

Estimating the relationship between disease progression and cost of care in dementia

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Background Previous studies have shown a positive relationship between disease severity and cost.

Aims To explore the factors affecting time to institutionalisation and estimate the relationship between the costs of care and disease progression.

Method Retrospective analysis of a longitudinal data-set for a cohort of 100 patients diagnosed with Alzheimer's disease or vascular dementia.

Results Changes in both Mini-Mental State Examination (MMSE) and Barthel scores have independent and significant marginal effects on costs. Each one-point decline in the MMSE score is associated with a £56 increase in the four-monthly costs, whereas each one-point fall in the Barthel index is associated with a £586 increase in costs.

Conclusions It may be inappropriate for economic models of disease progression in dementia to be based solely on measures of cognitive change. MMSE and the Barthel index are independent significant predictors of time to institutionalisation and cost of care, but changes in the Barthel index are particularly important in predicting costs outside institutional care.

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There are an estimated 700 000 people with dementia in the UK, of whom 400 000 have Alzheimer's disease (The Alzheimer's Disease Society, 2001). Incidence is age dependent, hence current trends in demographic change are likely to result in an increase in the prevalence of the disease and an impact on the overall cost of care. A number of estimates of the costs of caring for dementia in England have been made (Gray & Fenn, 1993; Souetre *et al*, 1995; Bosanquet *et al*, 1998) but these have been based on prevalence data and relatively unsophisticated averaging. Little is known of the longitudinal costs of dementia for individuals or groups of patients. These costs depend on two important factors: the setting in which care is given and the progression of dementia, including the range of cognitive and behavioural problems. Several published studies (Ernst *et al*, 1997; Hux *et al*, 1998; Jonsson *et al*, 1999; Kavanagh & Knapp, 1999, 2002; McNamee *et al*, 1999; Souetre *et al*, 1999) have examined the relationship between cognitive function and patient costs but none of these go beyond using cross-sectional analysis and only two of the studies considered behavioural or daily living aspects of disease progression (McNamee *et al*, 1999; Kavanagh & Knapp, 2002).

The objectives of this study were to explore the factors affecting time to institutionalisation and to estimate the relationship between the costs of care and disease progression, measured by cognitive function, behavioural scores and activities of daily living (ADL), using retrospective analysis of a longitudinal data-set for a cohort of 100 patients diagnosed with Alzheimer's disease and/or vascular dementia.

METHOD

Setting and participants

The data for this study were extracted retrospectively from the research data of

100 subjects (51% male) with a clinical diagnosis of dementia recruited to a *prospective* longitudinal study of behaviour in dementia (Hope *et al*, 1997a,b). The diagnosis comprised 51% Alzheimer's disease, 6% Alzheimer's disease/vascular dementia and 2% vascular dementia from pathological diagnosis and 28% Alzheimer's disease, 7% Alzheimer's disease/vascular dementia, 1% vascular dementia and 5% other types of dementia from clinical diagnosis. They were recruited to the study through local general practitioners (GPs), community psychiatric nurses (CPNs) and consultant geriatricians. At the start of the study, the subjects were all living at home with a carer who was able to give detailed information about the subject. All subjects lived in Oxfordshire, UK. The subjects were representative of the general population with regard to the distribution of social class by occupation and their diagnosis (Hope *et al*, 1997b). At four-monthly intervals the subjects were assessed in terms of their cognition and the carers were interviewed about the subjects' behaviour, ADL and all health, social and long-term care services used. Additional information on the carer's attitude to caring and physical ability to cope was collected at the beginning of the study. The date of the first interviews ranged from February 1988 to May 1989. The maximum number of interviews was 33, with the final interview for the final subject taking place in August 1999 (see Fig. 1). This enabled analysis over an 11-year period.

Out of the 100 subjects interviewed at study entry, six withdrew from the study and three were still alive at August 1999. The mean age at study entry was 78 years (s.d.=7.0) but, given that all subjects had already been diagnosed with dementia when recruited to the study, the mean age at onset was 73 years (s.d.=7.5).

