Psychological Medicine, Page 1 of 11. © 2007 Cambridge University Press
doi:10.1017/S0033291706009676 Printed in the United Kingdom

REVIEW ARTICLE

Predicting costs of mental health care: a critical literature review

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ABSTRACT

Background. Cost evaluation research in the mental health field is being increasingly recognized as a way to achieve a more effective deployment of scarce resources. However, there is a paucity of studies that seek to identify predictors of psychiatric service utilization and costs. This paper aims to critically review the published research in the field of psychiatric service utilization and costs, and discusses current methodological developments in this field.

Method. Sixteen studies were identified and are critically reviewed.

Results. No single variable alone can explain variations in costs between patients; instead, a range of different clinical and non-clinical variables provides a greater explanation of cost variations. Having a history of previous psychiatric service use is the most consistent predictor of higher psychiatric costs. Only one study considers indirect costs incurred by users, their families and friends and society as a whole, with the remaining 15 studies focusing on direct mental health care costs. There is a lack of studies that consider the future psychiatric service utilization and costs of care of children and older people. The cross-validation of predictive models is not yet routine, with only four of the studies including a cross-validation procedure.

Conclusions. The predictive approach in mental health cost evaluation has relevance for both mental health policy and practice. However, there is a paucity of studies that focus on children, older people and indirect costs. Furthermore, there remain a number of methodological challenges to address.

INTRODUCTION

In recent years there has been an increase in the number of cost evaluation studies that seek to identify factors related to psychiatric service utilization and costs (Knapp, 1999). The purpose of these types of studies is twofold: first, to achieve a more cost-efficient deployment of resources; and second, to develop more equitable funding systems better tailored to meeting the mental health needs of local and national populations (Amaddeo *et al*. 2000; Knapp *et al*. 2003; Barbui *et al*. 2004; Grigoletti *et al*. 2004, 2006). To date, there are only a few published studies that seek to predict (or forecast) future psychiatric service utilization and costs. The aim of this paper was to review 16 published studies, identified as cost prediction studies, with a focus both on the studies' findings, particularly those of a clinical relevance, and the methodological approaches used.

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Background

The restructuring of mental health care services, from institutional to community-based settings,

has been conducted within increasingly cost-conscious policy and practice environments (Beecham *et al.* 1997). Within this context, the growing role and relevance of economics in health-care decision making is being recognized and appreciated. As commented by Knapp (1999): 'more and more stakeholders in mental health care systems want economic evidence to guide their arguments, decisions and behaviours' (p. 165).

Mirandola *et al.* (2004) outline three main types of research approaches in health cost evaluation: (i) studies that describe costs in different groups of patients (descriptive approach); (ii) studies that attempt to explain the variations in costs between patient groups, taking into account different clinical, social and service history variables (explanatory approach); and (iii) studies that aim to predict the costs of future patients, either individually or collectively (predictive approach). Most studies published to date in this field fall into the first two categories. These types of studies have provided useful indicators to suggest why the care for some patients is more costly than for others. The combination of having a previous psychiatric history, particular personal characteristics and diagnostic group appears to be a better predictor of higher psychiatric costs than diagnostic group alone. This conclusion seems to apply in a variety of research settings and also in different European countries, as confirmed by a recent cross-national study conducted in five European countries, investigating the patterns and costs of care for patients with schizophrenia (Knapp *et al.* 2002).

These findings have important clinical implications; they provide a greater understanding of which patient characteristics influence service utilization and costs, and provide guidance, in terms of likely patterns of service and resource utilization, for those responsible for the planning and provision of mental health services. However, descriptive and explanatory studies are retrospective in nature and although they can provide useful data regarding psychiatric cost variations, their ability to 'predict' service utilization and costs is limited. Predictive studies, however, aim to estimate or predict psychiatric service utilization and costs for future users of mental health services, for whom empirical cost data remain unknown. This is the third 'predictive' approach described by Mirandola *et al.* (2004).

