

**HOSPITAL RE-ADMISSION RATES:
LITERATURE REVIEW – FULL REPORT**

**Alastair Mason, Edel Daly and Michael Goldacre
National Centre for Health Outcomes Development**

July 2000

UNIT OF HEALTH-CARE EPIDEMIOLOGY

UNIVERSITY OF OXFORD

REPORT MR3



record-based

O

U

T

C

O

M

E

measures

**UHCE OXFORD REPORT MR3
HOSPITAL RE-ADMISSION RATES: LITERATURE REVIEW**

**Alastair Mason, Edel Daly and Michael Goldacre
National Centre for Health Outcomes Development
July 2000**

CONTENTS

Chapter 1	Introduction	2
Chapter 2	Studies to identify predictors and causes of re-admission	4
Chapter 3	Studies to assess the effect of length of stay on re-admission risk	30
Chapter 4	Studies examining whether re-admissions are preventable and the relationship to quality of care in the index admission	42
Chapter 5	Studies to assess the use of re-admission rates in comparing hospital performance	51
Chapter 6	Studies to examine technical issues in compiling re-admission rates	55
Chapter 7	Summary of findings from the literature review	61
	References	65

INTRODUCTION

Over the last ten years there has been increasing interest in using re-admission rates as an outcome indicator to make comparisons over time and between hospitals. Re-admission was considered to be a potential indicator of poor outcome in seven of the ten health outcome indicator reports published by NCHOD in 1999. In view of the increasing importance that information about re-admissions is likely to have, the Department of Health commissioned NCHOD (Oxford) to prepare a detailed review of the use of re-admission rates as a health outcome indicator.

This report contains:

- Summary of the key issues relating to re-admission rates.
- Detailed review of the literature about the use of re-admission rates.

Key issues

Unforeseen re-admissions may be a consequence of the natural course of the patient's disease or may result from sub-optimal care during the first admission. Because of the possible link between unplanned re-admission and sub-optimal quality of care, variation in quality of care, either over time or between hospitals, might result in variation in re-admission rates.

The *calculation* of re-admission rates requires the linking of two hospital episodes that meet specified criteria occurring within a specified time period. The main issues relating to this are:

- methodology used to link hospital episodes and the completeness of matching
- definition of index admission in terms of diagnostic specificity
- definition of a re-admission in terms of:
 - type of admission (emergency and/or elective)
 - diagnostic specificity
- time period chosen within which events must occur
- risk adjustment for factors such as age, sex or case-mix
- accuracy and completeness of data required for derivation of the indicator, particularly diagnosis and procedure recording and coding.

The *usefulness* of an outcome indicator will depend on:

- attributability of the outcome measured to the quality of health care
- reliability of the indicator
- sensitivity of the indicator to changes or variation in the quality of health care.

Key issues relating to the *interpretation* of re-admission information are:

- statistical power, relating to the adequacy of the number of events and size of the population denominators to show significant variations
- extent to which expectations of performance can be quantified by defining benchmarks
- creation of perverse incentives and games playing.

Literature search questions

The particular interest in re-admission rates currently in the NHS is related to whether they are good indicators for comparing clinical performance over time and between hospitals. Therefore, in reviewing the literature an attempt has been made to address the following questions:

- Do properly compiled re-admission rates reflect the quality of care in the index admission? (see Chapter 4).
- Are re-admission rates avoidable or preventable? (see Chapter 4).
- Are re-admission rates a useful way of comparing hospital performance? (see Chapter 5).
- What factors other than quality of care in the index admission influence re-admission rates? (see Chapter 2).
- Does the index admission length of stay influence re-admission rates? (see Chapter 3).
- How should re-admission rates be compiled if they are to reflect the quality of care in the index admission? (see Chapter 6).

Search strategy

Various free-text searches were performed in Medline, EMBASE and PsychLIT for the years 1990 to 2000 using various combinations of the following words and phrases:

re-admission; readmission; re-hospitalisation; rehospitalisation; hospitalisation; patient admission; hospital admission; patient discharge; hospital discharge; or postoperative complication;

combined with:

quality indicator; outcome indicator; clinical indicator; performance indicator; quality of health care; quality of care; quality assessment; outcome assessment; process assessment; preventability; avoidability; quality comparisons; quality assurance; quality improvement; hospital performance; hospital standards; league table; health services research; health policy; length of stay; statistics and numerical data; surgical volume; or record linkage.

In addition, a number of other strategies were employed to identify relevant publications. These included:

- electronic searching for publications by key researchers working in the field
- electronic searching for publications which cited key papers on this subject
- hand searching of reference lists of key papers
- electronic or hand searching of recent issues of journals where relevant significant papers are most likely to appear (e.g. Medical Care; Quality in Health Care).

STUDIES TO IDENTIFY PREDICTORS AND CAUSES OF RE-ADMISSION

A number of studies have been done to identify:

- predictors or risk factors for re-admission
- reasons or causes for re-admission.

The studies can be classified by patient group as those involving:

- general population of patients
- elderly patients
- patients with medical conditions
- patients with mental illness
- patients after surgery
- paediatric patients
- maternity patients.

General population of patients

The studies done on a general population of patients that have been reviewed are:

- *Fink (1993)* studied patterns of hospitalisation amongst all admissions made in 1977 to non-psychiatric units by residents of two Danish municipalities.
- *Johansen (1994)* studied hospital utilisation patterns for 1989/90 for residents of two Canadian states.
- *Librero (1999)* analysed 106,673 admissions in Valencia.
- *Waite (1994)* conducted a retrospective case-control study to examine the association between patients' measured burden of disease and risk of hospital re-admission
- *Weissman (1994)* carried out a prospective study in four Massachusetts hospitals to assess the impact of socio-economic status and other social factors on the risk of re-admission in approximately 12,000 patients.
- *Holloway (1990)* identified demographic, clinical, and social risk factors for re-admission within 30 days of discharge among a random sample of 6,317 veterans.

Fink (1993) found that:

- Predictors of re-admission were mental illness and multiple co-morbidities.
- Gender, age and length of stay were not related to re-admission rates.

Johansen (1994) found that:

- Re-admission rates in the two states were 11 and 12%.
- Re-admission rates increased with age from 50 onwards.
- Cancer diagnoses were associated with highest re-admission rates.

Librero (1999) found that the highest co-morbidity as measured by the Charlson Index was associated with increased re-admission at 30 and 365 days. However, the 365 day rate of re-admission in the group with the greatest co-morbidity dropped, probably due to an increase in mortality after hospitalisation.

In the *Waite (1994)* study none of the five validated indices studied (Charlson, Kaplan-Feinstein, Index of Coexistent Disease, Smith, adapted Charlson) discriminated among patients who did and those who did not have six-month hospital re-admissions. Indices varied in their ability to capture individual heterogeneity and in inter-observer variability.

In the *Weissman (1994)* study, after adjustment for age, gender, hospital, severity of illness, and the overall probability of re-admission within each diagnosis related group, significant predictors of risk of re-admission within 60 days included:

- being poor (OR = 1.25, $p < 0.05$)
- unskilled or semiskilled occupation (OR = 1.25, $p < 0.05$)
- living in rented accommodation (OR = 1.23, $p < 0.01$).
- non-white (OR = 0.76, $p < 0.01$)
- uninsured (OR = 0.48, $p < 0.01$).

Significant predictors of risk of re-admission within seven days included:

- living in rented accommodation (OR = 1.32, $p < 0.05$)
- non-white (OR = 0.72, $p < 0.05$)
- uninsured (OR = 0.36, $p < 0.05$).

The following factors were not significantly associated with risk of re-admission:

- marital status
- living situation
- availability of help at home.

In the *Holloway (1990)* study, 22% of patients had early re-admissions. Significant predictors ($p < 0.05$) of early re-admission included:

- discharge from a geriatrics/intermediate care bed (OR = 2.75 relative to medical ward)
- discharge diagnosis of a chronic disease (OR = 2.03-2.67 relative to acute or self-limiting disorders)
- two or more surgical procedures performed (OR = 1.87 relative to no surgery).

Other predictors of re-admission included:

- increasing distance from the VA hospital (OR = 1.18)
- increasing age also added re-admission risk (OR = 1.10).

Factors not significantly predictive of re-admission included:

- length of stay
- marital status
- place of disposition.

Elderly patients

The studies done on elderly patients that have been reviewed are:

- *Caplan (1998)* studied the social factors influencing the re-admission of 468 patients over 75 discharged from a hospital emergency department.

- *Chu (1999)* reviewed the significant factors for re-admission by carrying out a case control study with 380 elderly patients who were emergency re-admissions and 380 matching controls.
- *Di Iorio (1998)* studied patient characteristics accounting for re-admission in 379 patients admitted to acute geriatric care units.
- *Marcantonio (1999)* studied patient characteristics associated with re-admission by carrying out a case control study with a group re-admitted within 30 days and a group who had not who were matched by principal diagnosis.
- *Kwok (1999)* studied factors predicting re-admission in 1204 elderly medical patients.
- *Koenig (1999)* studied the effect of depression on the re-admission rate of 331 elderly patients discharged from hospital, 48% of whom were diagnosed as being depressed.
- *Whittle (1998)* analysed the provider characteristics influencing re-admission rates for 22,294 elderly patients who had had pneumonia.
- *Experton (1999)* sought to identify whether hospital re-admissions varied among frail elderly in managed care as opposed to those paying fee for service.
- *Colledge (1994)* studied factors related to re-admission among 226 consecutive patients aged over 75 years discharged following an acute medical admission to a district general hospital.
- *Victor (1985)* reviewed the significant risk factors for re-admission within three months among a 4% random sample of patients aged 65 years and over discharged from non-psychiatric NHS hospitals in Wales.
- *Williams (1988)* used a case-control design to identify the principal causes of early unplanned re-admission among a random sample of 133 elderly patients re-admitted to a district general hospital within 28 days of discharge.
- *Kane (1998)* studied the effect of type of post-discharge care in a cohort of older Medicare patients with stroke or hip fracture on the risk of re-admission in the year following discharge from one of 52 hospitals.
- *Fisher (1994)* compared the re-admission rates among older (≥ 65 years) medical/surgical Medicare patients in two different geographical areas and examined the potential relationship with mortality in a three-year follow-up study.
- *Victor (1990)* examined re-admissions within six months among 386 patients aged 65 and over admitted to one of two London hospitals in May 1988 and discharged alive, in an attempt to identify risk factors for re-admission.
- *Wei (1995)* undertook multivariate logistic regression analysis of data on discharge screen results (assessed by Peer Review Organizations) for a 3% random sample of Medicare beneficiaries (aged 65 years or older) admitted to California hospitals during 1987-1988 ($n = 20,136$), to evaluate whether patient mortality and re-admission within 30 days may be affected by possible errors in care at discharge.
- *Townsend (1988)* compared re-admission rates over 18 months among 903 patients aged over 75 years randomised to a community-based discharge

scheme (involving care-attendant support on the first day back home and for up to 12 hours per week for two weeks) or to standard aftercare.

- *Reed (1991)* identified risk factors for early (within 14 days or less) re-admission among 155 cases and matched 155 controls from a sample of male veterans aged 65 years and over.
- *Kelly (1992)* assessed risk factors for re-admission to a geriatric medical unit within one year of discharge among 211 patients.
- *Graham (1983)* assessed reasons for re-admission to a geriatric medical unit within twelve months of discharge from any hospital in the district among 153 re-admitted patients.
- *Gooding (1985)* investigated the effect of diagnosis on the risk of re-admission among 444 elderly patients (aged 65 years or older) with a primary discharge diagnosis of cerebrovascular disease, hip fracture, or congestive heart failure.
- *Fethke (1986)* assessed risk factors for unplanned re-admission within six weeks, six months, and one year after discharge among 101 patients (aged 70 years or above) discharged to the community from an acute-care hospital.
- *Riley (1986)* examined characteristics of re-hospitalisation within 30 days of discharge following eight common surgical procedures among aged Medicare patients.
- *Anderson (1985)* identified predictors of re-admission to an acute care hospital within 60 days of discharge among a nationally random sample of Medicare patients.

In the *Caplan (1998)* study, the main social risk factors for re-admission in 28 days were:

- dependence in bathing (RR=2.41 and 95% CI 1.32-4.41)
- dressing (2.38 and 1.22-4.63)
- finance (1.66 and 1.23-2.25)
- using the stairs (1.60 and 1.09-2.33)
- transport (1.61 and 1.25-2.06)
- shopping (1.39 and 1.12-1.73).

In the *Chu (1999)* study, significant risk factors for re-admission within 28 days identified in the multivariate logistic regression model were:

- end stage renal failure (OR=5.48 and 95% CI 1.69-17.75)
- adverse drug reaction (4.19 and 1.56-11.2)
- dysphagia (3.90 and 1.50-10.11)
- advanced malignancy (2.45 and 1.37-4.37)
- no income (2.28 and 1.19-4.37)
- chronic obstructive airways disease (2.10 and 1.47-3.02)
- congestive heart failure (1.63 and 1.05-2.53)
- number of co-morbidities (1.30 and 1.13 -1.49)
- number of activity of daily living impairments (1.13 and 1.08-1.19).

In the *Di Iorio (1998)* study it was concluded that interventions aimed at improving unsatisfactory social conditions may reduce re-admission rates. Re-admissions were classified as early (within three months), late (between three and six months) and multiple (two or more). The control group were patients not re-admitted.

The main findings using univariate analysis were:

- Early re-admissions were sicker, had more social problems and were more functionally impaired than controls.
- Late re-admissions were sicker than controls.
- Multiple re-admissions were sicker and had more social problems than controls.

Using multivariate analysis the main findings were:

- Early re-admission was associated with unsatisfactory social conditions, living alone, severity of disease and cognitive impairment.
- Late re-admission was associated with co-morbidity only.
- Multiple re-admission was associated with unsatisfactory social conditions and to initial hospital admission.

In the *Marcantonio (1999)* study, patient characteristics significantly associated with re-admission within 30 days were:

- history of depression (OR=3.2; 95% CI 1.4-7.9)
- five or more co-morbidities (OR=2.6; 95% CI 1.5-4.7)
- aged over 80 (OR=1.8; 95% CI 1.0-3.2).

In the *Kwok (1999)* study risk factors were identified by multiple regression for re-admissions within 28 days, recurrent re-admissions and avoidable re-admissions. The main findings were:

- Rate for 28 day re-admission was 18%, 6% had recurrent and 3% avoidable re-admissions.
- Recent hospital stay predicted all types of re-admission.
- Re-admission at 28 days was predicted by length of stay, Barthel Index of activities of daily living and unresolved medical problems.
- Recurrent re-admission was predicted by poor family support, residence in a home for the elderly and unresolved medical problems.

Koenig (1999) found that the elderly patients who had depression had higher rates of re-admission even after physical health status had been controlled for.

Whittle (1998) found that, after adjusting for patient factors, re-admission rates were not related to hospital teaching status, specialty of physician or urban location.

Experton (1999) concluded that policies promoting stringent utilisation control may be problematic for the frail elderly. The odds of having a preventable re-admission within 90 days were 3.5 (p=0.06) to 5.8 (p=0.02) times as high for HMO enrollees compared to those paying fee for service.

Colledge (1994) found that increased risk of re-admission within six months was associated with:

- admission in the year prior to the index admission
- a higher number of co-morbidities
- a higher use of social services
- the absence of a carer.

Risk of re-admission did not appear to be associated with:

- age or gender
- mental test score
- home circumstances
- diagnosis
- length of stay.

In the *Victor (1985)* study the proportion of re-admissions did not demonstrate any significant association with social or demographic characteristics of patients. Rather, re-admissions appeared to be due to a relapse or breakdown of the original medical condition.

In the *Williams (1988)* study seven principal reasons for early unplanned re-admission were identified following interviews of patients, their carers, the ward sisters, and the patients' general practitioners. They were:

- relapse of original condition (51%)
- development of a new problem (15%)
- carer problems (14%)
- complications of the initial illness (5%)
- need for terminal care (6%)
- problems with medication (6%)
- problems with services (3%).

In most cases of unplanned re-admission there were also contributory factors. Those implicated in over one-third of cases were:

- carer problems (83%)
- premature discharge (58% in carer's or patient's opinion, 31% in GP's opinion)
- lack of information from hospital to GP (47%)
- living alone (43%)
- poor health on discharge in patient's or carer's opinion (37%)
- inadequate preparation for discharge (37%).

It was thought that unplanned re-admission was avoidable for 78 (59%) patients. Risk of re-admission was associated with:

- low income
- previous hospital admission
- ongoing nursing care
- admission by general practitioners.

In the *Kane (1998)* study it was found that in general, the more disabled patients went to nursing homes and rehabilitation, but the overlap in distribution was sufficient to conduct the analyses. The significant findings were:

- Hip fracture patients discharged to home health care had the highest adjusted re-hospitalisation rate whereas hip fracture patients discharged to nursing homes had the lowest adjusted re-hospitalisation rate ($p < 0.05$).
- Stroke patients discharged to home health had the lowest re-hospitalisation rates ($p < 0.05$) while stroke patients discharged to nursing homes had the highest mortality rate ($p < 0.01$).

In the *Fisher (1994)* study, the main findings were:

- Higher re-admission rates were found in Boston as compared with New Haven for each of five diagnostic cohorts (acute myocardial infarction; stroke; gastrointestinal bleeding; hip fracture; potentially curative surgery for breast, colon, or lung cancer) and each age, sex, and race sub-group examined.
- The relative rate of re-admission in Boston as compared with New Haven was 1.64 (95% CI 1.53-1.76) for all cohorts combined.
- No relation was found between mortality (within 30 days after discharge or over the three-year follow-up) and either community-specific or hospital-specific re-admission rates.
- These findings could not be explained by differences in the severity of illness.
- A threshold effect of hospital-bed availability on decisions to admit patients is a possible explanation for the above findings.

In the *Victor (1990)* study the main findings were:

- Re-admission rates were not related to the demographic characteristics of patients.
- Re-admissions within six months were significantly higher among those with a previous hospital admission in the 12 months before the index admission (46% v 32%, $p=0.05$) and there was no difference between the two groups in the proportions admitted within 14 days.
- The average length of stay of re-admitted patients was 12 days compared with 15 for those not re-admitted and consistently patients re-admitted had a shorter length of stay than those not re-admitted.

In the *Wei (1995)* study, results were adjusted for other patient characteristics. Key findings were that four discharge screens indicated an increased risk of a post-discharge adverse outcome (mortality or re-admission within 30 days):

- absence of documentation of discharge planning
- elevated temperature at discharge
- abnormal pulse at discharge
- un-addressed abnormal test results at discharge.

Three other discharge screens examined were unrelated to post-discharge adverse outcomes:

- abnormal blood pressure at discharge
- IV fluids or drugs at discharge
- wound drainage before discharge.

Townsend (1988) compared re-admissions among 903 elderly patients randomised to a community-based discharge scheme or to standard aftercare. Key findings were:

- Emergency re-admissions over the ensuing 18 months were significantly higher in the control group than in the intervention group and their average length of stay was longer (30.6 days compared with 17.1 days).

- Patients initially admitted as emergencies were significantly more likely to be re-admitted than those first admitted on a planned basis (12% compared with 5% within four weeks and 26% compared with 11.5% within three months).
- Among those who lived alone, people who received only standard aftercare were re-admitted more than twice as often as those who had been supported by care attendants ($p < 0.01$).
- It was concluded that 'emergency re-admission may be an indication of the breakdown of a patient's independence in the community'.

Reed (1991) found that risk factors associated with re-admission risk were:

- two or more hospital admissions in the previous year (OR = 3.06)
- any medication dosage change in the 48 hours prior to discharge (OR = 2.34)
- a visiting nurse referral for follow-up (OR = 2.78).

A factor found to be inversely associated with risk of re-admission was:

- discharge from the geriatric evaluation unit (OR = 0.09).

Kelly (1992) found that the main reasons for re-admission were:

- deterioration of existing disease (47.4%)
- new medical events (33.2%)
- poor management of previous discharge (9.5%)
- social problems (5.7%).

In the study by *Graham (1983)*, reasons for re-admission included:

- unavoidable clinical deterioration (32%)
- inadequate medical management (21%)
- non-compliance of patient (20.2%)
- social problems (18.3%)
- inadequate rehabilitation (8.5%).

Gooding (1985) found that 24% of patients were re-admitted to the same institution at least once during the six-month follow-up period. Patients with a primary diagnosis of congestive heart failure were at highest risk of hospital re-admission (36%).

In the study by *Fethke (1986)*, 47 out of 101 patients experienced at least one unplanned re-admission within one year of discharge. Significant predictors of re-admission in the short term included:

- sex
- being widowed
- a weighted severity-of-illness factor
- life satisfaction.