Resource use and unit costs

A coding frame was designed and information on resource utilisation was extracted from each subject's four-monthly assessment records on the following: number and duration of acute hospitalisations and respite care; number of out-patient visits, day care and home attendances by district nurses, CPNs, home helps or other care assistants; and number of visits by or to the GP or practice nurse. Details on the use of special aids and

adaptations such as wheelchairs, bath/bed hoists, incontinence pads and sheets and any special dietary requirements were also recorded. An important aspect of care for a patient with dementia is where the care took place. At each interview it was noted whether the subject still resided at home or had been institutionalised. The point at which subjects were rated as being 'institutionalised' was taken as the time when they were admitted to a hospital ward or a nursing home for permanent care (Hope *et al.*, 1998).

Unit costs were attached to these cost-generating events (see Table 1), enabling an estimation of patient-specific costs of dementia by the four-month period from study entry to death or censor point. Where appropriate, the unit costs of all hospital admissions and out-patient visits were based on information from financial returns for the specified trusts. The unit costs of home attendances by district nurses, CPNs, home helps or other care assistants and visits by or to the GP or practice nurse were taken from previously published sources (Netten *et al.*, 1998, 1999). The market price of equipment, consumables and non-structural home modifications was used. Residential and nursing home care costs were based on actual costs of care in each facility. All unit costs were updated to 1998 prices and are reported in UK £ sterling.

Indicators of disease progression

As part of the original cohort study, data were collected every 4 months on the cognitive, behavioural and functional abilities of the patients using the Mini-Mental State Examination (MMSE; Folstein *et al.*, 1975) and the Present Behavioural Examination (PBE; Hope & Fairburn, 1992). The MMSE score ranges from 0 to 30, with a score of zero indicating the severest loss of cognitive function. The behavioural and functional data collected using the PBE questionnaire were transcribed onto the Barthel ADL index (Wade & Collin, 1988). For the purpose of this paper it was felt that it was better to transcribe the data collected using the PBE to the Barthel index owing to the complexity of the PBE, the greater familiarity with the Barthel index, to enable comparisons with other studies and the fact that the Barthel index is widely used in long-term care insurance. This index measures functional capabilities such as bowel and bladder continence, toilet use, bathing, feeding, grooming, dressing, mobility and ability to cope with stairs. The score ranges from 0 to 20, again with zero indicating the greatest impairment. The transformed data were believed to have good validity, because the information required to complete the Barthel index was much less than the information collected by the PBE. Two other variables

measuring degrees of aggressive behaviour and wakefulness, which are dimensions of behaviour not included in the MMSE or Barthel index, were obtained from the PBE questionnaire and included in the analysis.

Data analysis

The data were entered into SPSS version 10, and primary analysis of the total cost per patient over the whole period was conducted. One-way analysis of variance was used to explore the difference in costs between disease severity scores for the MMSE and Barthel index. For the purpose of further analysis using longitudinal and survival and analysis techniques, the data were transferred to another statistical software package: Stata version 6.

Variations in the measured aggregate cost per four-month period and the impact of covariates such as age, measures of disease progression and care regime were explored using a fixed-effects regression model (Greene, 1999). In this model, consistent patient-specific differences in costs that are not explained by the covariates are estimated through the regression constants (the 'fixed effects') rather than absorbed into the residual. The second analytical technique used in this paper to explore the relationship between time to institutionalisation and covariates such as age, gender, disease progression and domestic circumstances is the Cox proportional hazards regression (Cox & Oakes, 1984). This technique is used to analyse time-to-event data. In this paper it explores the impact of the (potentially time-varying) covariates described above on the hazard of institutionalisation.

RESULTS

Costs

The total cost per patient over the course of the study (mean follow-up was 40 months, range 1–132) averaged £66 697 (s.d.= 60 249). Figure 2 shows that institutional care, comprising long-stay nursing home, residential home and long-stay hospitalisations, represents a major component (69%) of the total cost, whereas respite care accounts for 15% of the total cost.

The relationship between the cognitive, functional and behavioural capabilities of the patients and the costs incurred caring for the patients was explored. The MMSE and Barthel scores were separated into