Why should we be interested in the prediction of psychiatric service utilization and costs? Mental health professionals, managers and planners are working within health-care systems with limited resources that face ever-increasing demands for services and treatments. Predictive cost research has the potential to provide an insight into the factors that are likely to influence psychiatric service utilization and costs. The knowledge of particular predictors, such as patients' personal characteristics, can assist in the future fiscal planning of mental health services, providing decision makers at all levels with evidence to help them make informed decisions.

METHOD

Search strategy

A search of English-language articles was undertaken using the following electronic databases: Medline (1980 to May 2006); PsycINFO (1980 to May 2006); EMBASE (1980 to May 2006); and EconLit (1969–2005). Search strategies were conducted using variations on the following search terms: MENTAL, MENTAL-HEALTH, MENTAL HEALTH SERVICES, PSYCHIAT$, PREDICT$, COST, COST AND COST ANALYSIS, COST-ALLOCATION, CHILD$, DEMENTIA, ALZHEIMER DISEASE. The bibliographies from relevant retrieved articles were reviewed for pertinent material. In addition, researchers with a known interest in the field were consulted regarding existing publications and work in progress.

Definition of a predictive study

The definition of a predictive study provided by Dunn *et al.* (2003), as one that aims to 'predict or forecast the costs of future patients (either individually or collectively)' (p. 399), was adopted for this review. To meet this definition, a paper was required to state explicitly the goal of predicting psychiatric service utilization and costs. Studies were also required to have a predictive component in the methodology, in terms of the selection of an appropriate regression model (or models) suitable for the forecasting of costs, as detailed by Dunn *et al.* (2003). Also required was some kind of assessment of the model's performance, using an index or statistic

Table 1. *Studies identified as predictive mental health cost evaluation studies*

Authors	Country	*n*	Clinical characteristics of sample	Setting[a]	Cost-prediction method(s)	% of variation in costs explained	Type of costs data	Cross-validation	Significant predictors of higher (↑) or lower (↓) costs
Bauer *et al.* (1997)	USA	103	Bipolar disorder	Hospital and community	Two-stage multiple linear regression	21%	Log-transformed costs	No	↑Episode status at clinic entry (major affective episode *versus* subsyndromal symptoms or euthymia); ↑history of childhood physical abuse
Carr *et al.* (2004)	Australia	980	Schizophrenia and other psychosis	Mental health services and primary care	Multiple hierarchical regression	Four models, ranging from 21·6% to 38·6%	Raw costs	No	[*always direct costs* (*D*) *unless indicated as indirect costs* (*I*)] ↑High-school education not completed (D&I); ↑male (I); ↑older age (I); ↑non-English speakers (I); ↑previously married (I); ↑earlier age of onset (D&I); ↑chronicity (D&I); ↑dissatisfaction with level of independence; ↑reality distortion and disorganization symptoms; ↑personal disability; ↑recent suicide or self-harm attempts; ↑greater impairment due to medication effects (I); ↑higher cigarette consumption (I); ↓frequency of alcohol consumption; ↓higher social functioning (I); ↓less depressed (I); ↓more friends (I)
Chisholm *et al.* (1997)	UK	1904	All diagnoses	Residential facilities	Multiple linear regression	Two samples, Ldn 21% non-Ldn 19%	Raw costs	No	↓Male (Ldn); ↑older age (>45 years Ldn); ↓older age (non-Ldn); ↓black ethnic group (Ldn); ↑<2 years in a psychiatric hospital; ↑diagnosis of schizophrenia and affective psychosis; ↑greater needs in relation to vulnerability, social interaction and aggressive or disruptive behaviour (Ldn); ↓higher daily living skills (Ldn); ↑greater needs in relation to daily living skills, suicidal thoughts or non-accidental injury and time use (non-Ldn); ↓socially isolated (non-Ldn); ↑previously or currently under Mental Health Act provision
Dellario *et al.* (1999)	USA	322	All diagnoses	Rehabilitation services	Multiple linear regression	22%	Raw costs	Yes	↑Male; ↑African-American; ↑bipolar disorder; ↑having a developmental disability; ↑higher levels of functioning
Ettner & Notman (1997)	USA	17 901 children, 12 218 adults	All diagnoses and substance abuse	Mental health and substance abuse services	Multiple linear regression	Four models for each age group, ranging from 0·6% to 13%	Square root transformation	No	No significant variables
Ginsberg *et al.* (1997)	Israel	11 446	All diagnoses	Hospital and day-care services	Multiple linear regression	Two models, 93% and 42%	Raw costs	No	↑Older age; ↑previous psychiatric hospital utilization; ↑diagnosis of schizophrenia, affective, organic, neurotic, childhood or other disorders
Kilian *et al.* (2002)	Germany	254	Schizophrenia	Community	Multiple linear regression and GLM	Three models, 31%, 31% and 32%	Raw and log-transformed costs	Yes	↓Older age; ↑psychiatric symptoms; ↑number of met needs; ↓having a job; ↓having a partner