Additional variables which were significant in the long term included:

- previous hospitalisation
- admission and discharge location.

Riley (1986) found that for re-hospitalisations within 30 days of discharge:

- Rates varied considerably among procedures.
- Rates increased with older age.
- Principal diagnoses were often related to the body system on which surgery was initially performed.

Anderson (1985) used logistic regression analysis to identify predictors of re-admission within 60 days. The best predictors of re-admission included:

- patient's disease history
- patient's diagnosis.

Patients with medical conditions

The studies done on patients with medical conditions that have been reviewed are:

- *Maynard (1997)* studied predictors of re-admission in patients who had had an acute myocardial infarction.
- *Philbin (1999)* studied the significant determinants of re-admission in 42,731 patients who were discharged with a diagnosis of congestive heart failure.
- *Krumholz (1997)* studied the reasons for and predictors of re-admission in 17,488 patients who were discharged with a diagnosis of congestive heart failure.
- *Kossovsky (1999)* studied 5,828 patients discharged from an internal medicine department to identify the risk factors associated with planned and unplanned re-admissions within 31 days.
- *Shipton (1996)* reviewed 13 articles on risk factors for re-admission of medical patients.
- *Yusuf (1998)* looked at the association between rates of invasive and revascularisation cardiac procedures and the risk of re-admission for unstable angina in a six-month follow-up study among 7,987 consecutive patients presenting with unstable angina or suspected myocardial infarction without ST-segment elevation recruited prospectively from 95 hospitals in six countries.
- *Herlitz (1988)* studied the relationship between size of myocardial infarct and risk of re-hospitalisation in a five-year follow-up study of 809 patients with recent myocardial infarction.
- *Sacco (1991)* looked at ethnic factors in relation to two-year re-admission rates among 1,034 patients aged over 39 years and resident in Northern Manhattan, who were hospitalised for stroke between 1983 and 1986.
- *Libbus (1997)* examined psychological and social factors associated with early (within four months of discharge) re-admission among 100 persons (aged 25-74 years) with a primary discharge diagnosis of ischaemic heart disease.
- *Corr (1995)* investigated the influence of rehabilitative intervention by an occupational therapist on outcomes among 110 stroke patients (aged 41-96 yrs) after their discharge from a stroke unit.
- *Woo (1992)* assessed 304 Chinese patients with acute stroke at three and 20 months to determine survival, disability, and rate of re-admission.

- *Primates* (1995) examined predictors of re-admission among patients with Crohn's disease and ulcerative colitis using data from the Oxford Record Linkage Study (ORLS) for the period 1970-1986.
- *Crane* (1992) studied risk factors for re-admission among people (aged 5-45 years) admitted for asthma during 1981-1987 in New Zealand by comparing 226 patients re-admitted for asthma within 12 months of discharge, with 263 control patients chosen from all index admissions.
- *Heard* (1997) examined the association between gender and the risk of re-admission in a cross-sectional study of people admitted for asthma to a low socioeconomic status (SES) hospital and a moderate-high SES hospital.
- *Stewart* (1999) conducted an 18-month follow-up study of a cohort of "high-risk" patients with congestive heart failure randomly assigned to receive either usual care (n=48) or a single home-based intervention (HBI) (n=49) immediately following hospital discharge, to examine the duration of the beneficial effect of the HBI on the risk of unplanned re-admission.

In the *Maynard* (1997) study, re-admission following myocardial infarction was associated with:

- female sex
- severity of the cardiac condition.

In the *Philbin* (1999) study it was concluded that, while patient characteristics, hospital features and processes of care may be used to estimate the re-admission risk, some of the variation may be the result of clinical decision making. The 21% of patients re-admitted having had congestive heart failure were characterised by:

- greater proportion of black people
- more co-morbidities
- higher prevalence of health insurance
- use of telemetry monitoring in initial admission.

Patients less likely to be re-admitted were:

- treated at community hospitals
- those having echocardiograms and cardiac catheterisation
- discharged to skilled nursing facilities.

In the *Krumholz* (1997) study 44% of patients with congestive heart failure were re-admitted within six months and 18% of all re-admissions were accounted for by the initial diagnosis. In the multivariate analysis significant predictors of re-admission included:

- Deyo co-morbidity score of more than one (OR=1.56; 95% CI 1.45-1.68)
- initial length of stay more than seven days (OR=1.32; 95% CI 1.24-1.41)
- male sex (OR=1.12; 95% CI 1.05-1.20).

Kossovsky (1999) found that 12.5% of the patients were re-admitted with slightly more planned than unplanned re-admissions. Increased risk of unplanned re-admission was associated with:

- index length of stay longer than three days
- increased number of co-morbidities
- diagnosis of neoplastic disease.

Increased risk of planned re-admission was associated with:

- male sex
- diagnoses of coronary heart disease, cardiac arrhythmia and neoplastic disease.

Shipton (1996) found that most medical re-admissions were caused by patients with congestive heart failure and chronic obstructive pulmonary disease. He concluded from the literature review that statistically significant predictors of re-admission for medical patients were:

- dependence
- age
- stage of illness
- length of initial hospital stay
- prior hospitalisation
- care after discharge
- mobility status.

Yusuf (1998) found that higher rates of invasive and revascularisation procedures were associated with lower rates of refractory angina or re-admission for unstable angina, no apparent reduction in cardiovascular death or myocardial infarction, but with higher rates of stroke.

Herlitz (1988) found that during five years of follow-up after acute myocardial infarction, patients with smaller infarcts tended to have a higher re-infarction rate and were re-hospitalised more often.

Sacco (1991) found that two-year re-admission rates, overall and for stroke, were similar for whites, blacks and Hispanics, whereas crude in-hospital mortality was greater in younger blacks and Hispanics compared with whites.

In the *Libbus (1997)* study, data on stress, coping strategies, and social network/social support were collected from patients prior to discharge from hospital. The main results were:

- Twenty four persons were re-admitted during the four-month study period.
- Greater use of the coping strategy "seeking social support" was associated with the re-admission of persons who had had their first admission for IHD.
- Less use of the coping strategy "accepting responsibility" was associated with the re-admission of persons who had a history of prior admission for IHD.

Corr (1995) found a significantly smaller number of re-admissions in the intervention group than in the control group, while there were few significant differences between the two groups in terms of activities of daily living, mood, and perceived quality of life.

In the study by *Woo (1992)* approximately 30% of patients were re-admitted within 20 months. Factors associated with a higher risk of re-admission included:

- elderly age
- Barthel Index < 15.

Findings from the study by *Primatesta (1995)* included:

- Over the study period, 835 patients with Crohn's disease (43% of the total) and 767 patients with ulcerative colitis (33%) were admitted more than once.
- Of patients who were re-admitted as emergencies, 95% had an emergency re-admission within 17 months of the first admission.
- For Crohn's disease, the risk of emergency re-admission was higher for people aged less than 45 years (OR= 1.6; 95% CI 1.3-2.0), for those in social classes IV and V (OR=1.7; 95% CI 1.3-2.3), and for those who were not operated upon during their index admission (OR= 2.0; 95% CI 1.6-2.5).
- For ulcerative colitis, the risk of emergency re-admission was higher for people aged less than 45 years (OR=1.4; 95% CI 1.2-1.8), for those in social classes IV and V (OR=1.4; 95% CI 1.0-1.8), and for those who were not operated upon during their index admission (OR=1.8; 95% CI 1.4-2.2). Re-admission rates were found to differ significantly by district of residence.

Crane (1992) found that factors associated with re-admission for asthma included:

- admission in the 12 months prior to the index admission (OR = 3.0; 95% CI 2.1-4.2; $p < 0.01$)
- the number of previous admissions
- prescribed oral corticosteroids (OR = 1.9; 95% CI 1.2-2.8; $p < 0.01$)
- three or more categories of prescribed asthma drugs (OR = 1.9; 95% CI 1.3-2.7; $p > 0.01$).

Heard (1997) examined re-admissions in people admitted for asthma to a low socioeconomic status (SES) hospital and a moderate-high SES hospital. The main findings were:

- Women represented 75% of the re-admission population at a low socioeconomic status (SES) hospital and 55% at a moderate-high SES hospital.
- Women at the low SES hospital were significantly more likely to have one re-admission within 12 months and over 30 times more likely to have two or more re-admissions than women at the moderate-high SES hospital.

Findings from *Stewart (1999)* were:

- The beneficial effect of the HBI on unplanned re-admission was sustained for the duration of the 18-month follow-up: HBI patients had fewer unplanned re-admissions during this period (64 vs 125; $p=0.02$).

- HBI patients also had fewer days of hospitalisation (2.5+/-2.7 vs 4.5+/-4.8 per patient; p=0.004).
- Once re-admitted, HBI patients were less likely to experience four or more re-admissions (3/31 vs 12/38; p=0.03).
- Unplanned re-admission was positively correlated with 14 days or more of unplanned re-admission in the six months before study entry (OR=5.4; p=0.006).

Patients with mental illness

The studies done on patients with mental illness that have been reviewed are:

- *Dekker (1997)* studied the effect of social deprivation on re-admission rates and length of stay in in-patients with mental illness in Amsterdam.
- *Foster (1999)* studied the effect of after care services on re-admission rates in 204 children discharged from psychiatric wards.
- *Vogel (1997)* identified the psychiatric and social predictors of multiple admissions by comparing 283 patients with at least three admissions with a control group.
- *Russo (1997)* sought to find out whether quality of life before admission was a predictor of re-admission within 18 months.
- *Segal (1998)* studied predictors of involuntary return in 417 patients admitted to a psychiatric service, 29% of whom were re-admitted within 12 months.
- *Steinert (1999)* studied predictors of re-admission in 138 patients admitted to a psychiatric hospital with a first episode of schizophrenia or schizoaffective disorder, 60 % of whom were re-admitted within two years.
- *Walker (1996)* studied predictors of re-admission within six months in a group of patients discharged from a psychiatric unit in a general hospital.
- *Lyons (1997)* examined predictors of hospital re-admission (within 30 days and six months of discharge) among a series of 255 patients (aged 11-67 yrs) admitted to seven psychiatric hospitals in a regional managed care program to determine whether re-admissions can serve as a quality indicator for an in-patient psychiatric service.
- *Deb (1995)* studied the causes of re-admission for psychiatric care in a group of patients with learning disorders.
- *O'Leary (1996)* using the Nottingham case register identified the predictors for re-admission for depressed patients treated with ECT.
- *Syttema (1999)* studied the risk of re-admission in cohorts of patients with schizophrenia in Australia and Holland.
- *Mojtabai (1997)* examined the effects of demographics, personal resources, and psychiatric characteristics on the risk of re-admission in 2002 patients (mean age 36.8 years) with first admissions to two Oklahoma state psychiatric facilities during a single year.
- *Olfson (1999)* assessed patient characteristics associated with hospital re-admission within three months of discharge among 262 adult in-patients with schizophrenia or schizoaffective disorder.
- *Peen (1997)* carried out an urban-rural comparison of admission and re-admission rates among 1,682 patients (aged over 15 years) with schizophrenia in the Netherlands.

- *Terp (1999)* undertook a study was to describe the prognosis and risk factors for the first re-admission after post-partum psychosis.
- *Clarke (1999)* examined the effects of seasonal variations on hospital admissions in patients admitted to Irish psychiatric in-patient facilities between 1989-1994 with a diagnosis of schizophrenia (n = 32,889) or manic, bipolar, and depressive disorder (n = 36,007).
- *Kessing (1999)* examined the effect of the number of episodes on the risk of re-admission (as a proxy for recurrence) among 7,925 unipolar patients and 2,011 bipolar patients with affective disorder using a case register of all hospital admissions with primary affective disorder between 1971 and 1993 in Denmark.
- *Kessing (1998)* investigated how the effect of socio-demographic variables (gender, age at onset, marital status) and illness-related factors (length of previous episodes, total duration of the illness) on the risk of re-admission (as a proxy for recurrence) changed with the progression of illness in affective disorder.
- *Song (1998)* examined the relative impact of characteristics of people with psychiatric disabilities and their service use on re-hospitalisation.
- *Daniels (1998)* examined the rate of re-hospitalisation for schizophrenia, bipolar disorder and depression over a five year period in Tasmania, Australia, and identified predictors of the number and duration of re-admissions.
- *Saarento (1997)* conducted a three year follow-up study of 537 patients aged 15 years or older (who contacted the psychiatric services but who had no contact with services in the previous 18 months) to investigate factors associated with re-hospitalisation.
- *Kent (1994)* attempted to identify factors that commonly contributed to the decision to re-hospitalise patients who made heavy use of mental health services.
- *Kent (1995)* reviewed 72 English language articles from the psychiatric and psychological literature published up to 1994 that examined heavy service use, patient characteristics contributing to it, and service delivery characteristics contributing to it.
- *Postrado (1995)* examined whether re-hospitalisation of patients with severe and persistent mental illness could be predicted by patients' quality of life, history of hospitalisations and severity of symptoms.
- *Thornicroft (1992)* attempted to identify risk factors that increase the likelihood of re-admission for long-stay psychiatric patients after discharge from hospital.
- *Downing (1999)* looked at changes in re-admission rates six months after implementation of the Care Programme Approach (CPA) to provide community-based services to those with mental disorders discharged from the psychiatric unit of a district general hospital. The objectives of the programme were to ensure continuity of care, to have a named keyworker providing coordinating care for each service user, and to reduce hospital re-admissions.
- *Caan (1994)* examined whether mental health patients with more than one ICD-9 diagnosis are more likely to be re-admitted than in-patients with single disorders. Rates of re-admission were judged by either the number of

admissions in the year following any dual diagnosis or by the interval to the next re-admission.

- *Sullivan (1995)* sought to identify risk factors for re-hospitalisation among patients with schizophrenia using a case-control design in which 101 re-admitted patients (aged 18-55 years) were compared with 101 control patients who had not been re-admitted (matched on gender, ethnicity, and length of time at risk for re-admission).
- *Pearson (1999)* carried out a prospective study of 163 chronically ill medical/surgical patients (mean age 67.0 ± 16.3 years) to examine the effect of health-related quality of life (HRQL) (assessed one month after discharge home following acute hospitalisation using the Short- Form Health Survey (SF-36)) on the risk of re-admission within six months.
- *Monnelly (1997)* sought to identify predictors of re-admission among psychiatric patients by comparing 243 patients re-admitted within 30 days to a Veteran's Hospital with 288 patients not re-admitted.
- *Phibbs (1997)* developed a model to assess the effect of case-mix on re-admission within six months of discharge among patients receiving treatment for substance abuse ($N = 313,886$) in 116 Veterans Affairs Medical Centers (VAMCs).
- *Korkeila (1998)* analysed data on re-admissions to Finnish psychiatric hospitals in the early 1990s to investigate factors predicting re-admission.

Dekker (1997) found that socioeconomic deprivation is:

- positively correlated with the proportion of re-admissions
- inversely correlated with length of stay.

Foster (1999) found that, after adjusting for a wide range of factors, the provision of after care services did not seem to influence re-admission rates.

In the *Vogel (1997)* study the principal diagnoses were affective disorders (35%), psychotic disorders (25%) and substance related disorders (24%). The predictors of multiple admissions were:

- co-morbidity of substance-related disorder
- longer duration of illness
- female sex
- younger age
- poorer psychosocial adjustment in the previous year.

Russo (1997) found that patient' quality of life before admission was a predictor of re-admission within 18 months independent of psychiatric status, demographic factors and level of care variables.

Segal (1998) found that:

- The likelihood of involuntary return was increased by a psychotic diagnosis and indications of dangerousness at the initial evaluation.
- The best predictor of involuntary return was the patient's initial condition in the psychiatric emergency service.

Steinert (1999) did not review medication compliance and found that the significant predictors of re-admission were:

- aggressive behaviour against self
- aggressive behaviour against others.

Walker (1996) found that predictors of re-admission were:

- nursing home residence
- score of >90 on North Carolina Functional Assessment Scale
- non-compliance with out-patient attendance
- referral from a small community hospital.

Lyons (1997) concluded that the use of psychiatric re-admission rates as quality indicators for hospital care is not recommended. The main findings were:

- 40% of re-admissions occurred within the first 30 days of a six-month follow-up.
- Risk of re-admission was associated with patients with greater impairment in self care, more severe symptoms and more persistent illness.
- Suicidal patients were less likely to be re-admitted.
- There was no evidence to suggest that poor hospital outcome or premature discharge was associated with higher re-admission rates within 30 days or six months. The lack of association between premature discharge and risk of re-admission (while controlling for severity of illness) was used as additional evidence that re-admission was not related to patient outcome.

Deb (1995) found that the commonest causes of psychiatric re-admission in the group of people with learning disabilities were:

- disturbed behaviour
- affective disorder
- psychoses.

O'Leary (1996) using multiple regression analysis found that predictors of re-admission in the population with depression who had had ECT were:

- endogenous subtype
- absence of psychomotor retardation
- previous history.

Sytéma (1999) found that the risk of re-admission for schizophrenia is predominantly affected by attributes of the illness. The relative risk of re-admission was the same in both geographical areas despite very different patterns of care.

Mojtabai (1997) undertook survival analysis of data on re-admissions of these 2002 patients to any of the seven state facilities providing in-patient treatment over the subsequent two-year period. Demographic, social and psychiatric variables significantly related to relapse rate included:

- the patients' diagnosis
- length of index hospitalisation
- level of functioning at discharge
- interaction of employment status and living status
- interaction of age and living status.

In the *Olfson (1999)* study, 24.4% of the sample were re-admitted within three months of discharge. Early re-admission was associated with:

- four or more previous hospitalisations
- comorbid substance use disorder
- major depression
- absence of a family meeting with in-patient staff
- prescription of a conventional rather than an atypical antipsychotic medication.

Peen (1997) found that:

- Admission rates showed a significant positive correlation with the degree of urbanization in the 15-34 and 35-54 year old age groups for both sexes.
- The average duration of hospitalisation and the average number of re-admissions showed no association with the degree of urbanization.

In the study by *Terp (1999)*, 1,173 women were diagnosed with a psychosis within 91 days of delivery between January 1973 and December 1993. Findings were:

- Compared to women admitted with other functional psychoses an increased risk of re-admission was found for women with a diagnosis of schizophrenia (RR = 2.4; 95% CI 1.9-3.1), and for women with a history of previous psychiatric admission (RR = 1.8; 95 % CI 1.5-2.1).
- Unmarried women showed an increased risk of re-admission.
- Preterm delivery was associated with a reduced risk of re-admission.
- The majority of re-admissions were related to the psychopathology of the patient and to lack of social support.

Findings from *Clarke (1999)* were:

- Both first admissions with mania, and re-admissions with bipolar affective disorder exhibited significant seasonality.
- In contrast, only first admissions with schizophrenia showed significant seasonal effects.

Kessing (1999) found that:

- The rate of re-admission increased, on average, 15% with every episode for unipolar patients and 9% with every episode for bipolar patients, when adjusted for differences in age and gender.
- The rate of re-admission was, on average, 1.6 times greater for bipolar patients than for unipolar patients.

Kessing (1998), using a case-register of all hospital admissions with primary affective disorder in Denmark during the period 1971-1993, found that:

- In the initial stages of the illness, bipolar patients had a substantially greater risk of re-admission compared with unipolar patients.
- In the initial stages of the illness, gender, age and marital status together with the total duration of the illness predicted the risk of re-admission in both unipolar and bipolar illness; some variables had different predictive effects in the two disorders.
- Later, however, the illness itself seemed to follow its own rhythm regardless of prior predictors.

Song (1998) analysed four years of community mental health service records and five years of state hospitalisation records for a major metropolitan area. The main findings were:

- Previous hospitalisation was the most powerful predictor of future hospitalisation, followed closely by community service utilization.
- Persons who were low utilizers of community services in the previous year and high utilizers in the current year were significantly more likely to be hospitalised and to have a greater number of hospitalisations in that year.

Daniels (1998) analysed data for all patients admitted to a Tasmanian public psychiatric in-patient facility with a primary diagnosis of schizophrenia (n = 329), bipolar disorder (n = 319) or depression (n = 524) over a five-year period. The main findings were:

- 71% of patients receiving a diagnosis of schizophrenia were re-admitted in the five year period compared to 59% for bipolar disorder and 48% for depression.
- For all three diagnoses, the number of prior admissions was a predictor of the number of re-admissions and the total number of days spent in hospital in the follow-up period.
- Age and sex also had significant effects, which varied across diagnostic groups.

