalisation phases: (1) admission work-up; (2) evaluation and treatment during the stay; and (3) readiness for discharge (box 1). The detailed list is available at the website http://www.medinter.ch/grassh.

As many criteria were not applicable to all patients, we calculated the proportion of fulfilled criteria in those applicable to each hospitalisation phase. We thus had three quality scores corresponding to each phase of the hospital stay: an admission score, a treatment score, and a discharge score. All information was abstracted from patients' charts by a trained nurse who was not blinded to LOS, but who was not aware of the fact that LOS was of particular interest in the analysis.

### Predictor variables

The main predictor variable of quality of hospital care analysed was LOS. Other variables were potential confounders:

(1) sociodemographic data: age, sex, and whether the patient lived alone;

(2) medical data: diagnosis of CHF known before admission to hospital, hypertension, diabetes, history of acute myocardial infarction, history of cardiac revascularisation by percutaneous transluminal coronary angioplasty or coronary artery bypass grafting, and intubation during the index stay;

(3) physical and laboratory findings on admission: systolic blood pressure, heart rate, serum sodium level, plasma creatinine level, rhythm and/or ST-T wave changes on admission ECG, and left ventricular ejection fraction.

**Box 1 Explicit criteria of quality of in-hospital care for CHF**

**I. Admission work-up criteria**
- History taking about:
  - symptoms of CHF
  - past history of CHF
  - . . .
- Physical examination:
  - vital signs
  - neck vein distension
  - . . .
- Laboratory tests on admission:
  - blood count
  - serum electrolytes
  - . . .

**II. Criteria for evaluation and treatment during the stay**
- Specific diagnostic tests:
  - diagnostic thoracocentesis, when appropriate
  - echocardiogram, when appropriate
  - . . .
- Treatment strategies:
  - oxygen supply, when appropriate
  - low dose heparin subcutaneously, when appropriate
  - vasodilator therapy
  - . . .

**III. Readiness for discharge criteria**
- Significant improvement in symptoms and signs
- Body weight stable or decreasing
- No change in cardiac medication for at least 24 hours
- . . .

Adapted and summarised from Ashton *et al*.[7] A complete list of the criteria with conditions of applicability and skip patterns are available at http://www.medinter.ch/grassh

**Table 1** Characteristics of the study patients (n=371)

| | |
|---|---|
| Mean (SD) age (years) | 75.5 (11.1) |
| Mean (SD) heart rate on admission (beats/min) | 93 (29) |
| Mean (SD) systolic BP on admission (mm Hg) | 147 (30) |
| Mean (SD) Charlson comorbidity index | 2.7 (2.1) |
| Mean (SD) left ventricular ejection fraction (%) (n=172) | 34 (12) |
| Men, n (%) | 194 (52.3%) |
| Living alone, n (%) | 170 (47.5%) |
| Known prior CHF, n (%) | 156 (43.5%) |
| History of revascularisation, n (%) | 67 (18.1%) |
| History of myocardial infarction, n (%) | 126 (34.1%) |
| Known hypertension, n (%) | 204 (55.0%) |
| Known diabetes mellitus, n (%) | 86 (23.2%) |
| Hypotension on admission, n (%) | 21 (5.7%) |
| Hyponatraemia on admission, n (%) | 60 (16.2%) |
| Creatinaemia >265.2 µmol/l on admission, n (%) | 16 (4.4%) |
| Non-sinus cardiac rhythm on admission, n (%) | 131 (35.6%) |
| New ST-T changes on admission, n (%) | 179 (52.7%) |
| Admission to an ICU, n (%) | 65 (17.5%) |
| Intubation during the stay, n (%) | 13 (3.5%) |

Comorbidities were assessed and scored according to Charlson *et al*.[8] This score assesses whether diseases which were not the cause of the hospitalisation were present at admission. They are rated according to their influence on mid term survival. Diseases that have a minor influence on survival (history of an old myocardial infarction, diabetes without complications, or chronic obstructive pulmonary disease) are scored 1 point; more severe disorders (renal failure, diabetes with complications, cancer, leukaemia or lymphoma in remission for less than 10 years) are scored 2 points; severe hepatic diseases such as cirrhosis with ascites or with upper gastrointestinal bleeding are scored 4 points; and short term life threatening disorders such as metastatic cancer or AIDS are scored 6 points.