[*continued overleaf*

Table 1 (*cont.*)

Authors	Country	*n*	Clinical characteristics of sample	Setting[a]	Cost-prediction method(s)	% of variation in costs explained	Type of costs data	Cross-validation	Significant predictors of higher (↑) or lower (↓) costs
Knapp *et al.* (1990)	UK	136	All diagnoses	Hospital and community	Multiple linear regression	38%	Raw costs	Yes	↑Male; ↓older age; ↑previous psychiatric hospital utilization (including current length of stay, total time spent and percentage of life in hospital); ↑negative symptoms (at PSE); ↑social behavioural problems; ↓more social contacts (only men)
Knapp *et al.* (1995)	UK	217	All diagnoses	Hospital and community	Multiple linear regression	36%	Raw costs	Yes	↑Male; ↓older age; ↑single; ↓divorced or separated men; ↑higher proportion of life spent in psychiatric hospitals; ↓less total time spent in psychiatric hospitals; ↑organic mental disorder; ↑learning disability; ↓affective disorder; ↓neurosis/personality disorder; ↑negative symptoms (at PSE); ↑social behavioural problems; ↑need for nursing care (only men); ↓more social contacts (only men)
McCrone *et al.* (1998)	UK	147	Psychosis	Community	Multiple linear regression	31·5%	Log-transformed costs	No	↑Younger age; ↑living alone; ↑born in the UK; ↑previous in-patient and day-hospital service use; ↓higher levels of social functioning; ↓not suicide risk
McCrone *et al.* (2000)	UK	101	Psychosis and substance abuse	Community	Multiple linear regression	Three models, 27%, 27% and 24%	Raw costs	No	↓White ethnicity; ↓diagnosis of schizophrenia; ↑having a dual diagnosis; ↑more years of education; ↑previously been homeless
McCrone *et al.* (2001)	UK	168	Psychosis	Community	Multiple linear regression	Two models, 37% and 31%	Raw costs	No	↑Male; ↑older age; ↑higher levels of disability; ↑more psychiatric symptoms; ↓more years of education; ↓longer duration of illness
McCrone *et al.* (2005)	UK	149	Depression in children and adolescent	Community	Multiple linear regression and GLM	Two models, 24% and 20%	Raw costs	No	↑Age at first contact; ↓year of first contact; ↑referred from outside South London; ↓female; ↓not living with two parents; ↓family history of mental illness; ↓depression score; ↑anxiety score; ↑suicidal ideation; ↑adult relationship score; ↓peer/siblings relationship score; ↓separation anxiety; ↓generalized anxiety; ↑substance abuse; ↑mixed depression and conduct disorders
Mirandola *et al.* (2004)	Italy	1725	All diagnoses	Community	Multiple linear regression	Four models, values range from 7% to 71%	Raw costs	No	↑Male (first ever patients only); ↑older age; ↑single status; ↓living with partner or family; ↓no education (illiterate); ↑lower professional status; ↑unemployed/sheltered work; ↑previous psychiatric history; ↓first contact with service planned; ↑schizophrenia; ↑GAF score (first ever patients only)