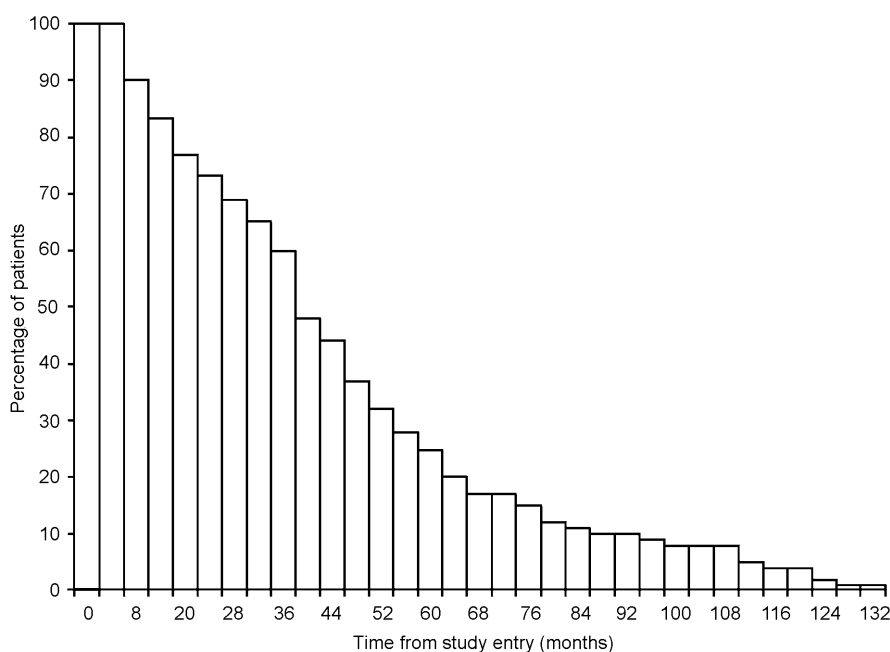


Fig. 1 Percentage of patients available at interview.

Table 1 Unit costs and sources of information

Type of service	Unit of service	Source	1998 prices
Hospital admissions ¹	General surgery	Per in-patient stay	TFR returns £225.77–285.78
	General medicine	Per in-patient stay	TFR returns £125.09–256.28
	Geriatrics	Per in-patient stay	TFR returns £120.01–157.64
	Psychiatric	Per in-patient stay	TFR returns £463.75
Out-patient visit ¹		Per out-patient visit	TFR returns £81.36–110.85
Psychiatrist	Domiciliary visit	Per hour of patient contact	Netten <i>et al</i> (1999) £238.00
GP	Surgery visit	Per visit (8.4 min)	Netten <i>et al</i> (1998) £14.00
	Domiciliary visit	Per visit (13.2 min+12 min travel)	Netten <i>et al</i> (1998) £46.00
	Domiciliary visit, emergency call	Per visit (13.2 min+12 min travel)	Netten <i>et al</i> (1998) £47.00
	GP telephone	10.8 min	Netten <i>et al</i> (1998) £17.00
Practice nurse	Surgery visit	Per consultation	Netten <i>et al</i> (1998) £7.29
Respite care	Community hospital	Per in-patient day	TFR returns £125.09
	Teaching hospital wards	Per in-patient day	TFR returns £125.09
	Private nursing home	Per in-patient day (based on care package of short-term resident week)	Netten <i>et al</i> (1999) £55.70
Day care		Per hour	Netten <i>et al</i> (1999) £4.75
Domiciliary help	District nurse	Per domiciliary visit	Netten <i>et al</i> (1998) £15.00
	Chiroprapist	Per domiciliary visit	Netten <i>et al</i> (1999) £15.00
	Care assistant	Per domiciliary visit (2-hr session)	CIPFA £25.00
	CPN	Per domiciliary visit	Netten <i>et al</i> (1998) £20.00
	Other helper (e.g. OT, physiotherapist)	Per domiciliary visit	Netten <i>et al</i> (1998) £35.00
Aids and adaptations	Wheelchair, walking frame, hoist	Per day	Netten <i>et al</i> (1998) £0.40
	Incontinence pads	Per pad	Personal communication ² £0.25
	Kylie/incontinence sheets	Per sheet	Personal communication ² £0.75
	Enema	Per enema	Personal communication ² £3.00
Accommodation	Private household	Per day	Netten (1990) £31.42–48.64
	Warden-controlled housing	Per day	Netten <i>et al</i> (1998) £17.29–37.71
	Residential home ²	Per day	Personal communication ² (4 homes) £31.42–61.43
	Nursing home ²	Per day	Personal communication ² (9 nursing homes) £54.42–82.14

GP, general practitioner; TFR, hospital trust financial returns; CPN, community psychiatric nurse; OT, occupational therapist; CIPFA, Chartered Institute of Public Finance and Accountancy.

1. Based on six Oxfordshire-based hospitals; hospital-specific costs were attached to the hospital-specific resource use information.

