SUBSTUDY 2

CARE TRAJECTORIES: THE NATURAL HISTORY OF CLIENTS MOVING THROUGH THE CONTINUING CARE SYSTEM

A Report Prepared for
the Health Transition Fund, Health Canada

September 2001

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CARE TRAJECTORIES: THE NATURAL HISTORY OF CLIENTS MOVING THROUGH THE CONTINUING CARE SYSTEM

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by Dean Uyeno, PhD
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PREFACE

The National Evaluation of the Cost-Effectiveness of Home Care is an integrated program of research with 15 studies being conducted across Canada. There is an overall strategy for the program of research to make it as useful to administrators and decision makers as possible. The program of research is designed to determine whether or not home care is a cost-effective alternative to institutional care, that is, care in long term care facilities and acute care hospitals. However, the program of research is also designed to provide an educational function to inform decision makers and the public about home care, and to provide advice about issues related to implementing new and cost-effective home care initiatives. Thus, the overall strategy has the following components:

- Conduct studies to determine whether or not home care is a cost-effective alternative to institutional care, and if so, under what conditions it is cost-effective.

- Conduct studies to inform decision makers about the nature and scope of home care services across Canada. These studies provide a baseline of information about home care clients, costs, and utilization. This baseline is important because there is currently no national database on home care in Canada.

- Conduct studies to explore opportunities for potential savings in the hospital sector by substituting home care services. At present there are relatively few areas noted in the literature where home care has been shown to be a cost-effective alternative to hospital care.

- Conduct studies to provide decision makers with information about some of the issues they may face if they try to implement new initiatives to enhance the cost-effectiveness of the health care system.

This study, Substudy 2, *Care Trajectories: The Natural History of Clients Moving Through the Continuing Care System*, has three major sections. The first section sets the context of the study. The second section describes the most common patterns of movement through the British Columbia continuing care system for the 1987/88 to 1996/97 fiscal years, for a cohort of clients admitted in the 1987/88 fiscal year. The third section compares 15 different statistical models to predict how people move through the system of care. It was found that Markovian modelling provided a high degree of predictability of future resource utilization.

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EXECUTIVE SUMMARY

This study has three sections. The first section sets the context for the study. The second section describes the most common patterns of movement through the British Columbia continuing care system for the 1987/88 to 1996/97 fiscal years, for a cohort of clients admitted in the 1987/88 fiscal year. The third section compares 15 different statistical models to predict how people move through the system of care. The data used in this study were obtained from the University of British Columbia which maintains a longitudinal database of BC data for hospitals, physicians, drugs, continuing care, mental health, and some aspects of vital statistics.

It was initially expected that there would be four to six common trajectories or patterns of movement which would account for a significant portion of all patterns. It was also assumed that people would progress through the system of care in a certain logical manner, entering at a low level of care in the community, moving up one or two care levels, then moving to a facility where they would move up through one or two care levels and then pass away.

The findings from this study indicate that, unlike our initial expectations, there was a wide variety of care trajectories, none with a large percentage of the clients. Within the ten years of data available to us, the most common pattern was for clients to enter the system at a given level and type of care and die without any changes in the level and type of care. The implications of these two results must be considered by clinicians, planners and policy makers.

For those who entered care in the community at level one, none of the top ten patterns of care included a move to a facility. However, at higher starting levels of care, there was a general trend toward an increasing proportion of clients having patterns which involved moves to a facility. In the vast majority of cases, those who entered care in a facility remained in facility care until they passed away or until the end of the ten years of data available to us.

Some 15 Markovian and non-Markovian forecasting methods were tested on nine years of actual data on the states of health of 6384 clients of the BC Continuing Care System. Markovian methods were shown to be more robust both in times of rapid and modest change. The forecasting errors from Markovian methods were small and were in general smaller than the errors for the non-Markovian methods (moving average, exponential smoothing, linear regression) against which they were compared. Further testing should be undertaken to determine how well Markovian methods work on longer range forecasts and on smaller populations.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Angela Tessaro for her work in preparing the database for analysis and for developing the initial set of transition probabilities.

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SECTION A: SETTING THE CONTEXT

1. INTRODUCTION

In British Columbia, continuing care is a comprehensive system of care for the elderly and persons with disabilities. It includes assessment and case management, short and long term home care and home support, and long term care facilities and chronic care facilities. There has been very little research on how clients move through this system of care.