Paveza *et al.* (1998)	USA	286	Older adults with cognitive impairment	Community	GLM	78%	Raw costs	No	↑Older age; ↑living independently; ↑living with relatives; ↑>75 years and cognitively impaired; ↑activities of daily living impairment; ↓higher MMSE score; ↑living in Cook County, Illinois; ↓living in Central or Northern Illinois
Rosenheck *et al.* (1993)	USA	18 308	Schizophrenia	Hospital and community	Multiple linear regression and logistic regression	Eight models, values range from 4·3% to 1·1%	Raw costs	No	↑Number of days hospitalized for schizophrenia during previous year; ↑receipt of VA disability payments for schizophrenia; ↑receipt of VA disability payments for an illness other than schizophrenia; ↑being unmarried; ↑mentally ill chemical abuser
McCrone *et al.* (1998)	UK	147	Psychosis	Community	Multiple linear regression	31·5%	Log-transformed costs	No	↑Younger age; ↑living alone; ↑born in the UK; ↑previous in-patient and day-hospital service use; ↓higher levels of social functioning; ↓not suicide risk
McCrone *et al.* (2000)	UK	101	Psychosis and substance abuse	Community	Multiple linear regression	Three models, 27%, 27% and 24%	Raw costs	No	↓White ethnicity; ↓diagnosis of schizophrenia; ↑having a dual diagnosis; ↑more years of education; ↑previously been homeless
McCrone *et al.* (2001)	UK	168	Psychosis	Community	Multiple linear regression	Two models, 37% and 31%	Raw costs	No	↑Male; ↑older age; ↑higher levels of disability; ↑more psychiatric symptoms; ↓more years of education; ↓longer duration of illness
Mirandola *et al.* (2004)	Italy	1725	All diagnoses	Community	Multiple linear regression	Four models, values range from 7% to 71%	Raw costs	No	↑Male (first ever patients only); ↑older age; ↑single status; ↓living with partner or family; ↓no education (illiterate); ↑lower professional status; ↑unemployed/sheltered work; ↑previous psychiatric history; ↓first contact with service planned; ↑schizophrenia; ↑GAF score (first ever patients only)
Paveza *et al.* (1998)	USA	286	Older adults with cognitive impairment	Community	GLM	78%	Raw costs	No	↑Older age; ↑living independently; ↑living with relatives; ↑>75 years and cognitively impaired; ↑activities of daily living impairment; ↓higher MMSE score; ↑living in Cook County, Illinois; ↓living in Central or Northern Illinois
Rosenheck *et al.* (1993)	USA	18 308	Schizophrenia	Hospital and community	Multiple linear regression and logistic regression	From 84% to 47%	Raw costs	No	↑Number of days hospitalized for schizophrenia during previous year; ↑receipt of VA disability payments for schizophrenia; ↑receipt of VA disability payments for an illness other than schizophrenia; ↑being unmarried; ↑mentally ill chemical abuser

Ldn, London; PSE, Present State Examination; GLM, generalized linear model; GAF, Global Assessment of Functioning; VA, Veteran Affairs; MMSE, Mini-Mental Status Examination;
[a] All mental health settings.

that measures the concordance between predicted and observed costs, such as the determination coefficient (R^2).

Inclusion and exclusion criteria

Papers were included if they presented original primary data from empirical studies conducted in mental health care settings across the lifespan, encompassing services for children and adolescents, adults and older people, including services for people with dementia and Alzheimer's disease. Only papers written in English were included, for reasons of practicality. Studies were excluded if they were non-mental health studies or involved people with alcohol or drug abuse problems without a mental health diagnosis (dual diagnosis studies were included). Studies of forensic services and psychiatric medication were excluded, as these types of studies were deemed beyond the scope of the review. Studies were also excluded if they had no predictive component, as defined above. Cost-effectiveness studies were therefore excluded as they do not predict service utilization or costs for future users of mental health services; the purpose of cost-effectiveness studies is to evaluate the effectiveness and 'best value' of different services, pharmacological treatments and other interventions.