2. Based on a survey of residential and nursing homes used by subjects in the study. Where homes failed to respond, unit costs are taken to be the average of the responders.

disease severity classifications that had been used previously in studies exploring the relationship between cost of disease and disease progression (Hux *et al*, 1998; Porsdal & Boysen, 1999). The MMSE score was divided into severe (<10), moderate (10–14), mild to moderate (15–20) and mild (>20) and the Barthel score into severe (0–9), moderate (10–14), slight (15–19) and no disability (20). Figure 3 shows how the average annual cost of care per patient increases significantly with severity of dementia. Focusing on cognition as measured by the MMSE, the annual cost

per patient was estimated to be £8312 (s.d.=5602) for mild disease, £11 643 (s.d.=7808) for mild to moderate disease, £15 681 (s.d.= 9509) for moderate disease and £22 267 (s.d.=14 507) for severe disease (one-way analysis of variance: $F=23.17$, $P<0.001$). On the Barthel ADL scale, average annual care cost per patient ranged from £8086 (s.d.=3556) for no disability, £12 752 (s.d.=7632) for slight disability, £23 240 (s.d.=15 638) for moderate disability to £23 516 (s.d.=13 253) for severe disability (one-way analysis of variance: $F=38.72$, $P<0.001$). The cost

information reported here is on an annual basis. Elsewhere in this paper the costs are based on a four-month period.

Cost per period

Given that the data were collected on a longitudinal basis, we explored the impact of the different variables on the total cost of care over time using longitudinal data methods. A list of the variables used in the analyses and their descriptions is displayed in Table 2. The results from the fixed-effects regression model are reported

in Table 3. The model is specified so that age, MMSE and Barthel covariates are interacted with a dummy variable indicating whether the patient was in long-term institutional care ($I_i=1$) or not ($I_i=0$). The results are discussed for each covariate in turn.

Institutionalisation

As predicted, the patients incur an additional cost of approximately £8000 per four-month period when in institutional care, assuming everything else is held constant. This is approximately equivalent to the annual cost of institutional care noted in Table 1.

Age

The model indicates that the age-institutionalised interaction term is significantly inversely associated with cost. When all other factors are held constant, each additional year of age reduces the cost incurred by £130 per four-month period, although this is not in itself statistically significant. When cared for in an institution, each additional year of age has the additional effect of significantly reducing four-monthly costs by a further £147 (i.e. £277 in total). These results imply that, having controlled for disease progression, older subjects at home or in an institution are less likely to have health and social care resources committed to them.

Measures of disease progression

The results indicate that changes in both the MMSE and Barthel scores have an independent and significant effect on costs, and that changes in the Barthel index have a larger impact. Each one-point decline in the MMSE score is associated with a £56 increase in four-monthly costs, whereas each one-point fall in the Barthel index is associated with a £586 increase in costs. Even allowing for the shorter range of the Barthel scale (20 points, compared with 30 points in the MMSE scale), it seems that changes in ADL have a much greater impact than cognitive changes on the health and social care resources required by dementia sufferers.

However, looking at the MMSE/Barthel and institutionalisation interaction terms, it appears that the pattern just described holds only for those outside institutional care. Once in institutional care, the results suggest that most costs are fixed and

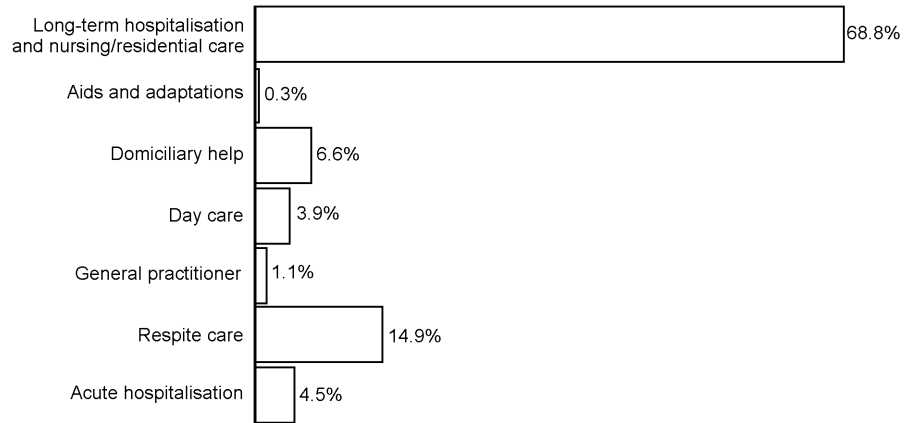


Fig. 2 Components of total cost.