This report documents the pattern of client movement within the care system. This movement can also be referred to as the "trajectory" of client care. Knowing how people move through the system is important for a number of reasons. If care patterns are predictable, clinicians can prepare in advance for changes in care status. The movement of clients within the system of care is also important for planning and for resource allocation. Most planning and resource allocation models look at the characteristics of clients and factors external to the system of care in order to predict future utilization patterns. However, it could be that the ways in which clients who are already in the system move between services may also contribute to resource pressures. For example, if clients come into home care they may progress to facility care at a steady pace year by year, or, it could be that most clients move into facility care in their fourth or fifth year of care. If the latter were the case, then there would be significant pressure on beds at certain points in time created from within the system of care.

The report has three sections. The first sets the context, while the second looks at the pattern of movement of clients within the system. The third section looks at various approaches to modelling the movement of clients, including Markovian modelling, to determine which approach is most predictive of actual outcomes.

2. METHODS

The data used for the analyses in this study were obtained from the University of British Columbia (UBC) which maintains a linkable longitudinal database with data for hospitals, physicians, drugs, continuing care, mental health and some aspects of vital statistics. UBC's Centre for Health Services and Policy Research (CHSPR) has done extensive work to link data by developing probabilistic linkages. Tests indicate a very high degree of accurate matches. More recently, after the advent of the unique health number in British Columbia, linkages have been made using this unique health number (Chamberlayne, Green, Barer and Hertzman, 1998).

Once the data were obtained, an extensive process of cleaning the data was undertaken. Each data set was analyzed for potential data-related problems by inspecting the ranges of each variable to be used in the analysis.

The document used to authorize access to all community and residential long term care services in British Columbia during the 1980s and 1990s was the "Care Advice" form. A care advice form is completed to order services for new clients. After the initial service order, a care advice form is filled out for any change from approved service such as a change of service, a change in care level, discharge or death.

While it appeared that the database for direct care services (nursing, PT/OT) was generally reliable, it had the most anomalies. Direct care services are not ordered through the same care advice form as long term care community services such as homemakers and adult day care. Data on visits are recorded every 6 months for active clients, and at discharge, on a separate direct care database.

Table 2-1 presents information on how the data were cleaned to arrive at the total sample number of 6384 for this study. These 6,384 clients were assessed in the 1987/88 fiscal year and started care within a one year period after their assessment. They constitute the cohort which is analyzed in this study. We were able to track the movement of these clients for a 10 year period to the end of fiscal 1996/97.

Table 2-1: Selection of the Sample for the Study from all New Assessments in the 1987/88 Fiscal Year

Total client records received in fiscal 1987/88	15259
MINUS	
Duplicate Records	264
No Assessment[1]	109
Less than 65 Years of Age	2179
Clients with No Care at All	1567
Ineligible or Declined Care	507
Started too Early[2]	45
Clients with no care in the first year after assessment	1316
Long Hospital Stays[3]	84
Clients with Short Stays[4]	1237
Outliers[5]	134
Not enough care[6]	1433
Total Sample	6384

[1]In this study a year is defined as being 364 days to ensure a standard number of days for each half year period (182 days) and each quarter (91 days). These exclusions are most likely clients who were admitted on the last day or two of the year (1988 was a leap year).

[2]Some clients started before the completion of their formal, first assessment. Clients who started care more than 60 days prior to their first assessment were excluded from the study.

[3]Clients with a continuous hospital stay of over 182 days were excluded from the study

[4]Clients with 91 days or less of care in the year after their first care were excluded from the study.

[5]Outliers are clients who had values which were more than five standard deviations from the mean for the average cost of MSP services, cost of prescription drugs, number of days in hospital, direct care visits, homemaker hours and direct care days for the two year period after the beginning of care. The five standard deviations criterion was used because the distributions for costs and utilization were quite skewed with most clients having relatively low levels of service and decreasingly small numbers having increasing amounts of service.

[6]Only clients who were in care 75 percent of the time in the first year were included in the study. Thus, this represents people who had at least three months of care (see footnote 4) but less than 9 months of care.