RESULTS

The literature search of the electronic databases, using the key words described, identified a total of 1426 articles as potentially relevant. Following the application of the inclusion and exclusion criteria, a total of 16 papers were identified as cost predictive studies, meeting the defined inclusion criteria, and were included in the review. The main characteristics and findings of these 16 papers are presented in Table 1. Two of the papers are based on the same Psychiatric Research in Service Measurement (PRISM) psychosis study (McCrone *et al.* 1998, 2001) but both papers are included in the review as they report on different phases of the study and different patient samples. All 16 studies are cross-sectional in design and vary in terms of settings and patient groups. For example, Chisholm *et al.* (1997) followed patients in residential facilities, Knapp *et al.* (1990, 1995) included patients discharged from two psychiatric hospitals, McCrone and colleagues focused on patients with psychosis (1998, 2001) and dual diagnosis (2000) and Mirandola *et al.* (2004) studied the costs of all patients seen in a community-based mental health service. Two of the studies considered the costs of children and adolescents (Ettner & Notman, 1997; McCrone *et al.* 2005) and one study focused on older adults with cognitive impairment (Paveza *et al.* 1998). Only one study (Carr *et al.* 2004) considers informal costs incurred by users, their families and friends and society as a whole, with the remaining 15 studies focusing on direct mental health care costs. The samples in the studies vary in size, ranging from 101 to 18 308 subjects, and inclusion criteria. Knapp (1999) reported that cost evaluation studies are concentrated geographically; this observation is also the case for predictive studies, with nine out of the 16 studies conducted in Europe, five in the USA, one in Australia and one in Israel. The main characteristics of the 16 studies are addressed in greater detail below.

Factors related to higher of lower costs

The reviewed studies consider a wide range of independent variables, indicating factors relating to higher or lower costs. These factors include: sociodemographic variables; clinical characteristics, with some studies incorporating social functioning abilities; and previous service use data. The significant variables for each study are shown in Table 1, revealing that the number and type of variables included by the different studies vary considerably. Some studies included a large number of independent variables, for example Carr *et al.* (2004) considered a set of 43 variables, whereas other studies were more selective, such as Dellario *et al.* (1999) who included 11 variables and Ginsberg *et al.* (1997) who included three. The choice of factors is based upon a number of different criteria: the patient groups, services and catchment areas of interest; the research hypotheses set by the researchers, based on the findings and shortcomings of previous studies; discussions with different stakeholder groups; and the availability of suitable data at both local and national levels. For example, some studies only included patients with a particular diagnosis such as bipolar disorder or psychosis; two studies only considered patients of Veteran Affairs (VA) medical centres

in the USA (Rosenheck *et al.* 1993; Bauer *et al.* 1997); ethnicity was included in those studies conducted in the USA, the UK and Australia but not in those conducted in Italy, Germany and Israel; and substance abuse was addressed by just four studies (Rosenheck *et al.* 1993; Ettner & Norman, 1997; McCrone *et al.* 2001, 2005).

From the findings of the 16 studies reviewed, the most consistent predictive variables of psychiatric costs, found to be significant in half or more of the studies, are: age (significant in 10 of the studies); diagnosis (significant in nine); gender (significant in eight); and the variables of previous psychiatric service utilization and previous psychiatric history (significant in seven when considered together). Having a history of previous psychiatric service use is the most consistent predictor of higher psychiatric costs. Age, gender and diagnosis can have either positive or negative effects on costs. Diagnosis was predictive of higher psychiatric costs in six of the studies, with inconsistent findings for the other three studies. For example, McCrone *et al.* (2000) found that a diagnosis of schizophrenia was a predictor of lower costs compared to the higher costs related to having a dual diagnosis, and concluded that patients with a dual diagnosis are more expensive to treat. Diagnosis was not always found to be very significant statistically in all of the studies; for example, Knapp *et al.* (1995) reported that diagnosis explained less than 1% of the variation in costs, and concluded that diagnosis alone is of little assistance in predicting either service requirements or costs. Other clinical factors, such as disease severity, are again not always found to be good predictors of higher costs, as concluded by Bauer *et al.* (1997).