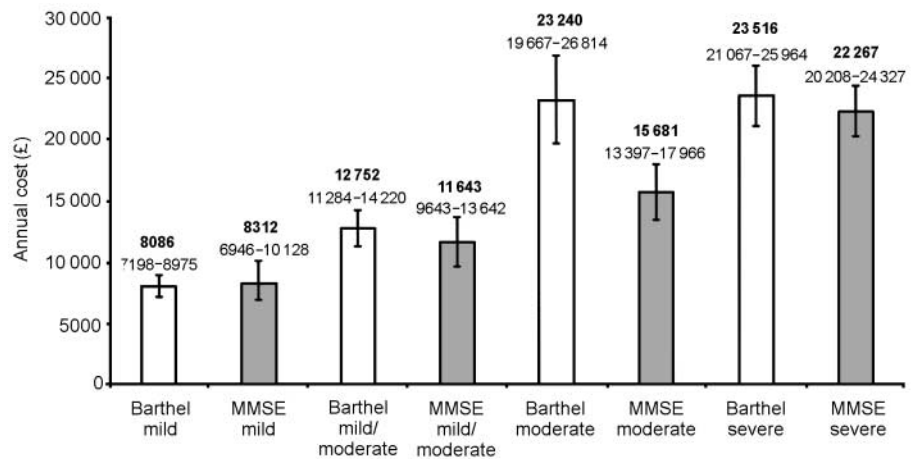


Fig. 3 Mean annual cost of care by Mini-Mental State Examination (MMSE) and Barthel severity scores with 95% confidence intervals.

therefore further declines in cognition or ADL have little additional impact on costs (although more detailed information on patient-specific nursing and other care inputs in institutional care would be required to confirm and explain this fully). The variable ‘wakefulness for reasons other than passing urine’ is the only behavioural variable to have a significant impact on the care costs. In fact, this variable significantly reduces costs by over £1000, perhaps because it correlates with other factors that reflect increased independence and therefore may be associated with a delay in the time to institutionalisation.

Time to permanent institutional care

The conditional probability that a patient with dementia is admitted to permanent

institutional care is likely to depend on his/her mental, physical and behavioural abilities combined with the support available from carers and community services. Table 4 shows the results for the Cox proportional hazards regression, in which time to institutionalisation is used to determine the way in which these factors affect the hazard of time to admission.

Age

The analysis shows a significant association between the age and the hazard of institutionalisation, indicating that as the individual ages, the hazard of being admitted to institutional care increases: this is indicative of a reduced time to institutionalisation. Because all subjects were living at home at entry to the study and had a mean age of 78 years, this result may have been

Table 2 Description of variables used in the analyses

Variable	Description	Frequency (n=1094)	Mean	s.d.
Inst	Institutionalised=1	400		
	Not institutionalised=0	694		
age	Patient age	1092	79	6.58
mmse	MMSE score, range 0–30	1075	8.71	8.79
barthel	Barthel score, range 0–20	1094	12.25	6.35
gende_0	Gender=male	495		
gende_1	Gender=female	599		
livin_0	Living alone	47		
livin_1	Living with spouse	699		
livin_2	Living with spouse and others	74		
livin_3	Living with family (excluding spouse)	214		
livin_4	Living with others (not family)	58		
care_1	Resents having to care for patient	5		
care_2	Caring because they feel they ought to	10		
care_3	No resentment to caring	85		
cope1	Not coping with caring	0		
cope2	Is coping but only just	12		
cope3	Moderately fit and able to do all that is necessary	27		
cope4	Physically fit and able to cope easily	61		
wake_1	Wakeful at night due to passing urine			
	1=mild (≤ 2 times per night)	601		
	2=severe (> 2 times per night)	462		
wake_2	Wakeful for other reasons			
	1=mild (≤ 2 times per night)	193		
	2=severe (> 2 times per night)	84		
agg_1	Physical aggression			
	1=mild	193		
	2=severe	211		
agg_2	Aggressive resistance			
	1=mild	183		
	2=severe	277		
agg > 3	Verbal aggression			
	1=mild	372		
	2=severe	349		

MMSE, Mini-Mental State Examination.

The 'care' and 'cope' variables were only assessed at the start of the study.