Saarento (1997) found that re-hospitalisation during the second and third years of follow-up was predicted by:

- hospitalisation and the number of emergency out-patient contacts during the first year of the study
- diagnosis of functional psychosis or personality disorder
- previous in-patient care.

Kent (1994) examined the case notes of 50 patients with frequent re-admissions to the South Australian Mental Health Services over a three year period. Factors which most frequently contributed to hospital re-admission included:

- lack of insight or denial of illness
- relationship problems
- suicidal ideation
- non-compliance with medication.

Grouping individual factors into four categories indicated that types most commonly contributing to re-admissions included:

- social factors (contributed to 38.9% of admissions)
- factors related to psychiatric and physical illness (31.1%)
- dangerousness to self or others (20.3%)
- substance abuse (9.7%).

Results from *Kent (1995)* were:

- Criteria for identifying and defining heavy users of psychiatric services vary among studies.
- Few studies of heavy service users have attempted to examine use of all psychiatric services, both in-patient and community based.

- In most studies, 10–30% of patients are identified as heavy users, those who utilize between 50-80% of service resources.
- This group consists of a constantly changing cohort of patients who generally have psychotic illnesses as well as comorbid personality disorders and high levels of drug and alcohol misuse.
- Few studies have examined social issues such as isolation, homelessness, and social support, although these factors appear to contribute significantly to heavy service use.

Postrado (1995) assessed a total of 559 patients at two and 12 months after hospital discharge. Findings were:

- Compared with patients who were not re-hospitalised, those who were re-hospitalised had more severe symptoms and were more likely to have a history of hospitalisation. Re-hospitalised patients reported more dissatisfaction with family relations and were more likely to report an arrest in the past two months.
- The two groups did not differ in other quality-of-life domains and in global quality of life.

Thornicroft (1992) followed-up 357 psychiatric patients who had been in one of two large North London psychiatric hospitals hospital for over one year; 118 were 'new' long stay and 239 'old' stay patients. Of all discharged patients, 97 (27%) were re-admitted at some time during the follow up period. The best explanatory factors for re-admission were:

- male sex
- younger age group
- high number of previous admissions
- higher levels of symptomatic and social behavioural disturbance
- a diagnosis of manic-depressive psychosis
- living in a non-staffed group home.

In the study by *Downing (1999)*, six months after implementation of the programme there was no evidence that the number of re-admissions had decreased among the 35 subjects (71% aged over 40 years) with severe and enduring mental disorders. The risk of re-admission was found to be associated with the number of admissions prior to the hospital discharge meeting preceding study entry.

In the study by *Caan (1994)*, 220 subjects, including single and multiple diagnoses patients, were compared by a four-way match criteria. The key findings were:

- Re-admission rates were significantly higher for subjects with second diagnoses of alcohol or drug dependence, compared to other dual diagnosis subjects matched for a common mental health disorder or compared to patients with single diagnoses.
- Patients with schizophrenia were especially prone to re-admission, if secondary alcohol or drug dependence was ever recorded.

Sullivan (1995) found that the following factors were associated with a greater risk of re-admission:

- non-compliance
- comorbid alcohol abuse
- a high level of criticism of subjects by study informants.

Factors which were found not to be associated with the risk of re-admission included:

- type and extent of out-patient service use
- access to care
- quality of life
- demographic variables (other than ethnicity and gender).

In the study by *Pearson (1999)*, 47 (35%) patients had an unplanned re-admission during follow-up; these patients demonstrated both significantly lower physical (32.2 ± 9.8 vs 38.6 ± 10.1 ; $p < 0.001$) and mental (45.1 ± 12.7 vs 49.9 ± 12.3 ; $p = 0.03$) health component scores in comparison to the remainder of the cohort. On multivariate analysis, independent correlates of unplanned re-admission were:

- presence of formal home assistance (OR 6.4; $p < 0.01$)
- five prescribed medications (OR 2.4; $p = 0.04$)
- two admissions in the six months before follow-up (OR 4.3; $p < 0.01$)
- an SF-36 physical component score of ≤ 40 (OR 2.2; $p = 0.05$).

Monnelly (1997) found in the population of veterans that the best predictors of re-admission were:

- greater number of previous re-admissions
- patient instability in the last five days of index admission.

Findings from *Phibbs (1997)* were:

- The case-mix model explained 36% of the observed variation across different facilities in re-admission rates.
- There were noticeable differences between the rankings of facilities based on actual and case mix-adjusted re-admission rates.
- The authors conclude that case-mix has a large effect on facility level re-admission rates for substance abuse treatment and that uncontrolled comparisons between facilities can be misleading.

Korkeila (1998) found that factors associated with an increased risk of multiple psychiatric re-admission included:

- previous admissions
- long length of stay
- diagnosis of psychosis or personality disorder.

Patients after surgery

The studies that have been done on patients who have had surgery that have been reviewed are:

- *Zitser-Gurevich (1999)* identified factors predicting re-admission in a prospective study of 4,835 CABG patients.

- *Sabourin (1999)* studied the reasons and predictors of re-admission in 124 patients who had had a CABG.
- *Seagroatt (1991)* reviewed 28 day re-admission rates in 11,607 patients who had had a total hip replacement.
- *Primatesta (1996)* reviewed 30 day re-admission rates in 30,675 patients who had had an operation for inguinal hernia.
- *Bissett (1998)* reviewed 28 day re-admission rates in 8,783 patients who had had an appendectomy.
- *Sultana (1997)* reviewed 30 day re-admission rates in 66,748 women who had had an operation for urinary incontinence.
- *Welch (1992)* used a retrospective cohort design to compare re-admission rates following four common surgical procedures (appendectomy, cesarean section, cholecystectomy, and transurethral prostatectomy) in Washington State rural and urban hospitals.

In the *Zitser-Gurevich (1999)* study of CABG it was concluded that, because of the heterogeneity of causes, a better outcome measure than disease specific re-admission rates might be cause-specific re-admission rates. In the study 24% of patients had re-admissions within three months. Although the logistic model had low predictive power (c-statistic= 0.65), significant multivariate predictors of total re-admissions included:

- pre-operative co-morbidities
- operative factors
- immediate post-operation complications
- socio-demographic factors
- provider characteristics.

The heterogeneous reasons for re-admissions were classified as:

- other cardiac reasons (35%)
- reasons other than cardiac or infection (23%)
- specific serious cardiac diagnoses (19%)
- specific infections at operation site (10%)
- other infections (7%).

In the *Sabourin (1999)* study which sought to identify reasons and predictors of re-admission for patients with CABG, 15% had re-admissions within six weeks. The primary reasons were:

- chest pain with or without shortness of breath (33%)
- incisional problems (17%)
- analgesic reactions (17%).

Logistic regression analysis, based on bivariate analyses, revealed that re-admission was predicted by:

- female sex (OR=4.7 and 95% CI 1.5-14.6)
- obesity (3.7 and 1.2-11.6).

Seagroatt (1991) found that the 28 day re-admission rate for patients with a total hip replacement was 2.8%. The main findings were:

- The emergency re-admission rates increased with age.
- The commonest cause for admission was thromboembolic disease.

Primatesta (1996) found that the 30 day re-admission rate for patients after an operation for inguinal hernia was 1.5%. The main findings were that patients who initially had an emergency repair rather than an elective repair:

- were older
- had higher 30 days re-admission rates (age-sex standardised rates per 1,000 operations were 29.0 and 13.7 respectively, $p < 0.01$)
- had significantly higher post-operative mortality rates.

Bissett (1998) found that the 28 day re-admission rate after appendectomy was 4.6%. The main findings were:

- Age and length of stay did not affect re-admission rates.
- A significantly higher proportion of re-admissions occurred where a normal appendix was removed.
- Hospitals performing more operations tended to have more re-admissions.
- Patients from more deprived areas were more likely to be re-admitted.

Sultana (1997) found that the 30 day re-admission rate after an operation for urinary incontinence was 4.8%, being higher in patients aged over 80. The most frequent causes of re-admission were:

- hypertension (16%)
- urinary tract infection (12%)
- unspecified complications (9%) .

Welch (1992) used a statewide hospital discharge database to identify all patients discharged following one of the above four procedures and all re-admissions to any hospital in the state within seven or 30 days of discharge. Key findings were:

- During the two-year period examined, there were no significant differences in re-admission rates for surgeries performed in rural and urban hospitals, although the re-admission rates for all four procedures were nominally lower in rural hospitals.
- Logistic regression analyses that controlled for factors that influence re-admission did not change these results.
- Early re-admission is an imperfect marker for poor surgical outcome, however, and other proxies for quality remain to be examined.

Paediatric patients

The studies done on paediatric patients that have been reviewed are:

- *Glasgow (1991)* compared the characteristics of children with diabetes re-admitted to a children's hospital between 1984 and 1989 with those of new-onset patients admitted for stabilization and education and with those of out-patients in the diabetes program.

- *Mitchell (1994)* examined risk factors for re-admission in an observational study of 1034 individual children admitted to hospital for asthma over a one year period and followed for a maximum of 33 months.
- *To (1996)* studied 28,646 hospital admissions for asthma among children in Ontario between April 1989 and March 1992 and looked at the effect of age on risk of re-admission.
- *Minkovitz (1999)* examined the effects of medical history, ambulatory care prior to hospitalisation, and ambulatory care after discharge on the risk of re-hospitalisation within one year among 119 low-income urban children (aged 0-14 years) hospitalised for asthma between July 1993 and June 1995.
- *Henry (1995)* administered a validated asthma knowledge questionnaire to parents of children admitted to hospital with asthma and examined the association of parental knowledge with the rate of re-admission.
- *Madge (1997)* performed a randomised control study of a nurse-led asthma home management training programme in 201 children (aged two years or more) admitted with acute asthma and examined the effect on rates of re-admission.
- *Wesseldine (1999)* conducted a randomised controlled trial involving 160 children aged 2-16 years admitted for asthma over a 12 month period to examine the impact of a structured, nurse-led discharge package on re-admission to hospital in the six months after discharge.
- *Charlton (1994)* randomised 77 children aged 3-14 years admitted with asthma or attending a hospital out-patient department to a patient education programme (run by a hospital clinic nurse) and self management plan or to no intervention.
- *Farber (1998)* assessed risk factors for re-admission among patients aged less than 15 years admitted for asthma to one Californian hospital, during September 1991-June 1993.

In the *Glasgow (1991)* study, re-admissions occurred more frequently in-patients who were:

- of black ethnic origin (71% compared with 38% of new-onset patients and 31% of out-patients) ($p < 0.001$)
- from one-parent homes (56% compared with 27% of new-onset patients and 24% of out-patients) ($p < 0.001$)
- without third-party insurance (45% compared with 18% of new-onset patients and 15% of out-patients) ($p < 0.001$).

Other findings were:

- Re-admissions were very common at 14 to 15 years of age (39% of re-admissions vs 18% of out-patients) and very uncommon in children younger than age nine (6% of re-admissions vs 27% of out-patients) ($p < 0.001$).
- Fewer re-admissions for ketoacidosis occurred in the summer than in any other season ($p < 0.05$).

- Over the five-year period following the introduction of a diabetes team and a program that emphasised the importance of ensuring that patients at risk of re-admission consistently received insulin injections, re-admissions fell by 47% while new-onset patients increased by 85%. This reduction was due to fewer re-admissions for ketoacidosis and fewer re-admissions in blacks, in-patients from one-parent homes, and in-patients without third-party insurance.

Mitchell (1994) found that after controlling for a wide range of variables, factors associated with a significantly increased risk of re-admission included:

- young age (for age < five years, RR = 1.71; 95% CI 1.41-2.08)
- female sex (RR=1.23; 95% CI 1.03-1.46)
- the number of previous admissions (this may reflect severity or behaviour of the illness) (one previous admission RR =1.32; two, RR =1.68; three, RR =2.00; four or more, RR =2.80)
- in-patient intravenous treatment (a marker of severe disease) (RR =1.29; 95% CI 1.08-1.55).

Factors which did not predict risk of re-admission included

- ethnicity
- respiratory and pulse rate
- medical team
- prescribed prophylactic treatment
- type of follow-up
- the use of action plans.

Key findings from the *To (1996)* study were:

- Admission rates decreased by 14.8% between 1987 and 1992; this decline was observed primarily in 5-17 year olds.
- Over the four-year period studied, 10,427 children (36.4%) were re-admitted at least once, representing 22,114 re-admissions, 16,196 (73.2%) of which were for asthma.
- The six-month probabilities of re-admission for asthma were 20.0% (0-4 year olds) and 11.7% (5-17 year olds).
- The estimated relative risks (RRs) indicated that younger children had a significantly higher risk of re-admission for asthma (RR=1.38; 95% CI 1.30-1.46) or asthma-related causes (RR=5.02; 95% CI 4.16-6.05).

Findings from *Minkovitch (1999)* included:

- Half of all children did not receive prescribed therapies and more than half were exposed to cigarette smoke at home.
- No differences in the receipt of prescribed therapies and exposure to cigarette smoke at home were seen between children re-admitted within one year (35 out of 119 children) and those not re-admitted.
- Children re-admitted were significantly more likely to have other chronic conditions (69% vs 49%; $p = 0.048$) and to have had a pulmonary consultation during the index admission (23% vs 4%; $p = 0001$).

Findings from *Henry (1995)* were:

- Increased parental knowledge about asthma was associated with previously diagnosed asthma, higher parental occupation, and no smoker in the home.
- The re-admission rate was related to the severity of the child's asthma and was not significantly associated with parental knowledge about asthma.

Findings from *Madge (1997)* were:

- Subsequent re-admissions were significantly reduced in the intervention group from 25% to 8% in follow up periods ranging from 2 -14 months ($\chi^2 = 9.63$; $p = 0.002$).
- This reduction was not accompanied by any increase in subsequent emergency room attendances nor, in the short term, by any increase in urgent community asthma treatment.
- The intervention group also showed significant reductions in day and night morbidity three to four weeks after admission to hospital.

Wesseldine (1999) found that children in the intervention group were significantly less likely to be re-admitted to hospital within six months of discharge than those in the control group (12 of 80 v 30 of 80 patients), and significantly less likely to attend the A&E department (6 of 80 v 31 of 80). Significantly fewer children in the intervention group had visits to their general practitioner for problematic asthma (31 of 78 v 72 of 77 for whom data were available).

Findings from *Charlton (1994)* were:

- The intervention group had fewer home visits by a general practitioner but were more likely to be re-admitted.
- Over a median of 283 days of follow-up, patients in the intervention group had significantly less restriction of activity, had fewer episodes of peak flow below 30% of best, and were more likely to make the correct response to an acute exacerbation of their asthma than the control group (71% v 47%, 95% CI 9.51-39.1).

Farber (1998) found that the risk of re-admission within 12 months of the index admission was highest in patients aged less than five years and in those who had a history of prior hospital admission. A single-session asthma class did not reduce risk for hospital re-admission.

Maternity patients

The study done on maternity patients that has been reviewed is:

- *Lydon-Rochelle (2000)* assessed the risk for maternal re-hospitalisation within 60 days associated with caesarean or assisted vaginal delivery compared with spontaneous vaginal delivery in a retrospective cohort study of routine statistics covering 256,795 births in Washington during the period 1987-1996.

Lydon-Rochelle (2000) found that:

- A total of 3149 women (1.2%) were re-hospitalised within 60 days of delivery.
- In logistic regression analyses adjusting for maternal age, re-hospitalisation was found to be more likely among women with caesarean delivery (RR=1.8; 95% CI 1.6-1.9) or assisted vaginal delivery (RR=1.3; 95% CI 1.2-1.4) than among women with spontaneous vaginal delivery.
- Caesarean delivery was associated with significantly increased risks of re-hospitalisation for uterine infection, obstetrical surgical wound complications, and cardiopulmonary and thromboembolic conditions.
- Among women with assisted vaginal delivery, significant increased risks were seen for re-hospitalisation with post-partum hemorrhage, obstetrical surgical wound complications, and pelvic injury.

STUDIES TO ASSESS THE RISK EFFECT OF LENGTH OF STAY ON RE-ADMISSION

Studies carried out specifically to review the effect of length of stay on re-admission rates can be classified by patient group as those involving:

- general population of patients
- patients with medical conditions
- patients with mental illness
- neonates and paediatric patients
- patients after surgery.

General population of patients

The studies done on general populations of patients that have been reviewed are:

- *Louis (1999)* examined the effects of the introduction of a hospital financing reform system in Italy in 1995 (which aimed to make hospitals more accountable for their productivity) on length of stay, re-admission rates and mortality rates for nine common medical and surgical conditions.
- *Jones (1986)* analysed hospital activity data for Leicestershire Health Authority to determine changes in average length of stay and re-admission rates between 1977 and 1983 for medical, surgical and geriatric medical patients.
- *Thomas (1991)* examined data on all discharges from 18 acute care hospitals over one year to identify predictors of early (within 31 days) unplanned re-admission risk including length of stay.
- *Epstein (1991)* compared trends in length of stay with trends in re-admission rates over a four year period (October 1982 to September 1986) for Medicare patients aged 65 years and older discharged from 107 Massachusetts acute care hospitals.
- *Evans (1993)* conducted a randomised clinical trial to evaluate whether a protocol for selecting patients for systematic discharge planning (on the basis of risk factors for frequent health care resource use identified on admission) could reduce the need for subsequent re-admission or skilled care.
- *Harrison (1995)* undertook a retrospective descriptive study among seven large acute care hospitals in Winnipeg to determine whether decreasing lengths of stay between 1989-90 and 1992-93 for selected diagnostic categories were associated with increased hospital re-admission rates and mean number of physician visits within 30 days after discharge.

In the *Louis (1999)* study, mean length of stay decreased from 9.1 days to 8.8 days ($p < 0.001$) between 1993 and 1996 while there was little or no change in mortality or re-admission rates.

In the *Jones (1986)* study, a re-admitted patient was defined as one re-admitted to the same hospital with the same unit number in the same calendar year. Key findings were:

- Between 1977 and 1983 the re-admission rate increased from 14.0 to 19.4% for medical patients, while the average length of stay decreased from 13.6 to 11.5 days.
- Over the same time period the re-admission rate increased from 9.1 to 14.0% for geriatric medical patients, while the average length of stay decreased from 116.5 to 88.9 days.
- The corresponding figures for surgical patients were an increase in the re-admission rate from 10.0 to 11.8%, and a reduction in average length of stay from 8.4 to 7.6 days.
- Patients re-admitted fewer than 30 days after the previous discharge had an in-hospital mortality rate which was 26% higher than the average for all patients, suggesting that their illness was more serious. Conversely, patients re-admitted more than 30 days after the first discharge had an in-hospital mortality rate which was 40% lower than the average.

In the *Thomas (1991)* study, the main findings were:

- Length of stay outlier status was significantly associated with re-admission risk in only eight out of 22 DRGs. For these DRGs, low length of stay outlier status was associated with reduced re-admission risk whereas the opposite relationship was observed for high outlier status.
- The authors suggest that the study's measures of severity/complexity do not capture all of the dimensions of patient severity/complexity and that length of stay outlier status simply reflects residual severity differences among patients.
- The key finding is that patients' risk of premature discharge does not appear to be a direct function of their lengths of stay.

In the study by *Epstein (1991)*, in addition to analysing all re-admissions, re-admissions for four medical and three surgical conditions were chosen for specific analysis. Only re-admissions to the same hospital were counted. The main findings were:

- Over the four years, lengths of stay decreased by 25% overall (from 9.9 to 7.5 days; $p < 0.01$) and by 12% to 38% for the individual conditions studied (all $p < 0.05$) after controlling for case-mix.
- A small part of the decrease in average length of stay was associated with prospective payment.
- Stage of illness was generally correlated with length of stay for the seven medical and surgical conditions examined.
- Overall re-admission rates within seven and 14 days increased by approximately 10% ($p < 0.05$). Re-admission rates for individual medical and surgical conditions were not significantly changed.

In the study by *Evans (1993)* half of the 835 patients identified as "at risk" for frequent health care resource use were randomly assigned to the experimental group ($n = 417$) and received discharge planning from day three of their hospital stay, while

the control group (n = 418) received discharge planning only if there was a written physician request. The main findings were:

- Patients receiving early, systematic discharge planning experienced an increased likelihood of successful return to home after hospital admission and a decreased chance of unscheduled re-admission for the nine-month study period.
- Length of the index hospital stay was not affected by early planning.