In five of the studies, older age is a significant predictor of higher costs (Ginsberg *et al.* 1997; Paveza *et al.* 1998; McCrone *et al.* 2001; Carr *et al.* 2004; Mirandola *et al.* 2004). However, in four of the studies costs are negatively associated with age, that is costs decrease with age (Knapp *et al.* 1990, 1995; McCrone *et al.* 1998; Kilian *et al.* 2002). The inconsistency in findings regarding age is even demonstrated within a single study by Chisholm *et al.* (1997), who found that in London costs fall with age until around 45 years and then rise, but with non-London residents, age had a negative relationship, with older residents costing less. Regarding gender, in seven of the studies being male is a predictor of higher costs, apart from the study by Chisholm *et al.* (1997) that found lower costs for men than for women.

From a clinical point of view, it might be expected that factors such as diagnosis or severity of illness would be the most significant predictors of future service utilization or higher costs. For example, we know from previous studies that patients with a diagnosis of schizophrenia and related disorders are heavy users of community-based services and have higher treatment costs (Amaddeo *et al.* 1997; Percudani *et al.* 2002). However, this review suggests that when looking at the prediction of service utilization and costs, clinical factors need to be considered alongside other factors, particularly those related to an individual's personal characteristics and previous use of psychiatric services. It is also evident from the studies included in our review that some important factors in predicting costs of psychiatric care remain unknown, with most of the studies explaining less than half of the variation in costs, as illustrated in Table 1.

Direct *versus* indirect costs

In this review only one study, conducted by Carr *et al.* (2004), considered indirect costs to the government and society in addition to direct mental health costs, that is those costs that are directly related to services provided by statutory health and social care agencies. The other 15 studies focused solely on direct mental health costs. Carr *et al.* (2004) explored the predictors of direct, indirect and total costs associated with schizophrenia and other psychoses from the perspectives of government and society. The indirect costs fell into two main categories: indirect or time-loss costs, which included transfer payments (e.g. pensions and other income support) and tax forgone (government perspective) and patient and carer earnings foregone (societal perspective); and other sector costs (e.g. accommodation support, legal and other administrative costs and voluntary sector costs). As shown in Table 1, some independent variables, such as failure to complete high-school education and earlier age of onset, were found to be predictors of both higher direct and indirect costs, whereas other independent variables were associated more strongly with

indirect costs, such as male gender, older age and being from a non-English-speaking background.

Methodologically speaking, indirect costs are complex to identify and measure, which may contribute to the relative neglect of indirect costs in cost evaluation studies to date (Clark *et al.* 2001). It could also be argued that direct costs are the only ones that psychiatric services should be concerned with in terms of resource allocation. However, there is an alternative view that mental health services should be taking a more comprehensive approach towards the costs of psychiatric care, with an interest in the indirect costs for those users of their services, their family and friends and society as a whole. Indeed, a significant number of the authors of the reviewed papers acknowledge the exclusion of informal care costs as a limitation, with some authors stating that indirect costs were not included because they are difficult to measure reliably. Certainly the study by Carr *et al.* (2004) has demonstrated the feasibility of including both direct and indirect costs.

Regression modelling

The 16 studies reviewed used a multiple regression as a statistical approach, a method used extensively to analyse health-care utilization and costs (Diehr *et al.* 1999). It is important to note that cost data are not easy to analyse; they are usually not normally distributed but extremely skewed with a mode at zero (cost data do not generally have negative values) and a distribution with a long, heavy right tail (Diehr *et al.* 1999). This is because in most health services, including mental health, only a small number of individuals incur very high costs, with the majority of service users consuming low levels of resources (Kilian *et al.* 2002). As a consequence, the residuals of the regression model(s) are frequently non-normal and heteroscedastic, meaning that the variance increases with the mean (as opposed to homoscendasticity, which implies that the variance is constant for any fixed combination of variables). Such characteristics are not conducive to regression methods, thus cost data are a particular challenge to analyse (Diehr *et al.* 1999). It is therefore significant that the majority of the predictive studies reviewed here (13 studies) used raw cost data rather than the logs of costs; the transformation of observed costs data leads to a better performance of regression models when the cost data are highly skewed.