Table 3 Fixed-effects regression on four-monthly total care cost

Variable	Coefficient	s.e.	t	P	95% CI
Inst	8390.66	4580.67	1.832	0.067	–600.33 to 17381.65
age	–129.97	104.37	–1.245	0.213	–334.84 to 74.90
liXage	–147.67	56.54	–2.612	0.009	–258.63 to –36.70
mmse	–56.77	26.64	–2.131	0.033	–109.06 to –4.47
liXmms_1	39.93	38.01	–1.051	0.294	–34.67 to 114.53
barthel	–586.16	57.08	–10.269	0.000	–698.21 to –474.12
liXbar_1	438.87	70.42	6.232	0.000	300.65 to 577.10
wake_1	–441.62	492.03	–0.898	0.370	–1407.39 to 524.15
wake_2	–1128.03	529.40	–2.131	0.033	–2167.15 to –88.91
agg_1	819.19	449.92	1.821	0.069	–63.91 to 1702.29
agg_2	–251.81	362.21	0.695	0.487	–962.75 to 459.14
agg_3	–36.43	324.41	–0.112	0.911	–673.19 to 600.33
constant	24273.25	8556.36	2.837	0.005	7478.72 to 41067.79

$R^2=0.25$; $F=34.90$; $P=0.000$.

anticipated, however, it should be noted that this age effect is identified after controlling for disease progression and carer commitment and capability.

Gender

A significant association between gender and the hazard of institutionalisation is also found, with women having a lower hazard than men (approximately 10% lower than men), implying longer times to institutionalisation (see Table 4).

The MMSE, Barthel and other measures of behaviour

As noted earlier, an advantage of this study compared with many others in the area is the presence of more than one measure of disease progression, allowing the opportunity to assess the relative importance of cognitive decline, behavioural change and ADL. The results indicate that both the MMSE score and the Barthel index are negatively associated with the hazard of institutionalisation: as each declines, along with the patient's deterioration, the hazard of being admitted increases and consequently the duration to institutionalisation falls. The inclusion of extra behavioural variables that measure wakefulness and aggressive behaviour that are not captured by the MMSE or Barthel index has no impact on the significant independent association between MMSE, Barthel and the hazard of being admitted to long-term care. This finding – that cognition and ADL have an independent and highly significant ($P < 0.004$) effect on the likelihood of being institutionalised – may have important implications for future study designs and analyses.

Domestic circumstances

Three measures were included relating to domestic circumstances: who the subject lived with, the attitude of the carer to caring at study entry and the physical ability of the carer to cope with caring. The results indicate that, when exploring the impact of who the patient lived with, living with others (including at least one member of the patient's family) significantly reduces the hazard of institutionalisation relative to living alone, and the strongest effects were found where the number of potential carers was highest. Living with others from outside the patient's family also seemed to reduce the

Table 4 Cox regression on time to institutionalisation

Variable	Coefficient	s.e.	Z	P	95% CI
age	0.069025	0.030	2.284	0.022	0.0097842 to 0.1282657
mmse	-0.100454	0.035	-2.910	0.004	-0.1681034 to -0.032804
barthel	-0.159344	0.037	-4.340	0.000	-0.2313129 to -0.087376
gende_1	-0.894397	0.375	-2.386	0.017	-1.6292 to -0.159595
Livin_1	-1.514713	0.660	-2.294	0.022	-2.808984 to -0.220443
Livin_2	-1.814786	0.889	-2.042	0.041	-3.556417 to -0.073156
Livin_3	-1.820078	0.702	-2.592	0.010	-3.196526 to -0.443630
Livin_4	-1.324685	0.888	-1.492	0.136	-3.064404 to 0.4150333
care_2	-1.441768	0.835	-1.727	0.084	-3.078484 to 0.1949474
care_3	-1.512468	0.717	-2.110	0.035	-2.917154 to -0.107782
cope3	0.639001	0.489	1.307	0.191	-0.3191401 to 1.597141
cope4	0.017134	0.484	0.035	0.972	-0.9316915 to 0.96596
wake_1	-0.005965	0.520	-0.011	0.991	-1.025691 to 1.013762
wake_2	1.193029	0.520	2.294	0.022	0.1739289 to 2.212128
agg_1	0.065185	0.470	0.129	0.897	-0.8597688 to 0.980810
agg_2	-0.665096	0.417	-1.593	0.111	-1.483282 to 0.153090
agg_3	0.309782	0.375	0.825	0.409	-0.4260757 to 1.045639

No. of subjects=100; no. of observations=710; no. of failures=58; log likelihood=-150.343; likelihood ratio $\chi^2=87.47$; $P=0.000$.

hazard of institutionalisation relative to living alone, but this effect was not statistically significant. (Even though subjects were categorised as living alone, they were still closely supervised by family/friends.) The results also indicate that the presence of a carer who has an active preference for caring for the subject at home (as assessed at baseline) significantly reduces the hazard of institutionalisation. Finally, there is no evidence of an independent association between the assessed physical ability of the carer to cope and the hazard of institutionalisation.