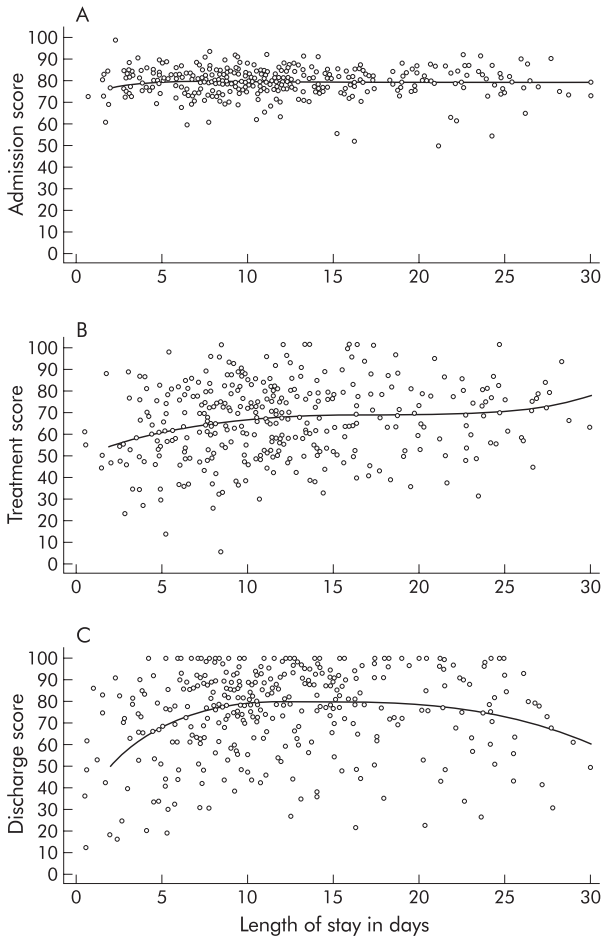


**Figure 1** Relationship between hospital length of stay and scores assessing quality of care: (A) admission score; (B) treatment score; (C) discharge score.

### Statistical analysis

The association between each quality score (admission, treatment and discharge) and LOS was examined using locally weighted smoothing scatterplots (LOWESS).[9] The influence of each additional hospital day on the different scores was tested in linear regression models. Variables reflecting patients' demographic and clinical characteristics that were significantly associated with quality of care in univariate analysis were incorporated into multivariate linear regression models. Two way interactions between LOS and potential confounding variables were also tested. Backward elimination was used until all remaining variables in the models reached a significance level of 0.05 or less.

## RESULTS

The characteristics of the 371 patients included in the study are shown in table 1. None of the patients stayed in hospital for less than 24 hours; the mean (SD) LOS was 13.2 (8.8) days (median 11 days, range 2–77 days). The mean (SD) admission, treatment, and discharge scores were 79.6 (5.8)%, 66.1 (17.2)%, and 76.0 (19.5)%, respectively.

Graphical analysis of the associations between LOS and admission, treatment, and discharge scores (fig 1) showed that:

- the admission score was not associated with LOS (fig 1A) and was not analysed further;

**Table 2** Univariate association between independent variables and the proportion of quality of care criteria observed for evaluation and treatment during the stay (treatment score) and readiness for discharge (discharge score)

| | Treatment score | | | Discharge score | | |
|---|---|---|---|---|---|---|
| | Difference | 95% CI | p value | Difference | 95% CI | p value |
| Length of stay (for each additional day) | 0.48 | 0.3 to 0.7 | < 0.001 | 2.46 | 1.6 to 3.3 | <0.001 |
| Age (for each additional decade) | –4.08 | –5.6 to –2.6 | <0.001 | 2.07 | 0.3 to 3.8 | 0.02 |
| Men | 2.96 | –0.5 to 6.5 | 0.09 | –4.26 | –8.2 to –0.3 | 0.04 |
| Living alone | –0.66 | –4.3 to 2.9 | 0.72 | 5.25 | 1.3 to 9.2 | 0.01 |
| Known prior CHF | 1.85 | –1.8 to 5.5 | 0.32 | –1.28 | –5.4 to 2.8 | 0.54 |
| History of revascularisation | 5.30 | 0.8 to 9.88 | 0.02 | –3.89 | –9.1 to 1.3 | 0.14 |
| History of myocardial infarction | 0.64 | –3.1 to 4.4 | 0.73 | –0.71 | –4.9 to 3.5 | 0.74 |
| Known hypertension | 0.64 | –2.9 to 4.2 | 0.72 | –0.95 | –5.0 to 3.1 | 0.64 |
| Known diabetes mellitus | 0.82 | –3.3 to 5.0 | 0.70 | 0.55 | –4.2 to 5.3 | 0.82 |
| Hypotension on admission | 0.33 | –7.3 to 7.9 | 0.93 | –2.37 | –11.0 to 6.2 | 0.59 |
| Hyponatraemia on admission | –3.18 | –8.0 to 1.6 | 0.19 | 1.75 | –3.7 to 7.2 | 0.53 |
| Serum creatinine >265.2 µmol/l on admission | 2.24 | –6.4 to 10.9 | 0.61 | 3.68 | –6.2 to 13.5 | 0.46 |
| Non-sinus cardiac rhythm on admission | 1.97 | –1.7 to 5.6 | 0.29 | –2.08 | –6.3 to 2.1 | 0.33 |
| Heart rate on admission (for 10 bpm increase) | 0.73 | 0.0 to 1.4 | 0.04 | 0.88 | 0.1 to 1.7 | 0.03 |
| Systolic BP on admission (for 10 mm Hg increase) | –0.18 | –0.8 to 0.4 | 0.56 | 0.19 | –0.5 to 0.9 | 0.58 |
| New ST–T changes on admission | 1.57 | –2.7 to 5.2 | 0.40 | 3.44 | –0.8 to 7.6 | 0.11 |
| Admission to an ICU | 8.82 | 4.3 to 13.4 | <0.001 | –0.38 | –5.6 to 4.9 | 0.89 |
| Intubation during the stay | 7.85 | 0.6 to 15.1 | 0.04 | 2.36 | –6.0 to 10.7 | 0.58 |
| Charlson comorbidity index (for 1 point increase) | –0.15 | –1.0 to 0.7 | 0.73 | 0.14 | –0.8 to 1.1 | 0.76 |
| Ejection fraction (n=172) (for 10% improvement) | –1.62 | –3.5 to 0.3 | 0.09 | –0.19 | –0.5 to 0.1 | 0.16 |