Harrison (1995) examined data on admissions to any one of the seven hospitals among Manitoba residents for AMI, bronchitis or asthma, transurethral prostatectomy (TURP), and uterine or adnexal procedures for non-malignant disease during the fiscal years 1989-90 to 1992-93. Patients with excessively long stays (more than 60 days), those who died in hospital, and those who were transferred to or from another institution were excluded from analyses. The key findings were:

- The length of stay decreased significantly over the four years for all of the four disease categories, the smallest change being observed for patients with AMI (11.1%) and the largest for those with bronchitis or asthma (22.0%).
- The re-admission rates for AMI, bronchitis or asthma, and TURP showed no consistent change over the four years.
- The re-admission rate for uterine or adnexal procedures increased significantly between the first and second year ($\chi^2 = 4.28$, $p = 0.04$) but then remained constant over the next three years.
- The mean number of physician visits increased slightly for AMI in the first year (1.92 to 2.01) and then remained virtually the same. It decreased slightly for bronchitis or asthma over the four years.
- There was no significant correlation between length of stay and re-admission rates for individual hospitals in 1992-93 in any of the four categories. Also, no correlation was observed between length of stay and mean number of physician visits for individual hospitals in 1992-93 in the categories AMI and bronchitis or asthma.
- Improving hospital efficiency by shortening length of stay does not appear to result in increased rates of re-admission or numbers of physician visits within 30 days after discharge from hospital.

Patients with medical conditions

The studies done on patients with medical conditions that have been reviewed are:

- *Ni (1999)* studied the lengths of stay and re-admission rates of patients in the Oregon hospital discharge database with congestive heart failure (CHF).
- *McCormick (1999)* studied lengths of stay and re-admission rates within 14 days in a cohort of 1,188 adult patients with pneumonia admitted to four hospitals.
- *Xu (2000)* identified factors related to length of stay and re-admission for Medicare patients hospitalised with peptic ulcer disease from 1992 through 1997.
- *Rushworth (1995)* carried out a study of hospital re-admission within six months among 5052 asthma patients (aged 1-44 years).

- *Chee (1996)* examined changes in the length of stay, re-admission rate and other clinical outcomes following the introduction of guidelines for the in-patient management of asthma in a hospital department.
- *Tallis (1995)* undertook a before-and-after study of patients (aged 50 years and over) admitted during 1992-1993 with a fractured neck of femur, to determine the effect of the introduction of a clinical management program (based on a critical path analysis) on length of stay and a range of outcomes.
- *Crockett (2000)* examined factors which impacted on the length of stay and re-admission within 28 days for 520 patients (aged ≥ 18 years) discharged with chronic airflow limitation from a South Australian hospital between December 1996 and March 1998.

Ni (1999) using multivariate analysis found that between 1991 and 1995:

- Hospital re-admission rates for patients with CHF remained constant with a mean of 15.3%.
- Mean length of stay decreased from 5.0 to 3.9 days.
- In-hospital mortality rate decreased from 6.9% to 4.7% independent of length of stay.

McCormick (1999) concluded that that longer stays could be reduced without adversely influencing patient outcomes. The main findings were:

- After adjustments for baseline case-mix, hospital re-admission rates within 14 days were similar in the four hospitals regardless of the mean length of stay.
- No differences were seen in other health outcomes including 14 day mortality rate and return to work.

In the *Xu (2000)* study, abstracted clinical data were used to derive associations for length of stay, re-admission rates, and the following processes of care: screening or treatment for *Helicobacter pylori*; screening for nonsteroidal anti-inflammatory drug (NSAID) use; and the performance of endoscopy. Key findings were:

- Re-admission rates remained relatively constant during the study period but decreased significantly when NSAID screening was documented during the hospitalisation.
- A reduction in length of stay of approximately one day was observed when screening or treatment for *H. pylori*, screening for NSAID use, or the performance of endoscopy was documented.
- In conclusion, adherence to selected processes of care is associated with shorter length of stay and lower re-admission rates.

Rushworth (1995) found that:

- Less than 10% of admissions had a length of stay of less than one day.
- 17.8% of patients were re-admitted at least once within six months of their index admission, while 3.7% had at least one early (within two weeks of discharge) re-admission.
- A length of stay of one day or more was associated with 0.41 times (95% CI 0.24-0.70) the risk of early (within two weeks of discharge) re-admission.

- A length of stay of one day or more was associated with a higher risk of late (two weeks to six months after discharge) re-admission (1.52; 95% CI 1.09-2.12).

Following introduction of the guidelines, *Chee (1996)* found:

- No difference in terms of length of hospital stay, mortality or visits to an accident and emergency department.
- A decrease (although not statistically significant) in the one month re-admission rate from 13.6% in 1993, to 7.4% and 5.9% in 1994.
- Definite improvements in history-taking, physical examination, review, monitoring and patient fulfillment of pre-discharge criteria.
- The underuse of peak flow measurements improved while the under-prescription of oxygen persisted.

In the *Tallis (1995)* study, outcomes among patients (n=88) admitted after the introduction of the clinical management program (April 1993) were compared with those among patients admitted in the six months before the introduction of the program (n=90). Patients with multiple fractures or metastatic disease were excluded. The main findings were:

- The length of stay for a fractured neck of femur declined from a mean of 19.3 days to a mean of 11.0 days ($p < 0.0001$).
- Outcome measures which did not change significantly included unplanned re-admission, the distance walked just before discharge from hospital, and the discharge destination, while the wound infection rate declined.

Crockett (2000) found that:

- Re-admission within 28 days was related to the number of co-morbidities and to age.
- A relationship between length of stay and the number of co-morbidities was identified: patients with fewer co-morbidities had shorter lengths of stay on average.

Patients with mental illness

The studies done on patients with mental illness that have been reviewed are:

- *Edward-Chandran (1996)* studied the relationship between length of stay and re-admission in patients discharged from two acute psychiatric units with initially high mean lengths of stay.
- *Korkeila (1998)* reviewed data about length of stay and re-admission rates on all discharges from Finnish psychiatric hospitals in the early 1990s.
- *Wickizer (1998)* investigated whether restrictions on length of stay imposed by an utilisation management programme influenced the 60 day re-admission rate in privately insured psychiatric cases.
- *Lieberman (1998)* examined hospital outcomes and the relationship between length of stay and re-admission for 206 depressed patients in three cohorts hospitalised between 1988-1996.
- *Druss (1998)* used multiple regression techniques on data for all admissions (n = 4,482) to a general hospital in-patient psychiatry unit between 1985 and

1993 to assess the association of demographic data with length of stay and likelihood of re-admission.

- *Appleby (1993)* undertook a study to determine whether duration of hospital treatment affects the rate and rapidity of re-hospitalisation among 1,500 schizophrenic patients from ten state hospitals.
- *Johnstone (1999)* conducted a systematic review of four randomised controlled trials comparing the effects of planned short hospital stay versus long hospital stay or standard care on the risk of re-admission for people with serious mental illness.

Edward-Chandran (1996) found that in one of the hospitals the length of stay reduced over six years from 25 to 16 days but an initial increase in re-admission rate returned to pre-study levels. There was no change in length of stay in the other hospital.

Korkeila (1998) found that long length of stay was associated with an increased risk of multiple re-admissions.

In the *Wickizer (1998)* study the commonest diagnoses were alcohol dependence (23%), recurrent depression (23%) and single event depression (21%). Overall 8% were re-admitted within 60 days. The main findings were:

- Patients whose length of stay was restricted were more likely to be re-admitted.
- For each day that the length of stay was restricted the adjusted odds of re-admission increased by 3% ($p=0.004$).

Key findings from the study by *Lieberman (1998)* were:

- Lengths of stay significantly declined over time (26.5 vs 19.5 vs 8.3 days for the three different cohorts studied).
- At discharge, the most recently hospitalised group showed higher residual depression and lower residual global functioning scores than the other groups. Other measures did not differ among the groups at discharge.
- Decreasing length of stay did not affect re-admission rates but one month after discharge, the shortest-stay group continued to show lower global functioning.

In the *Druss (1998)* study, results indicate that:

- Variables associated with re-admission include Medicaid status and psychotic diagnosis.
- Between 1985 and 1993 the hospital was increasingly treating a poorer, sicker group of patients with shorter lengths of stay and more re-admissions.
- The rise in re-admissions, particularly within vulnerable populations, could represent an inadequate length of initial treatment.

Appleby (1993) looked at two times to initial relapse; 30 days and 18 months. The key findings were:

- Length of stay was significantly related to each time to relapse (30 days and 18 months) after controlling for the effects of number of previous admissions and age.

- In conclusion, although the magnitude of the effect was small, brief-stay patients were more likely to be re-hospitalised within 30 days after discharge than patients treated for longer periods.

Johnstone (1999) found that patients allocated to planned short hospital stays had:

- no more re-admissions (in four trials, OR=0.93, 95% CI 0.66-1.29 with no heterogeneity between trials)
- no more losses to follow up
- more successful discharges on time than patients allocated to long hospital stays or standard care.

This review suggests that planned short hospital stays do not encourage a "revolving door" pattern of care for people with serious mental illness.

Neonates and paediatric patients

The studies done on neonates and paediatric patients that have been reviewed are:

- *Lock (1999)* studied retrospectively the impact of implementing an early discharge policy (24 hours after birth) on 28 day re-admission rates in 5,936 infants born before implementation of the policy and 1,073 neonates after it.
- *Oberer (1996)* assessed the effect of the implementation of clinical pathways for vaginal and cesarean section births and for normal newborns in a hospital (>2000 births annually) challenged to develop high-quality, cost-effective, and clinically efficient care under the constraints of a reduced length of stay.
- *Bragg (1997)* investigated the effect of implementing a structured approach for discharge within 24 hours of birth.
- *Edmonson (1997)* investigated the effect of day one or two discharge by comparing 210 re-admitted neonates with 730 control subjects.
- *Kotagal (1999)* studied retrospectively the impact of decreasing post-natal length of stay on seven and 14 day re-admission rates in a cohort of 102,678 full term neonates.
- *Wickizer (1999)* studied 8,568 paediatric patients to see whether restrictions on length of stay imposed by an utilisation management programme influenced the risk of 60 day re-admissions.
- *South (1997)* examined changes in length of stay and unplanned re-admission rates following the introduction of case-mix funding among 11,939 children admitted with acute asthma to Australian hospitals.
- *Stromberg (1996)* looked at changes in length of stay and re-admission rate among paediatric asthma patients admitted to a Swedish county hospital between 1973 and 1993.
- *Sacchetti (1997)* studied the effects of early discharge of newborns on subsequent admission to hospital and on emergency department utilisation during the first ten days of life.
- *Grullon (1997)* conducted a review of published studies describing early post-partum discharge (less than 48 hours after vaginal birth or 96 hours after caesarean delivery) including five randomised controlled trials (none of which met criteria for properly designed trials), ten cohort studies, one case-control study, and 12 case-series reports.

Lock (1999) concluded that care is needed in establishing whether a reduction in stay to less than 36 hours is harmful to newborn babies. The main findings were that following implementation of the early discharge policy:

- Mean length of stay reduced from 1.9 days to 1.6 days.
- Re-admission rate increased from 6.7% to 11.7% (OR=1.86; 95% CI 1.5-2.3).
- Main reason for early re-admission was neonatal jaundice.

Findings from *Oberer (1996)* were:

- Successful implementation of the clinical pathways decreased the average length of stay for uncomplicated deliveries from 2.02 to 1.67 days and for normal newborns from 1.99 to 1.43 days.
- Data from quality outcome indicators that measure the rate of occurrence of emergency department admissions or hospital re-admissions for either mother or newborn within 14 days of birth revealed no increase in either variance since the clinical pathways were implemented.

Bragg (1997) found that the implementation of an early discharge programme did not have an association with an increased risk of neonatal re-admission.

Edmondson (1997) found that day one or two discharge for an uncomplicated birth had no effect on the risk of re-admission within 28 days.

Kotagal (1999) concluded that reductions in length of stay had not resulted in an increase in re-admissions. The major findings were:

- Over four years the proportion discharged following a short stay increased from 21 to 60 % (p<0.001).
- Over four years the mean length of stay decreased from 2.2 to 1.6 days (p<0.001).
- Re-admission rate at seven days decreased from 1.3% to 1.0% (p=0.01).
- Re-admission rate at 14 days decreased from 2.1% to 1.7% (p=0.03).

Wickizer (1999) concluded that limiting the length of stay of paediatric patients may increase the risk of re-admission, especially for those who are mentally ill. The main finding was:

- Patients admitted for medical or psychiatric care, whose hospital stay was restricted by concurrent review were more likely to be re-admitted within 60 days (p<0.05).

South (1997) found no increases in unplanned re-admission rates within seven or 14 days despite a significant reduction in mean length of stay for the index admission from 64.5 to 39 hours (p=0.001).

Stromberg (1996) found that:

- The mean length of stay in hospital decreased significantly between 1973 and 1993 while the re-admission rate remained stable over the period studied.
- Admission rates decreased over the period studied.

Sacchetti (1997) found that between 1989 and 1995:

- The average length of stay for deliveries decreased from 2.79 days to 1.85 days.
- There was evidence of an overall increase in emergency department utilisation by neonates.
- No increase in re-admission rates for these infants was documented, indicating that patient severity did not increase with emergency department utilisation.

Grullon (1997) found that most published studies did not show an increase in maternal or neonatal morbidity after early discharge, and concluded that available data did not support or condemn widespread use of early post-partum discharge in the general population but that early post-partum discharge appeared safe for carefully selected, consenting patients.

Patients after surgery

The studies done on patients after surgery that have been reviewed are:

- *Rumble (1996)* studied 780 patients who had had a CABG to see whether using a critical path tool that decreased length of stay effected re-admission rates.
- *Velasco (1996)* studied patients who had had a CABG to see whether using a critical pathway tool that decreased length of stay effected re-admission rates.
- *Kreder (1998)* compared re-admission rates between surgeons doing a high volume of hip replacements with shorter lengths of stay and surgeons doing a lower volume with longer lengths of stay.
- *Dowsey (1999)* compared the effect on re-admission rates of implementing a clinical pathway in 92 patients undergoing primary hip or knee arthroplasty with that in 71 patients having an established standard of care.
- *Leyland (1995)* examined the effect of length of stay on re-admission rates in eight homogeneous groups of patients discharged from general surgery wards.
- *Gregor (1996)* studied 77 patients undergoing elective knee or hip arthroplasty in Vancouver to see whether using a clinical pathway tool that decreased length of stay affected re-admission rates.
- *Gorski (1999)* analysed 1,218 consecutive patients who underwent transabdominal colorectal surgery between July 1990 and June 1997, for length of stay, mortality, morbidity, and discharge disposition.
- *Huber (1998)* examined the impact of a clinical pathway for elective infrarenal aortic reconstruction among 65 patients on length of stay, re-admissions and resource utilization in a university medical center.
- *Holloway (1998)* retrospectively analysed data on 7,019 patients undergoing a carotid endarterectomy between 1990 and 1995 in ten academic medical centers to assess whether the patterns of in-patient care have changed and to assess any impact on patient outcomes.
- *Klein (1996)* undertook a study to determine the effect of shortened hospital stay on costs, adverse surgical outcomes, and patient satisfaction for a

consecutive sample of 374 patients undergoing radical retropubic prostatectomy between July 1989 and November 1995.

- *Henderson (1989)* compared re-admission rates following day surgery with those following in-patient care for 12 surgical conditions using data from the Oxford Record Linkage Study. Day surgery may be regarded as an extreme example of short length of stay.
- *Cowper (1997)* assessed the impact of early hospital discharge (post-operative length of stay < or = five days) on short-term clinical outcomes among 83,347 non-health maintenance organization (HMO) elderly Medicare patients who underwent coronary artery bypass graft surgery (CABG) in the United States in 1992.

Rumble (1996) found that using a critical path tool significantly decreased hospital and surgical length of stay but that there was no increase in re-admissions.

Velasco (1996) found that using a critical path tool significantly reduced hospital length of stay without increasing re-admission or post-operative mortality rates.

Kreder (1998) found that there was no difference in re-admission rates between the surgeons with high volumes of hip replacements and shorter lengths of stay and those doing low volumes with longer lengths of stay. The main findings were:

- Surgeons doing more than 27 operations annually (above 80th percentile) discharged patients 2.4 days earlier ($p < 0.05$) than surgeons doing less than nine operations annually (below 20th percentile).
- This finding was not influenced by adjusting for age, sex, hospital volume, co-morbidity or diagnosis.

Dowsey (1999) found that implementing a clinical pathway approach to hip and knee arthroplasty led to:

- shorter mean length of stay ($p = 0.01$)
- lower re-admission rate ($p = 0.06$).

Leyland (1995) concluded that pressures to reduce length of stay may not be without consequences for health outcomes such as re-admission rates. The main findings were:

- Using crude figures there was a slight positive correlation between length of stay and re-admission rate at hospital level.
- The use of hospital residuals from a length of stay model as explanatory variables in a model, however, brings to light a negative association between length of stay and re-admission.

Gregor (1996) found using a clinical pathway tool led to a statistically significant reduction in median length of stay (12 to nine days; $p < 0.001$) nine months after implementation of the pathway, which was sustained for at least 18 additional months. No changes in post-operative complications or re-admission rate were found.

In the *Gorski (1999)* study, re-admission data within 120 days of discharge were available for 678 consecutive patients from July 1993 to June 1997. Key findings were:

- There was no annual difference ($p = 0.012$) in the distribution of patient disease severity scores at admission.
- There was a significant reduction in total length of stay of 3.1 (12.9-9.8) days during the seven years ($p = 0.001$).
- Of the 678 patients followed up for re-admission, 100 (14.7 percent) were re-admitted within 120 days, with no annual difference ($p = 0.302$).
- Mortality, morbidity, discharge disposition and re-admission rates were not affected by a decreased length of stay after colorectal surgery.

Findings from *Huber (1998)* were:

- The impact of the clinical pathway was determined by retrospective comparison of outcomes between the pathway patients ($n = 45$) and a pre-pathway control group ($n = 20$).
- There were no significant differences in the patient demographics, comorbid conditions, operative indications, or type of reconstruction between the groups.
- The pathway resulted in significant decreases in the total length of stay and pre-operative length of stay and a trend toward a significant decrease ($p = 0.08$) in the intensive care length of stay for the admission during which the operation was performed.
- The pathway resulted in significant decreases in hospital costs.
- Despite these reductions, the discharge disposition, 30-day re-admissions, and number of post-operative clinic visits within 90 days of discharge were not different.

Findings from *Holloway (1998)* were as follows:

- Over the six-year study period, the number of carotid endarterectomies performed more than doubled and the percentage of hospital admissions for patients 65 years or older increased from 65% to 75%.
- Mean length of stay halved and the percentage of admissions with transfers to the intensive care unit decreased from 56% to 26% of cases.
- There were no trends in in-patient mortality, discharge to an institution, or 30 day re-admission rate.
- There were no significant trends indicative of poorer quality of care as measured by the frequency of secondary diagnoses or post-procedure diagnostic test use indicative of complications.

In the *Klein (1996)* study, the main findings were:

- Length of stay was shortened from a median seven to two nights after surgery during the study ($p < 0.0001$), whereas the acute complication, 30-day re-admission, and 30-day mortality rates remained constant.
- Overall, patient satisfaction (assessed in a random subset of 150 patients by anonymous questionnaire) was high, with 83.5% of patients rating LOS as "just right".
- Reducing length of stay resulted in a 43% decrease in mean cost per case while mean cost per day increased by 22% to 35%.

Henderson (1989) used data from the Oxford Record Linkage Study covering five districts for the years 1976 to 1985 to compare re-admission rates after day surgery and in-patient care. The main findings were:

- Emergency re-admission rates after day surgery were similar to those following in-patient treatment.
- The use of day surgery for some conditions judged suitable for day care was found to be low.

Key findings from the study by *Cowper (1997)* were:

- The 6% of patients who were discharged early tended to be younger, male and have fewer co-morbid illnesses.
- Those discharged early did not experience higher 60-day rates of re-admission or death, suggesting that physicians were able to identify low risk candidates for early discharge.

STUDIES TO EXAMINE WHETHER RE-ADMISSIONS ARE PREVENTABLE AND THE RELATIONSHIP WITH QUALITY OF CARE IN THE INITIAL ADMISSION

According to a recent definition, quality of care consists of the degree to which health services increase the likelihood of desired health outcomes and are consistent with current professional knowledge; a definition that introduces both requirements of outcomes and the appropriateness of the process used (*Giangrande, 1998*).

A number of studies have been done to identify:

- whether re-admissions are preventable
- the extent to which re-admissions are influenced by the quality of care in the initial admission.