DISCUSSION

This is a unique study in that no other has had access to a data-set of patients with dementia employing frequent longitudinal assessment of time-varying covariates such as resource use, residential status, age and disease progression. It illustrates that although there are only 100 patients in this data-set, its longitudinal nature, with a mean follow-up time of 40 months, generates a rich source of information.

Modelling disease progression on the basis of changes in cognition and ADL

One of the key findings from this study is that it may be inappropriate to model

disease progression in dementia solely on the basis of measures of cognitive change. It has been suggested elsewhere (Davies *et al*, 2000; McDonnell *et al*, 2001) that changes in scores for ADL and information on behavioural disturbances may be potential indicators of progression to institutional care and costs of care. This study has shown that the MMSE and the Barthel index are independent significant predictors of time to institutionalisation and cost of care, but changes in the levels of ADL seem to be much more important than changes in cognition in predicting costs outside institutional care. It is also interesting to note that despite the inclusion of measures of behavioural disturbances not captured by the MMSE or Barthel index, such as wakefulness and aggression, the MMSE and Barthel index remain independent significant predictors of time to institutionalisation and care costs. This finding may have wide-ranging implications for future studies in this area: for example, pivotal trials of therapies for dementia have placed a strong emphasis on changes in cognition, and almost all the modelling work conducted to date on the cost-effectiveness of dementia interventions uses the impact of therapy on cognition as the linking mechanism to costs of care. The possibility that cognitive changes lead to changes in ADL would require further investigation, but such research goes beyond the bounds of the current study.

Institutionalisation and respite care

The study confirms findings from previous research that institutionalisation represents a significant proportion of the total cost burden for dementia patients. Institutionalisation accounts for 69% of the total care costs and, when all other factors are held constant, it adds an additional cost of approximately £8000 per four-month period. Less expected is the finding that respite care represents the next most important burden of resource use, accounting for 15% of the total care costs for dementia patients. This suggests that more attention should be paid to the collection of information on respite care in prospective studies and that onset of need for respite care should be included in modelling studies.

In contrast with the majority of previous studies – which have assumed costs to be constant once a person with dementia is admitted to institutional care – a feature of this study is that the costs of care in institutions do not consist solely of the flat rate cost per week of the institution, but also include such items as GP consultations, out-patient visits and short-term hospital stays. Some evidence exists on health service use among elderly people in institutional care, but not specifically those with dementia (Kavanagh & Knapp, 1998). A valuable extension to this study would be to explore in more detail the variation in the actual nursing care and other resources used by individuals within an institutional setting: in the absence of such data, there is no clear evidence that disease progression while in institutional care increases costs. However, the finding in this study that age is inversely associated with the cost of care both at home and in institutional care is intriguing, because it suggests the possible existence of age-related rationing: controlling for everything else, a person with dementia appears less likely to get access to health and social care as his/her age increases.

Lifetime costs of dementia

Finally, the empirical estimates of the effects of disease progression on care costs that this study has established should be valuable in assessing more accurately the true lifetime costs of dementia and their association with disease progression and, in future work,

modelling the cost-effectiveness of therapeutic interventions.

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CLINICAL IMPLICATIONS

■ It may be inappropriate for economic models of disease progression in dementia to be based solely on measures of cognitive change.

■ Institutionalisation represents a significant proportion of the total cost burden for patients with dementia.

■ The empirical estimates of the effects of disease progression on care costs that this study has established are valuable in assessing more accurately the true lifetime costs of dementia and their association with disease progression.

LIMITATIONS

■ The original data were not collected for the purpose of this particular study.

■ The same size of 100 subjects is relatively modest and, if solely used on a cross-sectional basis, would have implications for the power of the study.

■ Although there is a nominal cost included for informal care in this study, it has not been estimated in detail.

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