Table 1 demonstrates that the studies used different types of regression models: multiple linear regression; multiple hierarchical regression; logistic regression; and the generalized linear model (GLM). A further divergence among the papers reviewed is the use of one- or two-part models. Thirteen out of the 16 studies used a one-part model, meaning that one or more regression equations were used to model the costs for all patients included in the respective studies. Two-part models are used when the goal is to distinguish between different subgroups within the dataset. The studies by Rosenheck *et al.* (1993), Ettner & Norman (1997) and Ginsberg *et al.* (1997) adopted a two-part model approach, with logistic regression equations used to discriminate between different patient groups, followed by ordinary least-squares (OLS) multiple regression equations to model the costs of the patient groups of interest. For more details regarding one- and two-part models, see Dunn *et al.* (2003).

There is some debate in the health economics literature regarding the most appropriate modelling strategy for cost data. Health economists often use log models to deal with skewed data by applying two alternative approaches: the OLS model and the GLM. Manning & Mullahy (2001) suggest that that no single alternative is best under all conditions, rather the choice depends upon factors such as: the skewness of the data; the presence of a heavy-tailed distribution; and heteroscedasticity. They recommend the comparison of different models, using both raw and logged costs data, to see which model is the most precise. Other authors (Diehr *et al.* 1999; Dunn *et al.* 2003) agree that the choice depends upon characteristics of the data and the purpose of the analysis, but that if the purpose is prediction then a one-part model involving OLS on raw costs data consistently performs as well as OLS on logged costs or the more theoretically 'correct' GLM.

Three of the papers in the review (Kilian *et al.* 2002; Mirandola *et al.* 2004; McCrone *et al.* 2005) address this methodological debate by comparing different regression models. For example, Kilian *et al.* (2002) compared the advantages and disadvantages of different

methods to estimate annual costs of care for 254 individuals with a diagnosis of schizophrenia who were treated by psychiatric services in Germany. The authors evaluated three different models: a linear OLS regression model with non-parametric standard errors (using raw costs); a log-transformed OLS model (log costs); and a GLM with a log-link and a gamma distribution (log costs). The three models were found to have similar results. McCrone *et al.* (2005) adopted a similar strategy to Kilian *et al.* (2002) and found that the OLS model had the greatest predictive power but that the differences between the OLS and GLM were not large. In a study of the effect of previous psychiatric history on the costs of care of 1725 patients in South Verona, Italy, Mirandola *et al.* (2004) divided the sample into four groups on the basis of their history of previous service utilization and evaluated the performance of various regression models within each patient group. The regression models performed to varying degrees for the different groups. The findings of these three studies demonstrate that there is no perfect method or model for the analysis of mental health cost data. Indeed, these findings highlight the importance of the choice of method, based upon a careful consideration of the characteristics of the data to be analysed and transparency in publications when describing the process of model selection (Kilian *et al.* 2002).

Cross-validation of the regression models

Four of the studies reviewed (Knapp *et al.* 1990, 1995; Dellario *et al.* 1999; Kilian *et al.* 2002) conducted a cross-validation procedure within their studies. The purpose of cross-validation is to evaluate the predictive capability of a model by repeating the regression, using the same variables, on a different dataset. Ideally, the dataset used for validation should be from a second, independent sample of patients. This was the case for two of the studies (Knapp *et al.* 1990, 1995), which attempted to predict the community costs of mental health reprovision for people leaving two long-stay psychiatric hospitals in the UK, based on the observed costs of a previous sample of residents who had moved out of the hospitals. The findings of these two studies have important policy implications in terms of the financial consequences of hospital closure policies. However, although both studies compared predicted costs for a group of individuals with actual observed costs collected from a previous cohort of patients, a further step would be to follow-up the subsequent cohort of hospital leavers, to assess the accuracy of the predictions of their costs of community care. This would provide the 'ultimate' cross-validation of the prediction process.