Studies of this nature that have been reviewed are:

- *Thomas (1996)* sought to determine whether re-admission rates provided valid information on hospital quality of care for 12 conditions.
- *Gautam (1996)* sought to determine how many re-admissions were avoidable by studying 713 discharges from care of the elderly assessment wards in an Aberdeen Hospital which were associated with 109 subsequent admissions to any local hospital within 28 days.
- *Haines-Wood (1996)* sought to determine how many re-admissions were avoidable by studying the re-admission rates of a cohort of 97 elderly patients.
- *Beggs (1996)* sought to determine the extent to which re-admission rates reflect the quality of antecedent care by carrying out a nested control study comparing 110 patients who had coronary artery bypass grafting (CABG) and who were re-admitted within 30 days with a control group of 224 patients.
- *Weissman (1999)* studied the occurrence of related adverse re-admissions in 1,758 patients with congestive heart failure or pneumonia.
- *Rosenheck (1999)* studied the relationship between clinical outcome measures and re-admission rates in 4,165 patients with post-traumatic stress disorder.
- *Ashton (1997)* in a meta-analysis examined the empirical evidence for the link between medical care in an initial admission and subsequent re-admission.
- *Ashton (1995)* conducted a case-control study to determine whether the quality of care (assessed by chart review) during a hospital stay was associated with unplanned re-admission within 14 days among male patients discharged from one of 12 Veterans Affairs hospitals after a hospitalisation for diabetes (n = 593), chronic obstructive lung disease (n = 1172), or heart failure (n = 748).
- *Ludke (1993)* compared the quality of care during an index hospital stay provided to samples of 134 unplanned re-admissions and 158 non-re-admissions from 50 Department of Veterans Affairs medical centres.

- *Hayward (1993)* reviewed 675 general medicine admissions at a university teaching hospital in an evaluation of six potential generic screens (including 28-day early re-admission) for poor quality in-patient care.
- *Frankl (1991)* studied all 327 re-admissions to the medical service of a university teaching hospital during a four month period to determine whether emergency re-admissions within 30 days of discharge are potentially preventable.
- *Williams (1988)* assessed the avoidability of early unplanned re-admission among a random sample of 133 elderly patients re-admitted to a district general hospital within 28 days of discharge.
- *Ashton (1996)* conducted a systematic review of the re-admission literature to determine the extent to which published evidence supported the relationship between early unscheduled re-admission and the quality of medical-surgical in-patient care.
- *Popplewell (1984)* conducted a clinical review of all 73 medical patients discharged and re-admitted during a two month period to determine what proportion of re-admissions to this busy Australian medical service were potentially avoidable.
- *Slack (1997)* tested the hypothesis that sustained differences in re-admission rate for acute asthma were associated with variations in clinical practice by comparing hospital care processes among 100 asthmatic patients (aged 16-44 years) discharged in 1992 from one of two city NHS hospitals that had recorded a sustained difference in re-admission rate for acute asthma.
- *Miles (1999)* examined all re-admissions to one hospital in October 1998 to assess what proportion were preventable.
- *Bates (1995)* undertook a study to evaluate the sensitivity and specificity of 15 screening criteria (including re-admission) for adverse events, preventable adverse events, and severe adverse events among 3,137 consecutive admissions to a medical service over a four month period at an urban tertiary care hospital.
- *Krumholz (1998)* undertook a retrospective cohort study of 450 elderly patients (aged 65 years or over) admitted to three Connecticut hospitals between 1993 and 1995 with unstable angina or chest pain, to compare practice patterns and 30-day re-admission rates before and after the publication of guidelines on the use of aspirin and heparin.
- *Graham (1983)* assessed the preventability of re-admission to a geriatric medical unit within twelve months of discharge from any hospital in the district among 153 re-admitted patients.
- *Kelly (1992)* assessed the preventability of re-admission to a geriatric medical unit within one year of discharge among 211 patients.
- *Clarke (1990)* investigated the avoidability of unplanned re-admissions within 28 days of discharge among a random sample of 74 general medical, geriatric, and general surgical patients with an unplanned re-admission in the North East Thames region.
- *Blais (1998)* examined the effect of regular therapy with inhaled corticosteroids on the risk of re-admission among 2,059 asthmatic patients (aged 5-54 years) hospitalised in Saskatchewan between 1977 and 1993.

- *Ashton (1999)* undertook a study of unplanned re-admission within 14 days involving roughly 2,500 Veterans Affairs patients with one of three diagnoses to evaluate the validity of three methods of quality assessment based on process-of-care criteria.

Thomas (1996) found that, for each of the conditions studied, re-admission rates of cases that had received poor quality care, as assessed by medical record review, were essentially the same as those whose care was judged to be satisfactory. This held true when the rates were adjusted for patients' demographic and clinical characteristics.

In the *Gautam (1996)* study it was concluded that the majority of re-admissions were medical and unavoidable and that the re-admission rate is not a good measure of the quality of care of elderly people. The main findings were:

- The 28 day re-admission rate was 15%.
- In 87% of the re-admitted population the cause of admission was a medical rather than social problem most commonly involving relapse of existing disease.
- Based on the opinions of the patients' GP, discharging consultant and an audit team, only 16 re-admissions (15%) were avoidable.
- The main area for improvement was considered to be pre-discharge assessment of home circumstances.

In the *Haines-Wood (1996)* study, the main findings were:

- The 30 day re-admission rate was 15%, at 90 days 24% and at 180 days 30%.
- Principal causes of re-admission were new medical event (47%) and deterioration of existing disease (36%).
- On four occasions (19%) the GP considered re-admission was preventable.

In the *Beggs (1996)* study of CABG it was concluded that, although the reasons for re-admission are heterogeneous and related to the severity of illness and co-morbidity, several of the most common are potentially preventable and related to the quality of care of the initial admission. In the analysis 24% of the variance was due to pre-operative severity of the illness and co-morbidity. The commonest reasons for re-admission were:

- wound infection (19%)
- atrial fibrillation (13%)
- pleural effusion (11%)
- thromboembolic event (10%).

In the *Weissman (1999)* study a related adverse re-admission (RAR) was defined as a re-admission that indicates potentially sub-optimal care during the initial admission. The authors concluded that although RARs are associated with a lower quality of care neither RARs or other re-admissions appear to be useful tools for comparing quality between hospitals.

Rosenheck (1999) concluded that hospital re-admission rates are significantly although modestly related to clinical outcomes. The main findings were:

- Number of hospital re-admissions in six months was significantly related to poor outcomes on five of the six clinical outcome indicators.
- Measures of re-admission were more strongly and consistently related to outcome than measures of access, intensity or continuity of out-patient care.

Ashton (1997) found 29 reports that met the following inclusion criteria:

- data on patients admitted to medical or surgical ward
- outcome measure person-based distinguishable re-admission within 31 days of discharge from index admission
- analysis of at least one element representing the process of care in the index admission
- comparison group of patients.

Of the reports 19 were chart analyses and separate meta-analyses were carried out of:

- substandard versus normative care
- normative versus exceptional care
- care of lower quality relative to care of higher quality.

The ten database studies examined the influence of a measured or unmeasured proxy for substandard care on re-admission. Quality of care was found to be significantly associated with re-admission in those studies:

- examining the actual process of care
- in which re-admission is the primary rather than a secondary outcome indicator
- including only unplanned re-admissions rather than all re-admissions
- counting re-admissions to all hospitals rather than index hospital only.

Overall, the results indicated that the process of care does affect the risk of re-admission within 31 days. The evidence supports the validity of early re-admission as an indicator of the quality of antecedent care. In particular:

- The strongest evidence came from the 16 studies which analysed the process of care in the index admission and meta-analysis yielded a summary estimate of 1.55 (95% CI 1.25-1.92) for the odds of re-admission following relatively low compared with higher quality care.
- In the nine studies that tested the hypothesis that exceptional care reduces the risk of re-admission, seven considered the effect of “enhanced” discharge planning. In a meta-analysis of these seven studies, patients who received standard discharge planning were 1.47 times as likely to be re-admitted as those who received “enhanced” discharge planning (95% CI 0.94-2.33).

It is not possible to conclude from this study whether re-admission rates are useful and efficient indicators by which to compare hospitals.

In the *Ashton (1995)* study, adherence scores (the percentage of applicable criteria that were met) were calculated for the admission workup, evaluation and treatment, and readiness for discharge. The main findings were:

- Adherence scores were found to correlate with early unplanned re-admission ($p < 0.05$), after adjustment for demographic characteristics, severity of illness, and need for care.
- For patients with diabetes and heart failure, decreased readiness-for-discharge adherence scores, correlated with increased risk for re-admission ($p = 0.001$ and $p = 0.016$, respectively).
- Among patients with obstructive lung disease, decreased admission-workup scores correlated with increased risk for re-admission ($p = 0.013$).
- One of seven re-admissions in patients with diabetes, one of five re-admissions in patients with heart failure, and one of 12 re-admissions in patients with obstructive lung disease were attributable to substandard care.
- The authors conclude that lower quality of in-patient care increases the risk for unplanned early re-admission in patients with heart failure, diabetes, or obstructive lung disease, and that, under certain circumstances, re-admission is associated with remediable deficiencies in the process of in-patient care.

In the *Ludke (1993)* study, four groups of commonly used quality indicators (occurrence of an adverse incident, inadequate discharge planning, high-risk discharge status, and unexpected transfer to special care unit) and seven re-admission risk factors (severity of illness, propensity for hospitalisation, occurrence of surgery, medical condition suggesting re-admission, age, race, and marital status) were included in a logistic regression analysis. The main findings were:

- Unexpected transfer to a special care unit was the only variable significantly associated with an increased risk of re-admission when controlling for other possible quality indicators and re-admission risk factors.
- Although not statistically significant, re-admitted hospitalisations had more frequent occurrences of adverse incidents and inadequate discharge planning than non-re-admitted hospitalisations.

In the study by *Hayward (1993)*, the quality of care for a stratified random sample of admissions was evaluated using structured implicit review. The key findings were that patients who died in-hospital were substantially more likely than those who were discharged alive to be rated as having had substandard care (30% vs. 10%; $p < 0.001$), whereas cases who had subsequent early re-admissions did not have poorer quality ratings.

Findings from the study by *Frankl (1991)* include:

- Nearly 75% of re-admissions were due to previously diagnosed medical conditions; complications of drugs or therapeutic procedures caused 29%, and patient compliance contributed to 11%.
- Three reviewers judged 28 (9%) re-admissions to be potentially preventable. These 28 re-admissions constituted 1% of all admissions to the medical service and did not result in any fatalities, indicating that the quality of care was generally very good.
- One third of the potentially preventable re-admissions were thought to be related to medical system failures, one third to an unfulfilled hope that the

patient would improve after discharge, and one third to other suboptimal judgements in evaluation or treatment.

- Of the 28 potentially preventable re-admissions, 89% occurred within ten days of discharge.
- The “predictive value” of a re-admission within 30 days for a quality problem was only about 10%; in cases of re-admission within ten days, the predictive value was only 16%.

The authors conclude that potentially preventable re-admissions would nearly always be detected by review of re-admissions within ten days of discharge and that many may be amenable to systematic interventions such as standardized pre-discharge assessment and better coordination of post-discharge follow-up.

In the *Williams (1988)* study the rate of unplanned re-admission was 6%. It was thought that unplanned re-admission was avoidable for 78 (59%) patients.

Ashton (1996) found that, up to 1994, only 11 comparative studies had been published that examined primary data on the link between substandard in-patient care and the likelihood of early re-admission. On the basis of their findings, Ashton and co-workers conclude that:

- In most negative studies, the absence of an association appears to be explainable on the basis of improper study design, omission of important variables, or mis-specification of variables.
- Variables intervening between or confounding the relationship of the process of in-patient care to early re-admission have received inadequate attention in published studies and that empiric re-admission research has been hampered by the lack of a consistent approach to account for these factors.
- From the evidence to date, it is impossible to say with confidence that early re-admission is or is not a valid and useful quality indicator.

They outlined several important potential confounders of the relationship between quality of care and risk of re-admission as part of a conceptual model they devised for the use of unscheduled re-admission (within 31 days) as an indicator of the quality of non-psychiatric in-patient care for adults. The potential confounders include:

- Re-admission to a hospital not covered by the study.
- Post-discharge out-patient care (unscheduled re-admission may be a better quality indicator for the continuum of in-patient and post-discharge care, rather than just for in-patient care).
- Discharge destination.
- Medical indigence.
- Discharge against medical advice.
- Inappropriate or “nonacute” use of the hospital.
- Hospital reimbursement methods in which the unit of payment is the hospital stay.
- The proportion of end-stage and “revolving door” patients in the hospital’s case mix. The level of prior hospital utilisation, which may be assumed to capture both end-stage and revolving door patients, is one of the strongest and most consistent predictors of early re-admission. Patients who have a

medical condition that requires frequent hospitalisation may be re-admitted because of the nature of their illness and not because of care provided during their preceding hospitalisation.

In the *Popplewell (1984)* study:

- Of the 73 early re-admissions reviewed, 60 were classed as unavoidable, whereas 13 re-admissions might have been avoided through improvements in the care (or in the arrangements for continuing care) of the patient during the preceding admission. There were no obvious differences in the case-mix of the avoidable and unavoidable groups.
- A greater proportion of the avoidable than the unavoidable re-admission group had an inappropriately short length of stay: five out of 13 compared with two out of 60 ($p < 0.05$).
- The avoidable re-admission group was characterised by a much greater incidence of inadequate arrangements for follow-up than the unavoidable re-admission group: seven out of 13 compared with one out of 60 ($p < 0.05$).

In the study by *Slack (1997)* data were collected by retrospective review of case notes for a random sample of 50 asthmatic patients (aged 16-44 years) from each of two hospitals using the criteria recommended by the British Thoracic Society. The main findings were:

- Hospital A had a lower re-admission rate than hospital B. The sample groups were similar for age, sex, deprivation of area of residence, and severity of episode.
- Systemic corticosteroids were given early more often ($p = 0.02$) and oral corticosteroids were prescribed at discharge more often ($p = 0.04$) in hospital A.
- When a short course of oral corticosteroids was prescribed the duration stated was longer ($p = 0.02$) and inhaled corticosteroids were started or the dose increased more often ($p = 0.02$) in hospital A.
- These results support the hypothesis that differences in re-admission rates for acute asthma are associated with variations in clinical practice. Sustained variation in re-admission rates is an outcome of health care, for acute asthma. The findings also support audit of the process of hospital asthma care as a proxy for outcome.

Findings from *Miles (1999)* were:

- Twenty-four out of 437 re-admissions (5.5%) were defined as adverse events being nominally due to inappropriate medical management; a further five re-admissions occurred because the scheduled theatre was cancelled, and the remaining re-admissions were due to the condition of the patient in each case.
- The adverse events showed no particular association with patient age, sex, hospital of original admission or hospital specialty. All were deemed extremely difficult cases by a senior clinician who undertook medical record review.

In the *Bates (1995)* study, judgments regarding presence, severity, and preventability of adverse events were made using guided implicit reviews by physicians. Key findings were:

- 341 (11%) of all admissions were judged to include an adverse event, of which 274 were severe and 145 were preventable.
- Sensitivity and specificity of individual screens varied widely, with prior hospitalisation the most sensitive (68%) but least specific (56%). Re-admission was intermediate (sensitivity 28%, specificity 80%), while death was specific (97%) but not sensitive (9%).
- The authors concluded that no small subset of screens identified a high percentage of adverse events.

Krumholz (1998) compared 300 consecutive elderly patients admitted during 1993-1994 with 150 consecutive elderly patients admitted in 1995. Key findings were:

- Comparing 1995 with the period 1993-1994 the use of aspirin (OR 2.3; 95% CI 1.3-4.0) and heparin (OR 2.8; 95% CI 1.6-4.9) on hospital admission significantly increased, and the use of aspirin at discharge (OR 1.4; 95% CI 0.8-2.4) increased.
- Concomitantly, there was a significant reduction in 30-day re-admission (OR 0.52; 95% CI 0.27-0.99).
- This study does not, however, prove an association (causal or non-causal) between this process of in-patient care and the re-admission rate.

Graham (1983) found that re-admission could have been prevented in 73 (47.7%) out of 153 geriatric medical patients.

In the study by *Kelly (1992)*, re-admission was judged preventable by better management of the previous admission and discharge in only 33 cases (15.6% of re-admissions). The results suggest that unplanned re-admission often reflects a highly dependent and medically frail group of patients, in whom early intervention with re-admission is appropriate.

Clarke (1990) found that:

- General medical and geriatric re-admissions and surgical re-admissions at 0-6 days after discharge were more likely to be assessed as avoidable than those at 21-27 days (medical re-admissions 32% vs 6%, surgical admissions 49% vs 19%).
- General surgical re-admissions were significantly more frequently assessed as avoidable than general medical and geriatric re-admissions.
- The extent of agreement between doctors varied, with general medical and geriatric re-admissions at 21-27 days after first discharge causing the greatest variability of judgment.

Blais (1998) found that

- During the first 15 days of regular therapy, users of inhaled corticosteroids were as likely as nonusers of these medications to be readmitted for asthma (RR =1.2; 95% CI 0.8-1.8).

- Subjects treated regularly with inhaled corticosteroids for at least 16 days and as long as 6 months were 40% less likely to be readmitted for asthma (RR = 0.6; 95% CI 0.4-0.9).
- After 6 months of regular treatment the protective effect disappeared (RR = 1.3; 95% CI 0.7-2.4). Confounding by severity appears to be the most likely explanation for this disappearance of the beneficial effect.

Ashton (1999) evaluated validity by comparing process-of-care scores between patients who were or were not subsequently re-admitted within 14 days. Key findings were:

- The three methods of quality assessment displayed high convergent validity and substantial predictive validity.
- Index-stay mean scores, using *explicit* criteria, were generally lower in patients subsequently re-admitted.
- Mean readiness-for-discharge scores were significantly lower in patients with heart failure or with diabetes who were re-admitted.
- Mean admission work-up scores were significantly lower in patients with lung disease who were re-admitted.
- The explicit criteria-based method of assessing process of care had greater inter-rater reliability than the implicit method.

STUDIES TO ASSESS THE USE OF RE-ADMISSION RATES IN COMPARING HOSPITAL PERFORMANCE

The studies which have specifically assessed the use of re-admission rates as comparative indicators of hospital performance are:

- *Thomas (1991)* examined data on all discharges from 18 acute care hospitals over one year using DRGs.
- *Leng (1999)* analysed emergency re-admission rates from the Scottish Morbidity Record Scheme to determine whether rates varied between specialties and hospitals.
- *Hofer (1995)* sought to evaluate the feasibility of using re-admission rates to identify poor quality hospitals by developing a model using data from 190 hospitals in Michigan.
- *Chambers (1990)* used Korner data for January 1988 to April 1989 for three districts in North East Thames region to compare re-admission rates between specialties.
- *Riley (1993)* examined the usefulness of re-admission for an adverse event as an outcome indicator for a range of surgical procedures in terms of the adequacy of statistical power for making comparisons at the hospital and small area level.
- *Wray (1997)* attempted to assess the validity of hospital outlier status as a quality indicator in an analysis of re-admission rates using risk-adjusted models for 17 disease categories with strong evidence of links between process and outcome.
- *DesHarnais (1991)* developed and validated three risk-adjusted measures of hospital quality including the risk-adjusted re-admissions index (RARI), the risk-adjusted mortality index (RAMI), and the risk-adjusted complication index (RACI), and then tested the relationships among the three indexes using a sample of 300 hospitals.

In the *Thomas (1991)* study key findings from the analysis of unplanned re-admissions in each of 22 sets of related DRGs were:

- Clinical and other risk factors for re-admission differ for different DRG groups.
- Age, sex, and race are significant predictors of early re-admission for some types of patients, after controlling for patients' clinical characteristics (e.g. for circulatory disorders, older age was found to be an independent risk factor for re-admission even after controlling for severity of illness: circulatory disorders typically are characterised by increasing levels of complications over time).
- Even within DRG groups, severity and complexity of the case are the variables most consistently associated with increased re-admission risk.
- In examining relationships between early re-admission and hospital characteristics (teaching status, number of beds, location, degree of variation in occupancy level), no consistent patterns suggestive of quality of care problems were apparent.
- The finding that hospital teaching status and bigger size were significant predictors of re-admission could, suggest the authors, be attributable to the

combined effects of referral bias (physicians tend to refer their sicker patients to specialists at teaching hospitals and/or larger hospitals) and failure of the study's measures of severity/complexity to adequately control for differences among hospitals for certain types of cases.

- For 14 out of 22 DRGs, re-admission risk was not influenced by whether or not patients were discharged home or into organised care environments. For stroke and biliary tract disorders, patients were at greater risk of re-admission if they were discharged home or against medical advice than if discharged to settings that have some capability to provide follow-up care.
- Overall, the study's results are inconclusive with regard to whether or not risk-adjusted re-admission rates can be used to detect potential quality of care problems at particular hospitals or among particular sub-groups of patients.