3. LITERATURE REVIEW

A comprehensive literature review was conducted of predictive modelling in the continuing care sector. Two articles were found which relate to British Columbia (Lane, Uyeno, Kliewer & Gutman, 1985; Lane, Uyeno, Stark, Gutman & McCashin, 1987). A third article by Gillen, Spore, Mor and Freiberger (1996) looked at transitions within nursing homes in 48 National Health Corporation (NHC) nursing homes between 1983 and 1987.

The study by Lane et al. (1985) was based on a population of 1,653 clients admitted in 1978 to the British Columbia continuing care system who were followed for a five year period. They looked at three different models of predicting the pattern of client movement within the system of care. They found that the first-order Markov chain model with stationary transition probabilities yielded superior forecasts to state-by-state moving average growth, and state-by-state regression analyses.

The 1987 Lane et al. article studied 9,483 clients in the British Columbia Long Term Care Program over the period 1978 to 1983. They found, as did the 1985 study, that the Markov model resulted in quite accurate forecasts of how clients move from state to state (level of care in the community and facilities) from the time of admission to death. Two end states, discharge and death, were also included in the analysis. The authors found that there was some instability in state transitions in the first year after admission to care. This "settling down" phenomenon is well known to care providers, administrators, and researchers. Once the first year of transition was eliminated, transition probabilities were fairly consistent and fairly predictive of actual utilization. The authors analysed various sub-sets of the data and found that the most highly predictive results occurred when clients were separated into male and female groups.

There is quite a different pattern in the use of long term care facilities in Canada than in the United States. In Canada, most people who are eventually admitted to a long term care or chronic care facility tend to stay in residential care. In contrast, in the United States, a significant proportion of clients use facilities on a short term basis. These differences are believed to be the result of different systems of care.

Gillen et al. (1996) used a continuous-time Markov chain analysis to look at transition patterns in long term care facilities for some 9,541 long-stay clients. They used an Activities of Daily Living (ADL) scale as their method to classify clients into care levels. Their model had five level of care states and four other states: death, hospitalization, return home, and other discharge. Clients were studied for months one to three and for the four quarters of their first year in care. The authors found that the number of functional transitions was greatest in the first thirty days. They also found that functional stability increased over time. For example, the probability for clients at the lowest level of care remaining in that state was 89 percent in the first 30 day period and 97 percent in the third thirty day period, if they started the period at that functional state.

It was also found that during the second quarter 27 percent of the original long stay sample (in care for at least 100 days) exited from facilities and 44.5 percent were hospitalized, 37.7 percent returned home,

and 16.4 percent died. During the third quarter 21 percent of the remaining clients exited the system and in the fourth quarter 13 percent were discharged. The authors also tested the significance of covariates on the transition intensities for each quarter. They found the following variables to be significantly related to transition intensities: age, marital status, primary source of payment, any cancer diagnosis, diagnosis of paralysis, presence for a psychiatric disorder other than dementia, and orientation status.

Apart from the above articles related to continuing care, there are relatively few examples of the use of Markovian analysis for forecasting in health management. From the standpoint of the vital function of forecasting, this is somewhat surprising because of the number of years this method has been well understood and because the heart of basic Markovian analysis is the quantification of the rate of change from one state to another, an essential element of forecasting. Grover, Coupal, Zowall, Rajan, Trachtenberg, Elhilali, Chetner and Goldenberg (2000) applied a Markovian state transition model to roughly forecast the health care requirements associated with prostrate cancer. Boult, Kane, Louis and Ibrahim (1991) did pilot Markovian studies to forecast the number of future disabled elderly. Kinosian, Stallard, Lee, Woodbury, Zbrozek, and Glick (2000) predicted care requirements and survival probabilities for people with Alzheimer's disease. Caro and Huybrechts (1999) created a rough model for the economics of strokes. This model had several Markovian submodels.

SECTION B: PATTERNS OF SERVICE UTILIZATION

4. FINDINGS

It was initially assumed that there would be four to six common trajectories or patterns of movement which would account for a significant proportion of all patterns. It was also assumed that people would progress through the system of care in a certain logical manner. That is, it was assumed that they would enter the system at a low care level in the community, move one or two care levels up and perhaps receive additional services, move to a facility, move up one or two care levels and then pass away. The data revealed that neither of these assumptions could be supported empirically. In fact, the pattern of progression from low level home care to high level facility care only occurred in a relatively small proportion of cases.