However, as noted by Dunn *et al.* (2003), it is often not possible, within the normal constraints of a research project, to have a second dataset at hand or the resources for this purpose. Another option, as advocated by Diehr *et al.* (1999), is to use the split-sample or internal approach. This involves splitting the original sample into two, developing the model on one of the subsamples (the 'training set') and then conducting the cross-validation on the second sample (the 'validation set'). This is the method adopted by two studies (Dellario *et al.* 1999; Kilian *et al.* 2002). These researchers randomly assigned the respective samples into two samples for the cross-validation procedure. However, the authors reported methodological limitations with their respective cross-validation processes; both studies reported a lack of statistical power due to small sample sizes at the outset. Clearly the split-sample approach is not ideal, particularly if a relatively small sample size is reduced when the sample is divided, as in the case of these studies. However, as already noted it is sometimes the only option when there is not a second dataset available. The scarcity of predictive studies, in their 'true' sense, that is considering the costs of an independent sample of future patients, needs to be addressed by future studies.

Limitations of review

Limitations of this review need to be addressed. The article is not a systematic review and only includes papers written in English. The review excludes cost-effectiveness studies, which are widespread in number but do not have a predictive component.

CONCLUSIONS

The ability to predict future service utilization and costs for local psychiatric services is important for both mental health policy and practice. A knowledge of which patient groups and

particular clinical and non-clinical characteristics incur the greatest psychiatric costs can assist in the targeting of appropriate resources and services, improving accessibility and equity in provision. The predictive studies reviewed here demonstrate that no single variable can explain variations in costs between patients. When seeking to predict future psychiatric service utilization and costs, clinical factors need to be considered alongside other factors, particularly those related to an individual's personal characteristics and previous use of psychiatric services. However, the majority of the studies reviewed here have only explained between a quarter and half of the variations in costs, highlighting the fact that some of the most important predictive factors of psychiatric service utilization and costs remain unknown. It is clear that future predictive studies need to broaden their scope in the exploration of potential predictive factors, for example: socio-economic characteristics of people and the places where they live; environmental factors; and levels of social cohesion within neighbourhoods.

This review has highlighted a paucity of predictive studies that focus on children, older people and indirect costs. The lack of attention on children and older people seems short-sighted considering the increasing demands for psychiatric services for both age groups. As highlighted by McCrone *et al.* (2005), it is now known that depression in childhood or adolescence can increase the risk of adult depression and that comorbid conduct disorder in childhood increases the risk of other mental health problems in adulthood. The ability to predict psychiatric costs and service utilization of current child and adolescent patients going into adulthood would assist greatly in the long-term planning for psychiatric service provision. Similarly, services for older people face increasing demands in many countries because of ageing populations and changing family structures. Within this context, the paucity of predictive studies of patient groups with dementia and Alzheimer's disease is surprising. Regarding the neglect of indirect costs in the studies in this review, with only one study considering indirect costs, it is acknowledged that, methodologically speaking, indirect costs are complex to identify and measure. However, the study by Carr *et al.* (2004) has demonstrated the feasibility of including both direct and indirect costs in a predictive study.

Debate remains regarding the most accurate methodology for the prediction of health-care costs, with a recommendation by some authors to compare different models in order to see which model is the most precise. This recommendation has been confirmed by the findings of the studies conducted by Kilian *et al.* (2002) and McCrone *et al.* (2005). McCrone *et al.* (2005) confirm the recommendation of Dunn *et al.* (2003) that, when the data follow a skewed distribution and the main aim is one of prediction, the OLS model may be the most suitable. It is clear from this review that the cross-validation of predictive models is not yet routine, with only four of the reviewed papers including a cross-validation within their studies. It is clear that methodological problems remain with this procedure and it requires some 'fine-tuning'. The split-sample approach, adopted by two of the studies, is prediction in a statistical and group sense but not in an observational or individual sense. Thus it can be concluded that cross-validation with two different datasets is currently considered the most effective way of evaluating how well a model will perform in a future sample, which is the ultimate goal of predictive cost evaluation research.

ACKNOWLEDGEMENTS

We thank three reviewers for their very helpful comments on an earlier version of this paper. The research was supported by a Marie Curie Fellowship of the European Community Programme Human Potential under contract number HPMF-CT-2002-01876.

DECLARATION OF INTEREST

None.

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