In the *Leng (1999)* study, the main findings were:

- Emergency re-admissions varied markedly between medical specialties, with highest rates in nephrology (24.2%; 95% CI 23.5-24.8) and haematology (20.4%; 95% CI 19.9-20.9), and the lowest in homeopathy (2.2%; 95% CI 1.6-2.7) and metabolic diseases (3.5%; 95% CI 2.4-4.5). This implies that the emergency re-admission rate should not be used as an outcome indicator across all medical specialties unless it is either standardised for specialty mix or restricted to certain specialties.
- The largest number of emergency re-admissions was in general medicine, accounting for 63% of the total. Restricting emergency re-admission rates to general medicine significantly altered previous rates and altered the rank order of hospital trusts.
- In the year preceding the emergency re-admission, 59% of all patients had been admitted to hospital at least once, and most emergency re-admissions (73.3%) resulted from a chronic underlying condition.
- In conclusion, significant variations in emergency re-admission rates occurred between medical specialties, suggesting that differences between hospital trusts are influenced by differences in specialties and thus case mix.
- The majority of emergency re-admissions occurred in patients with an underlying chronic condition, and many had a history of multiple previous hospital admissions.
- The emergency re-admission rate is therefore unlikely to be a valid outcome indicator reflecting quality of care until routine data are available for standardisation by case mix.

Hofer (1995) evaluated the ability of early re-admission rates to distinguish 19 poor quality from 171 average quality hospitals. A model was developed and DRG specific and DRG aggregated re-admission rates were calculated. It was concluded that the circumstances under which DRG specific re-admission rates would be useful to detect poor quality hospitals are unlikely to occur. Even when collapsing all the medical DRGs the re-admission rates are only likely to be accurate predictors if quality differences are quite large and if unmeasured case-mix differences account for a small amount of inter-hospital variation in the rates.

Chambers (1990) compared re-admission rates between specialties. Key findings were:

- All specialties showed an early peak in the number of re-admissions, which levelled off by 28 days.
- Medical specialties had a relatively low early peak and a higher background level whereas surgical specialties had a more pronounced early peak and a relatively low background level.
- Re-admission rates at 28 days were appreciably lower in surgical specialties than in medical specialties (for example, general surgery 4.1% v geriatric medicine 15.1%).
- The risk of re-admission was increased in male patients and in older age-groups.
- Statistically valid annual comparisons of standardised re-admission rates may be made among districts only for combinations of specialties; those among individual consultants or specialties are unlikely to be valid because of inadequate statistical power.

Riley (1993) broadly defined adverse events as complications, failure of the procedure to achieve its therapeutic goal, and untoward events associated with the natural history of the disease. Key findings from this study were:

- Almost 36% and 20% of patients undergoing percutaneous transluminal coronary angioplasty and CABG surgery respectively were re-hospitalised for an adverse event within a year.
- Following the other six procedures studied (cholecystectomy, partial excision of the large intestine, total knee replacement, total hip replacement, replacement of the head of the femur, and reduction of fracture of the femur) between 4% and 9% of patients were re-hospitalised for an adverse event.
- For the purpose of making comparisons at the hospital or small area level, re-admissions for adverse events may be a useful outcome measure for cardiac procedures but less useful for the other surgical procedures studied because of their relative rarity.

Findings from the study by *Wray (1997)* were:

- Hospitals found to have extreme re-admission rates in one year were more likely to have extreme rates in subsequent years.
- Hospitals with extreme rates in one condition were more likely to have extreme rates in related disease categories.
- The correlation of outlier status across time and across diseases was stronger in the 17 disease categories with strong links between process and outcome than in 10 comparison disease categories with weaker process-outcome links.

Although hospital outlier status as identified in this study did not appear to be random, the causal factors leading to outlier status could include:

- systematic unmeasured patient variation
- practice pattern variation that, although stable with time, is not indicative of substandard care
- true quality-of-care problems.

DesHarnais (1991) found that:

- No relationship existed between a hospital's ranking on any one of the three indexes and its ranking on the other two indexes, suggesting that no measure of quality should be used by itself to represent different aspects of the quality of hospital care.
- Hospitals with high rankings on their mortality rates did not necessarily rank high on their re-admission rates or complication rates.
- Adequate overall measures of hospital quality will need to include multiple measures in order to be credible and to reflect the complexity of hospital care.

STUDIES TO EXAMINE TECHNICAL ISSUES IN COMPILING RE-ADMISSION RATES

The main technical issues that need to be addressed in compiling re-admission rates are:

- methods of linking hospital episode data
- type of index admission and diagnostic specificity
- type of re-admission
- range of re-admission diagnoses
- range of hospitals to which re-admitted
- time cut-off point
- exclusion of interim deaths
- dealing with patient transfer
- adjusting for case-mix and other potential confounders
- accuracy and completeness of data to link episodes and describe index and re-admission
- statistical power.

Methods of linking

The technical issues concerned with linking hospital episode data have been studied in the Oxford Record Linkage Study for many years. Record linkage is the process of bringing together related records, or abstracts of records, which have been compiled separately. It may be used to bring together different data about the same medical event (e.g. a hospital admissions record, a discharge record, clinical data, laboratory data) or data on different episodes of illness for the same person. The crux of the actual process of linkage is the comparison of two records and the decision as to whether they refer to the same person. Linked medical records lend themselves, in particular, to the calculation of re-admission rates as outcome measures.

Gill (1993) and *Kendrick (1993)* have outlined the four main steps involved in the linkage of records:

- file blocking
- matching
- linkage
- validation and checking.

The first step is file blocking which involves putting records in an order (e.g. alphabetical) to make searching more efficient for the purpose of making comparisons between records. With very large data sets, comparing every record in a system with every other record may be impossible, and blocking is used to minimise the number of comparisons needed. It is desirable to use at least two different methods of blocking to effect matches by one method that may have been missed by the other (e.g. blocking on dates of birth followed independently by blocking on names). Thus records will fail to be compared only if they differ on an item from both sets of blocking criteria.

The next step is matching which is the process of comparing records to determine whether they do or do not relate to the same person. When records created at different

times and in different places are to be linked, it should be possible, in principle, to link these using a personal identification number such as the NHS number.

Currently, partial identifiers such as forenames, surname, sex, date of birth, and postcode of residence, are used to identify different records relating to the same individual. When using partial identifiers, such as forenames and surname, character by character matching is not recommended if precision of matching is required. "Failure to match" records belonging to the same person on this basis occurs partly because there are fairly high levels of error in spelling and recording names, and particularly because the recording of names may vary. For each of the identifying items used to link records, there may be a discrepancy rate of up to 3% in pairs of records belonging to the same person. Thus exact character by character matching could miss up to 15% of true links if five separate identifying items are used (the sum of the item-specific discrepancies).

In computerised linkage of medical records, probability matching, using an array of identifiers, achieves much higher levels of correct matching than is generally achievable by exact character by character comparisons. A composite score or match weight can be calculated for each pair of records indicating the probability that they relate to the same person, using calculations based on the discriminating power of each identifying item used in the matching process. In the Scottish Record Linkage System which employs probability matching (using name, initial, sex, and date of birth) clerical checking shows that on a pair-wise basis, both the false positive rate (the proportion of linked pairs of records which do not in fact refer to the same individual) and the false negative rate (the proportion of truly matched pairs which the system fails to link) are around 1%.

After records have been matched, *linkage* is undertaken, which is the process of assembling correctly matched records, identified as relating to the same person, into a time-sequenced composite record for the individual.

Finally, *validation checks and corrections* are carried out in which any inconsistencies between different records for the same person are identified and corrected. This cycle may, in practice, account for a significant part of the resource required to match and link records in an established linkage system.

Type of index admission and diagnostic specificity

One study reviewed examined the effect of including only unplanned index admissions when analysing re-admission rates. *Townsend (1988)* found that elderly patients initially admitted as emergencies were significantly more likely to be re-admitted than those first admitted on a planned basis (12% compared with 5% within four weeks, and 26% compared with 11.5% within three months).

While many studies have looked at re-admissions among patient groups admitted for a range of index diagnoses, the risk of re-admission appears to be strongly linked to diagnosis. For chronic conditions, recurrent re-admission may reflect the natural course of the disease rather than be indicative of quality of care problems.

Johansen (1994), using linked hospital morbidity records to study hospital utilisation patterns in two Canadian states found that cancer diagnoses were associated with the highest hospital re-admission rates.

Including a range of index diagnoses has the advantage of increased statistical power when undertaking comparative analyses.

Type of re-admission

Most of the studies reviewed have included only one type of re-admission, those which are emergency or unplanned.

Ashton (1996) concluded that in the analysis of early re-admission as an index of quality, planned re-admissions should be excluded from the analysis because they lead to the outcome of interest while conforming to acceptable practice standards. Failure to distinguish between scheduled and unscheduled re-admissions makes it more difficult to detect an association between substandard care and early re-admission.

Kossovsky (1999) analysed both unplanned and planned re-admissions from an internal medicine department. Planned re-admissions constituted more than half of the total. It was concluded that a crude re-admission rate incorporating both types of re-admission was unlikely to be a useful indicator of the quality of care in the index admission.

In a meta-analytic review, *Ashton (1997)* found that quality of in-patient care was significantly associated with re-admission among medical-surgical patients in studies that included only unplanned re-admissions (rather than all re-admissions).

Range of re-admission diagnoses

Few studies have addressed the range of diagnoses attributed to the re-admission. Counts have been made of overall re-admission rates for any cause as well as of those related solely to specific diagnoses or causes.

Colledge (1994) looked at the diagnoses attributed to re-admission among 226 consecutive medical patients aged over 75 years and related this to the interval between index admission and re-admission. He found that out of 46 patients who required emergency re-admission within three months of discharge (yielding a re-admission rates of 20.3%), 19 had a diagnosis related to their original admission, and 27 an unrelated diagnosis. The mean time to re-admission was 34 days, but this was significantly shorter (21 days) in those with a related diagnosis.

Zitser-Gurevich (1999) in a study of patients re-admitted after CABG suggested that cause specific re-admission rates would be a better outcome for evaluating care after this operation than an overall re-admission rate.

Daradkeh (1997) examined the stability of ICD-10 psychiatric diagnoses (defined as a measure of the degree to which diagnoses remain unchanged at a later hospital admission) in 168 re-admissions to in-patient psychiatric units among 107 patients

during the period 1993-1995. The level of diagnostic stability varied widely across diagnoses: high levels were found for F1-psychiatric disorders (100%), F2-schizophrenia (87%), F3-bipolar disorders (87%) and F3-depressive disorders (73%), while poor levels were found for several types of disorder including neurotic, stress-related, F4-adjustment, and personality disorders.

Range of hospitals to which re-admitted

It is important in calculating re-admission rates to include the widest range of hospitals to which the patient could be admitted. The most useful studies are those that can link hospital episodes for large populations. The range of hospitals involved was considered in the *Ashton (1997)* meta-analysis to be an important characteristic of re-admission studies that could be used to determine index hospital quality of care.

Time cut-off point

Many studies have found that a significant proportion of re-admissions occur at a cut-off point of about a month (28, 30 or 31 days according to the study).

Henderson (1993) found that re-admissions were clustered strikingly in the first four weeks after discharge. One third of all re-admissions in the year after discharge occurred in the first month after discharge.

Chambers (1990) analysed the pattern of re-admissions with time in a range of specialties and suggested that re-admission rates should be measured at not more than 28 days after the index discharge.

In the meta-analysis by *Ashton (1997)* a criteria of inclusion was that the study should have a cut-off point of 31 days.

Brooten (1996) studied the profile of post-discharge re-hospitalisations for seven high risk patient groups (total sample N = 764). In four out of the seven patient groups studied (women post-unplanned cesarean birth and their infants, women post-hysterectomy surgery, and elderly surgical cardiac patients), 60%-100% of the re-hospitalisations occurred within four weeks of discharge. The remaining three groups included very low birthweight infants, pregnant women with diabetes, and elderly medical cardiac patients.

Tierney (1995) suggests in a review of re-admission of elderly patients that early re-admissions are the most undesirable and potentially the most preventable. The authors argue that for the purposes of research and audit, re-admission rates should be measured at seven day intervals for the first month, and monthly thereafter, so as not to obscure early re-admissions.

Frankl (1991) found that out of 28 potentially avoidable medical re-admissions occurring within 30 days, 25 of these occurred within ten days of discharge. The author suggests that potentially preventable medical re-admissions may be most likely to occur within ten days of discharge.

Korkeila (1998) analysed data on all discharges from Finnish psychiatric hospitals in the early 1990s to investigate factors predicting the interval between re-admissions and found that patients with psychosis or personality disorder were re-admitted more rapidly than patients with an organic disorder.

The decision on what time interval to use will depend, to some extent, on the subject under study (*Henderson, 1989*). For example, in monitoring the success of hip arthroplasties, a much longer time period for re-admission would be appropriate than in monitoring re-admissions for infection after abdominal operations.

Exclusion of interim deaths

The importance of excluding interim deaths is highlighted in the study by *Librero (1999)*. It is worth emphasising that the exclusion of interim deaths is particularly important in compiling outcome indicators based on re-admissions for conditions with relatively high case-fatality rates (e.g. myocardial infarction). For such conditions, the presentation of outcome indicators based on case-fatality rates alongside re-admission indicators is desirable. In the analysis of late re-admissions (i.e. with a long interim period between discharge and the cut-off point for re-admission) among elderly people, the exclusion of interim deaths is also important given the increasing risk of mortality with age.

Patients who die in hospital may be more likely to have had substandard care than those discharged alive (*Hayward, 1993*), while death shortly after leaving hospital may be the result of premature discharge (*Brook, 1992*). For particular diagnoses, an inverse relationship may exist between a hospital's in-patient death rate and the early re-admission rate. *Ashton (1996)* suggests that for certain conditions, death or re-admission within a specified time period may be an appropriate composite indicator of quality of care.

Wray (1995) found that for certain conditions, poor quality in-patient care would be more likely to lead to death than to early re-admission. For such conditions, outcome indicators based on case-fatality rates will be more appropriate than those based on re-admission rates.

Dealing with patient transfers

A linked data-system may enable the continued identification of patients after transfer to other hospitals. This is important since, for some conditions, a considerable burden of morbidity may be shifted to other hospitals that continue the medical care of transferred patients. *Birdi (1995)*, in a study of morbidity among 322 consecutive adult patients undergoing cardiac surgery found that 23% of patients were transferred to other hospitals for continued medical care, and that the re-admission rate within six weeks of discharge was lower in patients sent home directly (10%), than in those who were transferred (22%; $P < 0.001$).

Adjusting for case-mix and other potential confounding variables

A study of re-admission rates for selected diagnoses in Scottish hospitals led authors to conclude that before meaningful comparisons of hospital performance can be made,

adjustment for all relevant demographic and case-mix variables should be undertaken (*Leyland, 1995*). This, however, is likely to be limited by the paucity of social and demographic data available in routine data sets.

Unjust judgements about hospital performance based on comparative indicators may increase the inequalities that medical care resource allocation should attempt to reduce (*Russell, 1998*). When comparing re-admission rates for different hospitals, adjusting for demographic risk factors such as low socio-economic status, may remove the incentive to improve care in the higher-risk group. Crude unadjusted measures may be better indicators of the current burden of morbidity and may help to channel health care resources to those most in need. On the other hand, the use of unadjusted re-admission rates as performance indicators may lead to perverse incentives with hospitals becoming risk averse and selecting patients with low associated risk.

While a range of demographic variables including age, gender, ethnicity, marital status, socio-economic status, and place of residence, may influence the relationship between quality of care and risk of re-admission, clinical variables such as diagnosis, co-morbidity, prior hospital use, severity of illness, and functional status appear to have a greater influence (*Ashton, 1996*).

On a technical note, when adjusting for co-morbidities, mistaking an iatrogenic clinical event for a problem present on admission to hospital, could enhance the apparent performance of the hospital (*Ansari, 1999*).

Accuracy and completeness of data

Accuracy and completeness of data for compiling re-admission rates is essential. This issue relates to all indicators calculated from hospital episode data and is not addressed specifically in this report.

The issue of the completeness of routine hospital data becomes particularly important when attempts are made to adjust for case-mix on the basis of secondary diagnoses. Hospitals that code secondary diagnoses more completely might appear to have a higher-risk group of patients compared to hospitals with patients of similar risk, but whose coding of secondary diagnoses is less complete (*DesHarnais, 1990*). Secondary diagnoses can be significantly under-recorded in hospital discharge data (*Dixon, 1998*).

Statistical power

In an analysis of re-admission rates for a national quality assessment of Veterans Affairs hospitals (*Wray, 1995*), the problems of inadequate statistical power were limited by including only those disease groups with a 14-day re-admission rate of at least 5%, and by combining clinically similar diagnostic related disease groups in the analyses. Disease groups for which 14-day re-admission rates were higher than 25% were excluded from study since such high re-admission rates may be associated with intractable clinical states that require high levels of hospital use regardless of the quality of care delivered.

SUMMARY OF FINDINGS FROM THE LITERATURE REVIEW

In reviewing the literature we attempted to address the following questions:

- Do properly compiled re-admission rates reflect the quality of care in the index admission? (see Chapter 4).
- Are re-admission rates avoidable or preventable? (see Chapter 4).
- Are re-admission rates a useful way of comparing hospital performance? (see Chapter 5).
- What factors other than quality of care in the index admission influence re-admission rates? (see Chapter 2).
- Does the index admission length of stay influence re-admission rates? (see Chapter 3).
- How should re-admission rates be compiled if they are to reflect the quality of care in the index admission? (see Chapter 6).

Re-admission rates and quality of care

Poor quality of care was found to be significantly associated with a higher risk of re-admission in the major meta-analysis which involved a review of 29 appropriate studies. The relationship was strongest in those studies in which the process of care in the index admission was measured during the index admission.

With regard to studies of individual physical conditions positive relationships have been found between poor quality of care in the index admission and re-admission rates for patients with congestive heart failure, pneumonia, diabetes, asthma and following CABG surgery.

The relationship between re-admission of psychiatric patients and the quality of antecedent in-patient care is more complex. Treatment may not be seen as one of the primary goals of in-patient psychiatric care. Indeed, there may be little time during brief hospitalisations to engage in treatment, particularly of severe and persistent mental illness. Re-admission, perhaps on several occasions, may be generally preferred to permanent admission, both by the patient and the system. However, there may be circumstances in which re-admission rates to psychiatric in-patient care are useful quality indicators for integrated systems of care. Re-admission could be seen as an indirect measure, albeit crude, of the goal of psychiatric patients living in the community.

Preventable or avoidable re-admissions

Some of the studies reviewed have tried to find out whether re-admissions are actually avoidable or preventable. In a number of small studies on elderly patients re-admission rates at one month have varied from 6-15%. Of these re-admissions, between 15 and 60% were considered to be unavoidable. The principle reasons for re-admission were a new medical event and deterioration of existing condition.

In two studies on re-admission of medical patients, 9% and 18% were considered to be preventable, while in a study of CABG patients it was concluded that several of the most common causes of re-admission were avoidable.

One study found that very early re-admissions (up to six days after discharge) among general medical, geriatric and surgical patients were more likely to be assessed as avoidable than those occurring at 21-27 days.

In the compilation of outcome indicators based on re-admission rates an important issue to consider, and one that is often overlooked, is that of false negatives – patients with avoidable adverse outcomes may not be counted as re-admissions, not because of cross-boundary flows but simply because they are not re-admitted to hospital anywhere.

Use of re-admission rates in comparing hospital performance

Only two of the seven reviewed studies specifically addressing the issue of hospital comparisons has been done in the UK. However, the conclusions that can be drawn point to an unresolved dilemma about the degree of diagnostic specificity to be used for both index and re-admission. If DRG specific rates are used, only major differences in performance will be detected because of problems with statistical power due to small numbers. On the other hand if specialty specific rates are used most of the difference between hospitals may be explained by different case-mixes. One study concluded that specialty specific comparisons may lack adequate statistical power.

Major work needs to be done to identify a level of specificity of re-admission rates which has adequate statistical power but is not so broad that case-mix differences invalidate any conclusions being drawn from the data.

Influences other than quality of care and length of stay in the index admission

Many studies have been done to identify the factors other than quality of care and length of stay in the index admission that might predict or be the cause of re-admission. Only factors relevant to patients in the NHS have been included in this summary.

In the studies of large populations looking at overall re-admission rates the only related factors consistently found to be associated with risk of re-admission included the number of co-morbidities and the number of previous hospitalisations.