**Table 3** Multivariate association between independent variables and the proportion of quality of care criteria observed for evaluation and treatment during the stay (treatment score) and readiness for discharge (discharge score)

| | Treatment score | | | Discharge score | | |
|---|---|---|---|---|---|---|
| | Difference | 95% CI | p value | Difference | 95% CI | p value |
| Length of stay (for each additional day) | 0.5 | 0.3 to 0.6 | <0.001 | – | – | – |
| Length of stay (for each additional day between days 1 and 10) | – | – | – | 2.6 | 1.7 to 3.4 | <0.001 |
| Age (for each additional decade) | –3.8 | –5.2 to –2.3 | <0.001 | 1.8 | 0.1 to 3.6 | 0.04 |
| Admission to an ICU | 5.1 | 0.7 to 9.5 | 0.02 | – | – | – |
| Living alone | – | – | – | 4.0 | 0.2 to 7.9 | <0.001 |

**Table 4** Association between each additional day of hospital length of stay (LOS) and the odds of fulfilling individual quality of care criteria significantly associated with LOS. Non-significant associations are not shown

| Criteria assessing quality of evaluation and treatment during hospital stay | Eligible patients | Odds ratio (95% CI) per day of LOS | p value |
|---|---|---|---|
| Evaluation and treatment | | | |
| Diagnostic thoracocentesis | 146 | 1.12 (1.05 to 1.19) | <0.001 |
| Echocardiogram | 310 | 1.05 (1.01 to 1.10) | 0.007 |
| 24 h ECG | 33 | 1.32 (1.05 to 1.64) | 0.02 |
| Daily weights obtained | 368 | 1.07 (1.02 to 1.13) | 0.007 |
| Potassium supplement given | 86 | 1.21 (1.04 to 1.41) | 0.01 |
| Low dose heparin or fulldose anticoagulation | 347 | 1.10 (1.03 to 1.18) | 0.004 |
| Readiness for discharge | | | |
| Improvement in dyspnoea | 370 | 1.13 (1.01 to 1.25)* | 0.02 |
| Improvement in neck vein distention | 370 | 1.15 (1.04 to 1.27)* | 0.007 |
| Improvement in pulmonary auscultation | 368 | 1.12 (1.01 to 1.24)* | 0.03 |
| Body weight stable or decreasing | 359 | 1.14 (1.02 to 1.28)* | 0.02 |
| Temperature <38.5°C in last 24 h | 371 | 1.14 (1.02 to 3.86)* | 0.04 |
| No change in cardiac medications in last 24 h | 353 | 1.21 (1.10 to 1.34)* | <0.001 |
| INR reached a plateau | 109 | 1.23 (1.00 to 1.51)* | 0.05 |
| Plans for post-discharge care stated on chart | 371 | 1.17 (1.06 to 1.28)* | 0.001 |

*Odds ratio (95% CI) per day of LOS up to day 10.

- the treatment score was linearly associated with LOS (fig 1B) and was further analysed in a simple linear model;
- the discharge score was associated with LOS during the first 10 days in hospital (fig 1C) so further analysis was focused on the initial phase of the hospitalisation.

Each additional day in hospital was associated with an increase in the treatment score of 0.5% (95% CI 0.3 to 0.7; $p<0.001$) and each day of LOS between days 2 and 10 was associated with an increase in the discharge score of 2.5% (95% CI 1.6 to 3.3; $p<0.001$).