The studies on elderly patients identify a variety of factors that effect the risk of re-admission. The most important are:

- social factors such as inability to carry out specific daily living tasks, poor living conditions, and poverty
- specific conditions such as depression, renal failure, cancer, chronic obstructive airways disease, and congestive heart failure
- number of co-morbidities
- adverse drug reactions.

For patients with medical conditions the only consistent factor was number of co-morbidities. In studies of chronic conditions such as asthma and congestive heart failure, the frequency of previous admission (which may reflect severity of the illness) was also found to be a predictor of re-admission.

For patients with mental illness the picture is more complex. The most important factors were:

- social factors such as socio-economic deprivation, poor psychosocial adjustment, lack of social support
- those associated with attributes of the illness such as presence of aggressive, disturbed or psychotic behaviour and multiplicity of symptoms
- presence of substance related disorder
- higher number of previous hospitalisations and longer duration of illness.

For surgical patients there were no consistently identified factors. For three groups, patients after a hernia operation, total hip replacement and operation for urinary incontinence, the re-admission rate rose with patient age.

The handful of reviewed studies of paediatric re-admissions indicate that age and severity of disease are important predictors of re-admission in asthmatic children.

Many American studies have examined the effect of organisational changes on re-admission rates. To date, few UK studies have been carried out but with the new NHS modernisation agenda, involving issues such as health improvement plans, open access facilities and nurse-led services, such studies will be essential.

There are a number of factors which, although outside the traditional domain of healthcare, appear to influence the risk of re-admission. However, in modern health and social care there is an expectation of seamless delivery of services, underlining the importance of shared responsibility between those providing health and social services.

Length of stay and risk of re-admission

There has been considerable interest in the effect of the length of stay of index admissions on re-admission rates. In the major studies that have involved a general patient population no evidence was found that shortening length of stay resulted in increased rates of early re-admission.

Overall, the results from the reviewed studies of patients with medical conditions suggested that decreasing lengths of stay do not lead to increased re-admission rates.

Studies carried out on patients with mental illness showed a mixed effect. A number showed a relationship between shorter lengths of stay and an increased rate of re-admission. However, others showed no effect and one suggested a relationship between longer lengths of stay and higher re-admission rates. A small elevation in the rate of re-admission might well be an acceptable trade-off for a reduction in the length of stay for psychiatric in-patient care.

Five out of the six studies examining the effect of decreasing post-natal length of stay on risk of re-admission which are reviewed here concluded that early discharge had no effect. A review of the subject conducted in 1997 concluded that the available data did not support or condemn widespread use of early post-partum discharge in the general population but that early post-partum discharge appeared safe for carefully selected consenting patients.

Two studies carried out among paediatric asthma patients found no increases in the re-admission rate despite significant reductions in the average length of stay over the study period.

All but one of the twelve reviewed studies which examined post-surgical length of stay in relation to risk of re-admission showed no effect of decreasing length of stay. One study found that re-admission rates following day surgery (the latter may be regarded as an extreme case of short length of stay) did not differ from those following in-patient care for the 12 surgical conditions studied.

Since length of stay may be a proxy for many things, including severity of illness, technical efficiency of the doctor and hospital, the occurrence of in-hospital complications, and the availability of an appropriate setting to which to discharge the patient, its interpretation in the context of a re-admission study is difficult.

Compilation of re-admission rates

For most purposes, in the compilation of re-admission rates to be used as an indicator of quality of care in the initial admission, the following points should be noted:

- For general purposes, use re-admission rates at one month calculated from date of final discharge (not transfer between hospitals) from index admission to date of admission of re-admission. However, the most appropriate interval depends on the distribution of the length of time between discharge and re-admission. This varies between clinical conditions.
- Use unplanned re-admissions rather than total re-admissions.
- Consider every admission an index event that could lead to a re-admission.
- Include, if possible, all re-admissions regardless of the hospital to which the re-admission occurs.
- Exclude index admissions that end in death and, where identifiable, exclude deaths occurring in the interim period between discharge and the cut-off point for re-admission.
- Standardise by age and other potential confounding factors.

For those conditions with relatively high mortality, simultaneous presentation of case-fatality data should enhance interpretation of re-admission data when making hospital comparisons.

An important area that needs more work concerns the diagnostic specificity of the index admission and of the re-admission. Some studies have covered individual index conditions while others have looked at a range of diagnoses. Most studies have used re-admission rates for any cause and there have been few studies comparing the use of any-cause with condition-specific or even cause-specific rates.

REFERENCES

- Anderson, G. F. and Steinberg, E. P. (1985). Predicting hospital readmissions in the Medicare population. *Inquiry* **22**, 251-258.
- Ansari, M. Z., Ackland, M. J., Jolley, D. J., Carson, N., and McDonald, I. G. (1999). Inter-hospital comparison of mortality rates. *International Journal for Quality in Health Care* **11**, 29-35.
- Appleby, L., Desai, P. N., Luchins, D. J., Gibbons, R. D., and Hedeker, D. R. (1993). Length of stay and recidivism in schizophrenia: a study of public psychiatric hospital patients. *Am.J.Psychiatry* **150**, 72-76.
- Ashton, C. M., Kuykendall, D. H., Johnson, M. L., Wray, N. P., and Wu, L. (1995). The association between the quality of inpatient care and early readmission. *Ann.Intern.Med.* **122**, 415-421.
- Ashton, C. M. and Wray, N. P. (1996). A conceptual framework for the study of early readmission as an indicator of quality of care. *Soc.Sci.Med.* **43**, 1533-1541.
- Ashton, C. M., Del Junco, D. J., Soucek, J., Wray, N. P., and Mansyur, C. L. (1997). The association between the quality of inpatient care and early readmission: a meta-analysis of the evidence. *Med.Care* **35**, 1044-1059.
- Ashton, C. M., Kuykendall, D. H., Johnson, M. L., and Wray, N. P. (1999). An empirical assessment of the validity of explicit and implicit process-of-care criteria for quality assessment. *Med.Care* **37**, 798-808.
- Bates, D. W., O'Neil, A. C., Petersen, L. A., Lee, T. H., and Brennan, T. A. (1995). Evaluation of screening criteria for adverse events in medical patients. *Med.Care* **33**, 452-462.
- Beggs, V. L., Birkemeyer, N. J., Nugent, W. C., Dacey, L. J., and O'Connor, G. T. (1996). Factors related to rehospitalization within thirty days of discharge after coronary artery bypass grafting. *Best.Pract.Benchmarking.Healthc.* **1**, 180-186.
- Birdi, I., Izzat, M. B., Angelini, G. D., and Bryan, A. J. (1995). In-hospital audit underestimates early postoperative morbidity after cardiac surgery. *Br.Heart J.* **74**, 556-558.
- Bisset, A. F. (1998). The case for clinical audit of emergency readmissions after appendicectomy. *J.R.Coll.Surg.Edinb.* **43**, 257-261.
- Blais, L., Ernst, P., Boivin, J. F., and Suissa, S. (1998). Inhaled corticosteroids and the prevention of readmission to hospital for asthma. *Am.J.Respir.Crit Care Med.* **158**, 126-132.
- Bragg, E. J., Rosenn, B. M., Khoury, J. C., Miodovnik, M., and Siddiqi, T. A. (1997). The effect of early discharge after vaginal delivery on neonatal readmission rates. *Obstet.Gynecol.* **89**, 930-933.

- Brook, R. H., Kahn, K. L., and Kosecoff, J. (1992). Assessing clinical instability at discharge: The clinician's responsibility. *JAMA* **268**, 1321-1322.
- Brooten, D., Naylor, M., Brown, L., York, R., Hollingsworth, A., Cohen, S., Roncoli, M., and Jacobsen, B. (1996). Profile of postdischarge rehospitalizations and acute care visits for seven patient groups. *Public Health Nurs.* **13**, 128-134.
- Caan, W. and Crowe, M. (1994). Using readmission rates as indicators of outcome in comparing psychiatric services. *Journal of Mental Health UK* **3**, 4-524.
- Caplan, G. A., Brown, A., Croker, W. D., and Doolan, J. (1998). Risk of admission within 4 weeks of discharge of elderly patients from the emergency department--the DEED study. Discharge of elderly from emergency department. *Age Ageing* **27**, 697-702.
- Chambers, M. and Clarke, A. (1990). Measuring readmission rates. *BMJ* **301**, 1134-1136.
- Charlton, I., Antoniou, A. G., Atkinson, J., Campbell, M. J., Chapman, E., Mackintosh, T., and Schapira, D. (1994). Asthma at the interface: bridging the gap between general practice and a district general hospital. *Arch.Dis.Child* **70**, 313-318.
- Chee, C. B., Wang, S. Y., and Poh, S. C. (1996). Department audit of inpatient management of asthma. *Singapore Med.J.* **37**, 370-373.
- Chu, L. W. and Pei, C. K. (1999). Risk factors for early emergency hospital readmission in elderly medical patients. *Gerontology* **45**, 220-226.
- Clarke, A. (1990). Are readmissions avoidable? *BMJ* **301**, 1136-1138.
- Clarke, M., Moran, P., Keogh, F., Morris, M., Kinsella, A., Larkin, C., Walsh, D., and O'Callaghan, E. (1999). Seasonal influences on admissions for affective disorder and schizophrenia in Ireland: A comparison of first and readmissions. *European.Psychiatry* **14**, 5-255.
- Colledge, N. R. and Ford, M. J. (1994). The early hospital readmission of elderly people. *Scott.Med.J.* **39**, 51-52.
- Corr, S. and Bayer, A. (1995). Occupational therapy for stroke patients after hospital discharge: A randomized controlled trial. *Clinical.Rehabilitation* **9**, 291-296.
- Cowper, P. A., Peterson, E. D., DeLong, E. R., Jollis, J. G., Muhlbaier, L. H., and Mark, D. B. (1997). Impact of early discharge after coronary artery bypass graft surgery on rates of hospital readmission and death. The Ischemic Heart Disease (IHD) Patient Outcomes Research Team (PORT) Investigators. *J.Am.Coll.Cardiol.* **30**, 908-913.
- Crane, J., Pearce, N., Burgess, C., Woodman, K., Robson, B., and Beasley, R. (1992). Markers of risk of asthma death or readmission in the 12 months following a hospital admission for asthma. *Int.J.Epidemiol.* **21**, 737-744.

- Crockett, A. J., Cranston, J. M., Moss, J. R., and Alpers, J. H. (2000). An association between length of stay and co-morbidity in chronic airflow limitation. *Int.J.Qual.Health Care* **12**, 41-46.
- Daniels, B. A., Kirkby, K. C., Hay, D. A., Mowry, B. J., and Jones, I. H. (1998). Predictability of rehospitalisation over 5 years for schizophrenia, bipolar disorder and depression. *Aust.N.Z.J.Psychiatry* **32**, 281-286.
- Daradkeh, T. K., El Rufaie, O. E. F., Younis, Y. O., and Ghubash, R. (1997). The diagnostic stability of ICD-10 psychiatric diagnoses in clinical practice. *European Psychiatry* **12**, 136-139.
- Deb, S. (1995). The pattern of psychiatric admissions to a hospital for people with a learning disability in the Grampian region between 1989 and 1991. *Health Bull.Edinb.* **53**, 148-152.
- Dekker, J., Peen, J., Goris, A., Heijnen, H., and Kwakman, H. (1997). Social deprivation and psychiatric admission rates in Amsterdam. *Soc.Psychiatry Psychiatr.Epidemiol.* **32**, 485-492.
- DesHarnais, S., McMahon-LF, J., and Wroblewski, R. (1991). Measuring outcomes of hospital care using multiple risk-adjusted indexes. *Health Serv.Res.* **26**, 425-445.
- Di Iorio, A., Longo, A.L., Mitidieri-Costanza, A., Bandinelli, S., Capasso, S., Gigante, M., Bavazzano, A., Guizzardi, G., Senin, U., Ferrucci, L., and Abate, G. (1998). Characteristics of geriatric patients related to early and late readmissions to hospital. *Aging Milano* **10**, 339-346.
- Dixon, J., Sanderson, C., Elliott, P., Walls, P., Jones, J., and Petticrew, M. (1998). Assessment of the reproducibility of clinical coding in routinely collected hospital activity data: a study in two hospitals. *J.Public Health Med.* **20**, 63-69.
- Downing, A. and Hatfield, B. (1999). The Care Programme approach: Dimensions of evaluation. *British.Journal of Social.Work* **29**, 6-860.
- Dowsey, M. M., Kilgour, M. L., Santamaria, N. M., and Choong, P. F. (1999). Clinical pathways in hip and knee arthroplasty: a prospective randomised controlled study. *Med.J.Aust.* **170**, 59-62.
- Druss, B. G., Bruce, M. L., Jacobs, S. C., and Hoff, R. A. (1998). Trends over a decade for a general hospital psychiatry unit. *Adm Policy Ment.Health* **25**, 427-435.
- Edmonson, M. B., Stoddard, J. J., and Owens, L. M. (1997). Hospital readmission with feeding-related problems after early postpartum discharge of normal newborns. *JAMA* **278**, 299-303.
- Edward-Chandran, T., Malcolm, D. E., and Bowen, R. C. (1996). Reduction of length of stay in an acute care psychiatric unit [published erratum appears in Can J Psychiatry 1996 Jun;41(5):319]. *Can.J.Psychiatry* **41**, 49-51.

Epstein, A. M., Bogen, J., Dreyer, P., and Thorpe, K. E. (1991). Trends in length of stay and rates of readmission in Massachusetts: implications for monitoring quality of care. *Inquiry* **28**, 19-28.

Evans, R. L. and Hendricks, R. D. (1993). Evaluating hospital discharge planning: a randomized clinical trial. *Med.Care* **31**, 358-370.

Experton, B., Ozminkowski, R. J., Pearlman, D. N., Li, Z., and Thompson, S. (1999). How does managed care manage the frail elderly? The case of hospital readmissions in fee-for-service versus HMO systems. *Am.J.Prev.Med.* **16**, 163-172.

Farber, H. J. (1998). Risk of readmission to hospital for pediatric asthma. *J.Asthma* **35**, 95-99.

Fethke, C. C., Smith, I. M., and Johnson, N. (1986). "Risk" factors affecting readmission of the elderly into the health care system. *Med.Care* **24**, 429-437.

Fink, P., Jensen, J., and Poulsen, C. S. (1993). A study of hospital admissions over time, using longitudinal latent structure analysis. *Scand.J.Soc.Med.* **21**, 211-219.

Fisher, E. S., Wennberg, J. E., Stukel, T. A., and Sharp, S. M. (1994). Hospital readmission rates for cohorts of Medicare beneficiaries in Boston and New Haven . *N.Engl.J.Med.* **331**, 989-995.

Foster, E. M. (1999). Do aftercare services reduce inpatient psychiatric readmissions? *Health Serv.Res.* **34**, 715-736.

Frankl, S. E., Breeling, J. L., and Goldman, L. (1991). Preventability of emergent hospital readmission . *Am.J.Med.* **90**, 667-674.

Gautam, P., Macduff, C., Brown, I., and Squair, J. (1996). Unplanned readmissions of elderly patients. *Health Bull.Edinb.* **54**, 449-457.

Giangrande, A. (1998). Quality of health care: The responsibility of health care professionals in delivering high quality services. *International Journal of Artificial Organs* **21**, 721-725.

Gill, L., Goldacre, M., Simmons, H., Bettley, G., and Griffith, M. (1993). Computerised linking of medical records: methodological guidelines. *J.Epidemiol.Community Health* **47**, 316-319.

Glasgow, A. M., Weissberg, B. J., Tynan, W. D., Epstein, S. F., Driscoll, C., Turek, J., and Beliveau, E. (1991). Readmissions of children with diabetes mellitus to a children's hospital. *Pediatrics* **88**, 98-104.

Gooding, J. and Jette, A. M. (1985). Hospital readmissions among the elderly. *J.Am.Geriatr.Soc.* **33**, 595-601.

Gorski, T. F., Rosen, L., Lawrence, S., Helfrich, D., and Reed, J. F., III (1999). Usefulness of a state-legislated, comparative database to evaluate quality in colorectal surgery. *Dis.Colon Rectum* **42**, 1381-1387.

- Graham, H. and Livesley, B. (1983). Can readmissions to a geriatric medical unit be prevented? *Lancet* **1** (8321), 404-406.
- Gregor, C., Pope, S., Werry, D., and Dodek, P. (1996). Reduced length of stay and improved appropriateness of care with a clinical path for total knee or hip arthroplasty. *Jt. Comm J. Qual. Improv.* **22**, 617-628.
- Grullon, K. E. and Grimes, D. A. (1997). The safety of early postpartum discharge: a review and critique. *Obstet. Gynecol.* **90**, 860-865.
- Haines-Wood, J., Gilmore, D. H., and Beringer, T. R. (1996). Re-admission of elderly patients after in-patient rehabilitation. *Ulster Med. J.* **65**, 142-144.
- Harrison, M. L., Graff, L. A., Roos, N. P., and Brownell, M. D. (1995). Discharging patients earlier from Winnipeg hospitals: does it adversely affect quality of care? *CMAJ.* **153**, 745-751.
- Hayward, R. A., Bernard, A. M., Rosevear, J. S., Anderson, J. E., and McMahon-LF, J. (1993). An evaluation of generic screens for poor quality of hospital care on a general medicine service. *Med. Care* **31**, 394-402.
- Heard, A. R., Campbell, D. A., Ruffin, R. E., Smith, B., Luke, C. G., and Roder, D. M. (1997). Rehospitalisation for asthma within 12 months: unequal rates on the basis of gender in two hospitals. *Aust. N. Z. J. Med.* **27**, 669-671.
- Henderson, J., Goldacre, M. J., Griffith, M., and Simmons, H. M. (1989). Day case surgery: geographical variation, trends and readmission rates. *J. Epidemiol. Community Health* **43**, 301-305.
- Henderson, J., Graveney, M. J., and Goldacre, M. J. (1993). Should emergency readmissions be used as health service indicators and in medical audit? *Health Services Management Research* **6**, 109-116.
- Henry, R. L., Cooper, D. M., and Halliday, J. A. (1995). Parental asthma knowledge: its association with readmission of children to hospital. *J. Paediatr. Child Health* **31**, 95-98.
- Herlitz, J., Bengtson, A., Hjalmarson, A., and Karlson, B. W. (1988). Morbidity during five years after myocardial infarction and its relation to infarct size. *Clin. Cardiol.* **11**, 672-677.
- Hofer, T. P. and Hayward, R. A. (1995). Can early re-admission rates accurately detect poor-quality hospitals? *Med. Care* **33**, 234-245.
- Holloway, R. G. Jr., Witter D. M. Jr., Mushlin, A. I., Lawton, K. B., McDermott, M. P., and Samsa, G. P. (1998). Carotid endarterectomy trends in the patterns and outcomes of care at academic medical centers, 1990 through 1995. *Arch. Neurol.* **55**, 25-32.
- Holloway, J. J., Medendorp, S. V., and Bromberg, J. (1990). Risk factors for early readmission among veterans. *Health Serv. Res.* **25**, 213-237.