Unadjusted analysis (table 2) showed that a higher treatment score had a significantly positive association with younger age, a history of myocardial revascularisation, a faster heart rate on admission, admission to an ICU during the hospital stay, and undergoing an intubation during the hospital stay; it had a significantly negative association with age. The discharge score was higher in women, older patients, those living at home alone, and in patients with a faster heart rate on admission.

In multivariate analysis (table 3) the treatment score remained positively associated with each additional day in hospital, admission to an ICU during the stay, and younger age, while each additional day between days 2 and 10, older age, and living at home alone were positively associated with a higher discharge score. However, none of these potential confounders substantially modified the relationship between LOS and either the treatment or the discharge scores.

Associations between each individual quality of care criteria and LOS varied from one criterion to the next. In unadjusted analysis (table 4) LOS was significantly associated with the following treatment criteria: performance of a diagnostic thoracocentesis; performance of an echocardiogram; performance of a 24 hour electrocardiogram; weight measurement obtained daily; restriction of activity; and use of low dose heparin. LOS between days 1 and 10 was significantly associated with the following discharge criteria: improvement in dyspnoea; improvement in pulmonary auscultation; improvement in neck vein distension; stable or decreased body weight; and no change in cardioactive medications during 24 hours before discharge. The other criteria showed no relationship with LOS.

## DISCUSSION

At our institution each additional hospital day was significantly and independently associated with the proportion of fulfilled criteria assessing the quality of evaluation and treatment during the stay of patients with CHF. The same was true for criteria assessing the readiness for discharge up to day 10. In contrast, fulfilment of criteria assessing the completeness of the admission work-up was not related to LOS. The latter finding is not surprising since admission work-up takes place in the first 2 days of the hospital stay and is therefore logically independent of the subsequent duration of the hospital stay. The theoretical coherence of this negative finding lends credibility to the positive associations that we found between LOS and other aspects of quality of care.

In principle, tests and treatments can be organised effectively to allow a short LOS without compromising quality of care. However, the relationship that we observed between LOS and the fulfilment of criteria assessing the quality of care suggests that reducing LOS beyond a certain limit may jeopardise quality of care.

Because this was an observational study we do not know whether a deliberate reduction in LOS, especially if it is accompanied by an intervention to maintain standards of care, would have a similarly deleterious impact on quality of care. Several studies have shown no detrimental effects of shorter hospital stays on various patient outcomes such as hospital readmissions or death in the weeks following discharge.[10–12] This apparent contradiction may be explained by the fact that these outcomes were more closely related to patient characteristics than to in-hospital quality of care[13 14] or that the quality of ambulatory care after the stay may have corrected substandard care during the hospital stay, especially if the patients were included in a formal post-hospitalisation programme.[15]

A relationship between long LOS and the occurrence of in-hospital complications has been reported.[16–18] In these studies, however, long LOS is often a consequence of a complication which, in turn, may be related to poor quality of care. The causal link is therefore reversed. In the present study we did not have sufficient power to show an association between quality of care and poorer survival after discharge. However, we found a significant association between lower discharge score and increased unplanned early readmissions.[14]

**Key messages**

- In patients admitted to hospital with congestive heart failure, a significant association was found between length of stay and the quality of treatment provided, as well as with readiness for discharge.
- Adequate care may require a sufficient length of stay.
- Reducing the length of stay may affect quality of care, unless processes of care are redesigned accordingly.

The mean LOS of 13.2 days observed in our study exceeds that reported from the USA[1 12] but is similar to that of other countries such as Scotland,[19] the Netherlands,[20] and Italy.[21] There is probably an important potential for shortening LOS in European countries. Our data suggest that careful reorganisation of the process of care should accompany any attempt to reduce LOS to avoid detrimental effects on quality of care.[22] Two instruments which may help to achieve this are a critical pathway describing the procedures to be performed[23 24] and a tool to identify unnecessary delays generated in the process of care.[23–25] The implementation of a critical pathway is one of the changes we plan to implement in our department. In this project, updated explicit quality of care criteria for patients with heart failure will be presented in the format of a criteria map, allowing physicians to verify the sequence, the timeliness, and the completeness of care provided to such patients. In addition, the criteria map will be used in retrospective chart reviews to monitor quality of care. Corrective measures will follow such observations.

One limitation of our study lies in its observational design. Without a controlled intervention, we can only speculate on the causality of associations between LOS and quality of care. Furthermore, because the data were abstracted from medical records, imperfect documentation may have diluted the observed associations. Since patients who died during hospitalisation were not included in the study—because one of its purposes was to assess the association between all three score of quality of care (admission, treatment and discharge) and LOS—we cannot rule out a different pattern of quality of care during the stay among these patients. Finally, the quality of care criteria that we used were rather simple and each considered only a segmented view of the care process; it is therefore possible that we may have missed some more subtle or holistic aspects of quality of care.

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