- Huber, T. S., Carlton, L. M., Harward, T. R., Russin, M. M., Phillips, P. T., Nalli, B. J., Flynn, T. C., and Seeger, J. M. (1998). Impact of a clinical pathway for elective infrarenal aortic reconstructions. *Ann.Surg.* **227**, 691-699.
- Johansen, H., Nair, C., and Bond, J. (1994). Who goes to the hospital? An investigation of high users of hospital days. *Health Rep.* **6**, 253-277.
- Johnstone, P. and Zolese, G. (1999). Systematic review of the effectiveness of planned short hospital stays for mental health care. *BMJ* **318**, 1387-1390.
- Jones, J. (1986). Readmission rates - The price of early discharge. *The Health Service Journal* (19 June), 825-825.
- Kane, R. L., Chen, Q., Finch, M., Blewett, L., Burns, R., and Moskowitz, M. (1998). Functional outcomes of posthospital care for stroke and hip fracture patients under medicare. *J.Am.Geriatr.Soc.* **46**, 1525-1533.
- Kelly, J. F., McDowell, H., Crawford, V., and Stout, R. W. (1992). Readmissions to a geriatric medical unit: is prevention possible? *Aging Milano.* **4**, 61-67.
- Kendrick, S. and Clarke, J. (1993). The Scottish Record Linkage System. *Health Bull.Edinb.* **51**, 72-79.
- Kent, S. and Yellowlees, P. (1994). Psychiatric and social reasons for frequent rehospitalization. *Hosp.Community Psychiatry* **45**, 347-350.
- Kent, S., Fogarty, M., and Yellowlees, P. (1995). A review of studies of heavy users of psychiatric services. *Psychiatr.Serv.* **46**, 1247-1253.
- Kessing, L. V., Andersen, P. K., and Mortensen, P. B. (1998). Predictors of recurrence in affective disorder: A case register study. *Journal of Affective Disorders* **49**, 2-108.
- Kessing, L. V. and Andersen, P. K. (1999). The effect of episodes on recurrence in affective disorder: A case register study. *Journal of Affective Disorders* **53**, 3-231.
- Klein, E. A., Grass, J. A., Calabrese, D. A., Kay, R. A., Sargeant, W., and O'Hara, J. F. (1996). Maintaining quality of care and patient satisfaction with radical prostatectomy in the era of cost containment. *Urology* **48**, 269-276.
- Koenig, H. G. and Kuchibhatla, M. (1999). Use of health services by medically ill depressed elderly patients after hospital discharge. *Am.J.Geriatr.Psychiatry* **7**, 48-56.
- Korkeila, J. A., Lehtinen, V., Tuori, T., and Helenius, H. (1998). Frequently hospitalised psychiatric patients: a study of predictive factors. *Soc.Psychiatry Psychiatr.Epidemiol.* **33**, 528-534.
- Kossovsky, M. P., Perneger, T. V., Sarasin, F. P., Bolla, F., Borst, F., and Gaspoz, J. M. (1999). Comparison between planned and unplanned readmissions to a department of internal medicine. *J.Clin.Epidemiol.* **52**, 151-156.
- Kotagal, U. R., Atherton, H. D., Eshett, R., Schoettker, P. J., and Perlstein, P. H. (1999). Safety of early discharge for Medicaid newborns. *JAMA* **282**, 1150-1156.

- Kreder, H. J., Williams, J. I., Jaglal, S., Hu, R., Axcell, T., and Stephen, D. (1998). Are complication rates for elective primary total hip arthroplasty in Ontario related to surgeon and hospital volumes? A preliminary investigation. *Can.J.Surg.* **41**, 431-437.
- Krumholz, H. M., Parent, E. M., Tu, N., Vaccarino, V., Wang, Y., Radford, M. J., and Hennen, J. (1997). Readmission after hospitalization for congestive heart failure among Medicare beneficiaries . *Arch.Intern.Med.* **157**, 99-104.
- Krumholz, H. M., Philbin-DM, J., Wang, Y., Vaccarino, V., Murillo, J. E., Therrien, M. L., Williams, J., and Radford, M. J. (1998). Trends in the quality of care for Medicare beneficiaries admitted to the hospital with unstable angina . *J.Am.Coll.Cardiol.* **31**, 957-963.
- Kwok, T., Lau, E., Woo, J., Luk, J. K., Wong, E., Sham, A., and Lee, S. H. (1999). Hospital readmission among older medical patients in Hong Kong. *J.R.Coll.Physicians Lond* **33**, 153-156.
- Leng, G. C., Walsh, D., Fowkes, F. G. R., and Swainson, C. P. (1999). Is the emergency readmission rate a valid outcome indicator? *Quality in Health Care* **8**, 234-238.
- Leyland, A. H. (1995). Examining the relationship between length of stay and readmission rates for selected diagnoses in Scottish hospitals. *IMA J.Math.Appl.Med.Biol.* **12**, 175-184.
- Libbus, K. (1997). Stress, coping, and social support as psychosocial factors in readmissions for ischaemic heart disease. *International.Journal of Nursing.Studies* **34**, 151-163.
- Librero, J., Peiro, S., and Ordinana, R. (1999). Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. *J.Clin.Epidemiol.* **52** , 171-179.
- Lieberman, P. B., Wiitala, S. A., Elliott, B., McCormick, S., and Goyette, S. B. (1998). Decreasing length of stay: are there effects on outcomes of psychiatric hospitalization? *Am.J.Psychiatry* **155**, 905-909.
- Lock, M. and Ray, J. G. (1999). Higher neonatal morbidity after routine early hospital discharge: are we sending newborns home too early? *CMAJ.* **161**, 249-253.
- Louis, D. Z., Yuen, E. J., Braga, M., Cicchetti, A., Rabinowitz, C., Laine, C., and Gonnella, J. S. (1999). Impact of a DRG-based hospital financing system on quality and outcomes of care in Italy. *Health Serv.Res.* **34**, 405-415.
- Ludke, R. L., Booth, B. M., and Lewis-Beck, J. A. (1993). Relationship between early readmission and hospital quality of care indicators. *Inquiry* **30**, 95-103.
- Lydon-Rochelle, M., Holt, V. L., Martin, D. P., and Easterling, T. R. (2000). Association between method of delivery and maternal rehospitalization. *JAMA* **282**, 2411-2416.

- Lyons, J. S., O'Mahoney, M. T., Miller, S. I., Neme, J., Kabat, J., and Miller, F. (1997). Predicting readmission to the psychiatric hospital in a managed care environment: implications for quality indicators . *Am.J.Psychiatry* **154**, 337-340.
- Madge, P., McColl, J., and Paton, J. (1997). Impact of a nurse-led home management training programme in children admitted to hospital with acute asthma: a randomised controlled study . *Thorax* **52**, 223-228.
- Marcantonio, E. R., McKean, S., Goldfinger, M., Kleefield, S., Yurkofsky, M., and Brennan, T. A. (1999). Factors associated with unplanned hospital readmission among patients 65 years of age and older in a Medicare managed care plan. *Am.J.Med.* **107**, 13-17.
- Maynard, C., Every, N. R., and Weaver, W. D. (1997). Factors associated with rehospitalization in patients with acute myocardial infarction. *Am.J.Cardiol.* **80**, 777-779.
- McCormick, D., Fine, M. J., Coley, C. M., Marrie, T. J., Lave, J. R., Obrosky, D. S., Kapoor, W. N., and Singer, D. E. (1999). Variation in length of hospital stay in patients with community-acquired pneumonia: are shorter stays associated with worse medical outcomes? *Am.J.Med.* **107**, 5-12.
- Miles, T. A. and Lowe, J. (1999). Are unplanned readmissions to hospital really preventable? *J.Qual.Clin.Pract.* **19**, 211-214.
- Minkovitz, C. S., Andrews, J. S., and Serwint, J. R. (1999). Rehospitalization of children with asthma. *Arch.Pediatr.Adolesc.Med.* **153**, 727-730.
- Mitchell, E. A., Bland, J. M., and Thompson, J. M. (1994). Risk factors for readmission to hospital for asthma in childhood. *Thorax* **49**, 33-36.
- Mojtabai, R., Nicholson, R. A., and Neesmith, D. H. (1997). Factors affecting relapse in patients discharged from a public hospital: results from survival analysis. *Psychiatr.Q.* **68**, 117-129.
- Monnelly, E. P. (1997). Instability before discharge and previous psychiatric admissions as predictors of early readmission. *Psychiatr.Serv.* **48**, 1584-1586.
- Ni, H., Nauman, D. J., and Hershberger, R. E. (1999). Analysis of trends in hospitalizations for heart failure. *J.Card Fail.* **5**, 79-84.
- O'Leary, D. A. and Lee, A. S. (1996). Seven year prognosis in depression. Mortality and readmission risk in the Nottingham ECT cohort. *Br.J.Psychiatry* **169**, 423-429.
- Oberer, D. and Auckerman, L. (1996). Best practice: clinical pathways for uncomplicated births. *Best.Pract.Benchmarking.Healthc.* **1**, 43-50.
- Olfson, M., Mechanic, D., Boyer, C. A., Hansell, S., Walkup, J., and Weiden, P. J. (1999). Assessing clinical predictions of early rehospitalization in schizophrenia. *Journal of Nervous.and Mental.Disease* **187**, 12-729.

- Pearson, S., Stewart, S., and Rubenach, S. (1999). Is health-related quality of life among older, chronically ill patients associated with unplanned readmission to hospital? *Aust.N.Z.J.Med.* **29**, 701-706.
- Peen, J. and Dekker, J. (1997). Admission rates for schizophrenia in the Netherlands: An urban/rural comparison. *Acta Psychiatrica.Scandinavica* **96**, 4-305.
- Phibbs, C. S., Swindle, R. W., and Recine, B. (1997). Does case mix matter for substance abuse treatment? A comparison of observed and case mix-adjusted readmission rates for inpatient substance abuse treatment in the Department of Veterans Affairs. *Health Serv.Res.* **31**, 755-771.
- Philbin, E. F. and DiSalvo, T. G. (1999). Prediction of hospital readmission for heart failure: development of a simple risk score based on administrative data. *J.Am.Coll.Cardiol.* **33**, 1560-1566.
- Popplewell, P. Y., Chalmers, J. P., Burns, R. J., Miller, C. D., and Rayner, P. Y. (1984). A review of early medical readmissions at the Flinders Medical Centre. *Aust.Clin.Rev.* March, 3-5.
- Postrado, L. T. and Lehman, A. F. (1995). Quality of life and clinical predictors of rehospitalization of persons with severe mental illness. *Psychiatr.Serv.* **46**, 1161-1165.
- Primatesta, P. and Goldacre, M. J. (1995). Crohn's disease and ulcerative colitis in England and the Oxford record linkage study area: a profile of hospitalized morbidity. *Int. J. Epidemiol.* **24**, 922-928.
- Primatesta, P. and Goldacre, M. J. (1996). Inguinal hernia repair: incidence of elective and emergency surgery, readmission and mortality . *Int.J.Epidemiol.* **25**, 835-839.
- Reed, R. L., Pearlman, R. A., and Buchner, D. M. (1991). Risk factors for early unplanned hospital readmission in the elderly. *J.Gen.Intern.Med.* **6**, 223-228.
- Riley, G. and Lubitz, J. (1986). Outcomes of surgery in the Medicare aged population: Rehospitalization after surgery. *Health Care Financing Review* **8**, 23-34.
- Riley, G., Lubitz, J., Gornick, M., Mentnech, R., Eggers, P., and McBean, M. (1993). Medicare beneficiaries: adverse outcomes after hospitalization for eight procedures. *Med.Care* **31**, 921-949.
- Rosenheck, R., Fontana, A., and Stolar, M. (1999). Assessing quality of care: administrative indicators and clinical outcomes in posttraumatic stress disorder. *Med.Care* **37**, 180-188.
- Rumble, S. J., Jernigan, M. H., and Rudisill, P. T. (1996). Determining the effectiveness of critical pathways for coronary artery bypass graft patients: retrospective comparison of readmission rates. *J.Nurs.Care Qual.* **11**, 34-40.
- Rushworth, R. L. and Rob, M. I. (1995). Readmissions to hospital: the contribution of morbidity data to the evaluation of asthma management. *Aust.J.Public Health* **19**, 363-367.

- Russell, E. (1998). The ethics of attribution: the case of health care outcome indicators. *Soc.Sci.Med.* **47**, 1161-1169.
- Russo, J., Roy, B. P., Jaffe, C., Ries, R., Dagadakis, C., and Avery, D. (1997). Psychiatric status, quality of life, and level of care as predictors of outcomes of acute inpatient treatment. *Psychiatr.Serv.* **48**, 1427-1434.
- Saarento, O., Nieminen, P., Hakko, H., Isohanni, M., and Vaisanen, E. (1997). Utilization of psychiatric in-patient care among new patients in a comprehensive community-care system: a 3-year follow-up study. *Acta Psychiatr.Scand.* **95**, 132-139.
- Sabourin, C. B. and Funk, M. (1999). Readmission of patients after coronary artery bypass graft surgery. *Heart Lung* **28**, 243-250.
- Sacchetti, A. D., Gerardi, M., Sawchuk, P., and Bihl, I. (1997). Boomerang babies: emergency department utilization by early discharge neonates. *Pediatr.Emerg.Care* **13**, 365-368.
- Sacco, R. L., Hauser, W. A., and Mohr, J. P. (1991). Hospitalized stroke in blacks and Hispanics in northern Manhattan. *Stroke* **22**, 1491-1496.
- Seagroatt, V., Tan, H. S., Goldacre, M., Bulstrode, C., Nugent, I., and Gill, L. (1991). Elective total hip replacement: incidence, emergency readmission rate, and postoperative mortality. *BMJ* **303**, 1431-1435.
- Segal, S. P., Akutsu, P. D., and Watson, M. A. (1998). Factors associated with involuntary return to a psychiatric emergency service within 12 months. *Psychiatr.Serv.* **49**, 1212-1217.
- Shipton, S. (1996). Risk factors associated with multiple hospital readmissions. *Home.Care Provid.* **1**, 83-85.
- Slack, R. and Bucknall, C. E. (1997). Readmission rates are associated with differences in the process of care in acute asthma. *Quality in Health Care* **6**, 194-198.
- Song, L. Y., Biegel, D. E., and Johnsen, J. A. (1998). Predictors of psychiatric rehospitalization for persons with serious and persistent mental illness. *Psychiatric.Rehabilitation Journal* **22**, 2-166.
- South, M. (1997). Reduction in length of hospital stay for acute childhood asthma associated with the introduction of casemix funding. *Med.J.Aust.* **167**, 11-13.
- Steinert, T., Wiebe, C., and Gebhardt, R. P. (1999). Aggressive behavior against self and others among first-admission patients with schizophrenia. *Psychiatr.Serv.* **50**, 85-90.
- Stewart, S., Vandenbroek, A. J., Pearson, S., and Horowitz, J. D. (1999). Prolonged beneficial effects of a home-based intervention on unplanned readmissions and mortality among patients with congestive heart failure. *Arch.Intern.Med.* **159**, 257-261.

- Stromberg, L. (1996). Decreasing admissions for childhood asthma to a Swedish county hospital. *Acta Paediatr.* **85**, 173-176.
- Sullivan, G., Wells, K. B., Morgenstern, H., and Leake, B. (1995). Identifying modifiable risk factors for rehospitalization: a case-control study of seriously mentally ill persons in Mississippi. *Am.J.Psychiatry* **152**, 1749-1756.
- Sultana, C. J., Campbell, J. W., Pisanelli, W. S., Sivinski, L., and Rimm, A. A. (1997). Morbidity and mortality of incontinence surgery in elderly women: an analysis of Medicare data. *Am.J.Obstet.Gynecol.* **176**, 344-348.
- Sytema, S. and Burgess, P. (1999). Continuity of care and readmission in two service systems: a comparative Victorian and Groningen case-register study. *Acta Psychiatr.Scand.* **100**, 212-219.
- Tallis, G. and Balla, J. I. (1995). Critical path analysis for the management of fractured neck of femur. *Aust.J.Public Health* **19**, 155-159.
- Terp, I. M., Engholm, G., Moller, H., and Mortensen, P. B. (1999). A follow-up study of postpartum psychoses: Prognosis and risk factors for readmission. *Acta Psychiatrica.Scandinavica* **100**, 1-46.
- Thomas, J. W. and Holloway, J. J. (1991). Investigating early readmission as an indicator for quality of care studies. *Med.Care* **29**, 377-394.
- Thomas, J. W. (1996). Does risk-adjusted readmission rate provide valid information on hospital quality? *Inquiry* **33**, 258-270.
- Thornicroft, G., Gooch, C., and Dayson, D. (1992). The TAPS project. 17: Readmission to hospital for long term psychiatric patients after discharge to the community. *BMJ* **305**, 996-998.
- Tierney, A. J. and Worth, A. (1995). Review: readmission of elderly patients to hospital. *Age Ageing* **24**, 163-166.
- To, T., Dick, P., Feldman, W., and Hernandez, R. (1996). A cohort study on childhood asthma admissions and readmissions. *Pediatrics* **98**, 191-195.
- Townsend, J., Piper, M., Frank, A. O., Dyer, S., North, W. R., and Meade, T. W. (1988). Reduction in hospital readmission stay of elderly patients by a community based hospital discharge scheme: a randomised controlled trial. *BMJ* **297**, 544-547.
- Velasco, F. T., Ko, W., Rosengart, T., Altorki, N., Lang, S., Gold, J. P., Krieger, K. H., and Isom, O. W. (1996). Cost containment in cardiac surgery: results with a critical pathway for coronary bypass surgery at the New York hospital-Cornell Medical Center. *Best.Pract.Benchmarking.Healthc.* **1**, 21-28.
- Victor, C. and Jefferies, S. (1990). Are readmission rates a useful indicator of outcome? *Geriatric Medicine* **20**, 19-20.
- Victor, C. R. and Vetter, N. J. (1985). The early readmission of the elderly to hospital. *Age Ageing* **14**, 37-42.

- Vogel, S. and Huguelet, P. (1997). Factors associated with multiple admissions to a public psychiatric hospital. *Acta Psychiatr.Scand.* **95**, 244-253.
- Waite, K., Oddone, E., Weinberger, M., Samsa, G., Foy, M., and Henderson, W. (1994). Lack of association between patients' measured burden of disease and risk for hospital readmission. *J.Clin.Epidemiol.* **47**, 1229-1236.
- Walker, R., Minor, S. D., Bloch, R., and Esinhart, J. (1996). High risk factors for rehospitalization within six months. *Psychiatr.Q.* **67**, 235-243.
- Wei, F., Mark, D., Hartz, A., and Campbell, C. (1995). Are PRO discharge screens associated with postdischarge adverse outcomes? *Health Serv.Res.* **30**, 489-506.
- Weissman, J. S., Stern, R. S., and Epstein, A. M. (1994). The impact of patient socioeconomic status and other social factors on readmission: a prospective study in four Massachusetts hospitals. *Inquiry* **31**, 163-172.
- Weissman, J. S., Ayanian, J. Z., Chasan, T. S., Sherwood, M. J., Roth, C., and Epstein, A. M. (1999). Hospital readmissions and quality of care. *Med.Care* **37**, 490-501.
- Welch, H. G., Larson, E. H., Hart, L. G., and Rosenblatt, R. A. (1992). Readmission after surgery in Washington State rural hospitals. *Am.J.Public Health* **82**, 407-411.
- Wesseldine, L. J., McCarthy, P., and Silverman, M. (1999). Structured discharge procedure for children admitted to hospital with acute asthma: a randomised controlled trial of nursing practice. *Arch.Dis.Child* **80**, 110-114.
- Whittle, J., Lin, C. J., Lave, J. R., Fine, M. J., Delaney, K. M., Joyce, D. Z., Young, W. W., and Kapoor, W. N. (1998). Relationship of provider characteristics to outcomes, process, and costs of care for community-acquired pneumonia. *Med.Care* **36**, 977-987.
- Wickizer, T. M. and Lessler, D. (1998). Do treatment restrictions imposed by utilization management increase the likelihood of readmission for psychiatric patients? *Med.Care* **36**, 844-850.
- Wickizer, T. M., Lessler, D., and Boyd, W. J. (1999). Effects of health care cost-containment programs on patterns of care and readmissions among children and adolescents. *Am.J.Public Health* **89**, 1353-1358.
- Williams, E. I. and Fitton, F. (1988). Factors affecting early unplanned readmission of elderly patients to hospital. *BMJ* **297**, 784-787.
- Woo, J., Yuen, Y. K., Kay, R., and Nicholls, M. G. (1992). Survival, disability, and residence 20 months after acute stroke in a Chinese population: implications for community care. *Disabil.Rehabil.* **14**, 36-40.
- Wray, N. P., Ashton, C. M., Kuykendall, D. H., Petersen, N. J., Soucek, J., and Hollingsworth, J. C. (1995). Selecting disease-outcome pairs for monitoring the quality of hospital care. *Med.Care* **33**, 75-89.

Wray, N. P., Peterson, N. J., Soucek, J., Ashton, C. M., and Hollingsworth, J. C. (1997). Application of an analytic model to early readmission rates within the Department of Veterans Affairs. *Med.Care* **35**, 768-781.

Xu, W., Hood, H. M., and Burgess, P. A. (2000). The description of outcomes in Medicare patients hospitalized with peptic ulcer disease. *Am.J.Gastroenterol.* **95**, 264-270.

Yusuf, S., Flather, M., Pogue, J., Hunt, D., Varigos, J., Piegas, L., Avezum, A., Anderson, J., Keltai, M., Budaj, A., Fox, K., and Ceremuzynski, L. (1998). Variations between countries in invasive cardiac procedures and outcomes in patients with suspected unstable angina or myocardial infarction without initial ST elevation. OASIS (Organisation to Assess Strategies for Ischaemic Syndromes) Registry Investigators . *Lancet* **352**, 507-514.

Zitser-Gurevich, Y., Simchen, E., Galai, N., and Braun, D. (1999). Prediction of readmissions after CABG using detailed follow-up data: the Israeli CABG Study (ISCAB) . *Med.Care* **37**, 625-636.