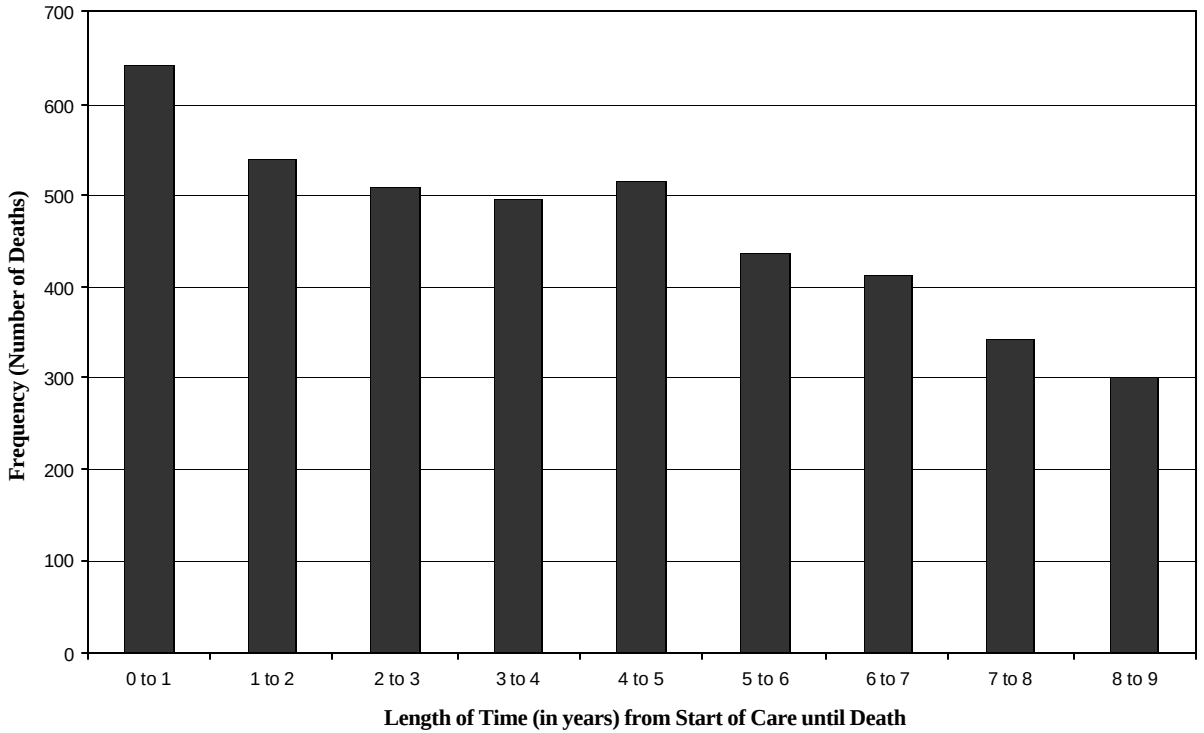
It was found that clients had a very wide variety of care trajectories and that the most common pattern within the ten years of data available to us was to enter the system at a given level and type of care and die. Both of the above findings represent significant new information about the natural history of client movement within the continuing care system. The full implications of these findings are not clear at this point. However, they will need to be considered by clinicians, planners and policy makers for their potential implications.

We had originally hoped to cost out common care trajectories. To our knowledge no one has yet costed out full episodes of care in the home care system. However, given the lack of common care trajectories, costing was not undertaken.

Overall, it was found that, over the 10-year period from 1987/88 to 1996/97, about two thirds of the clients died and one third were still alive. Figure 4-1 presents a schematic overview of the number of deaths which occurred over the ten year period of the study.

Given the complexity of the care patterns we present our data in three layers. Table 4-1 presents patterns based on four states: home/community, facility, dead and no care. As noted above, any change to care is recorded on the Care Advice form. We found that there were gaps in care between the end of one care advice and the beginning of another care advice. These gaps could occur for several reasons such as a long hospital stay, an extended trip with family, or a temporary move to another province. The designation "no care" represents the state in which the client is not receiving continuing care services.

Figure 4-1: Number of Deaths per Year



Note: Only 9 years of data are presented as some clients, while assessed in fiscal 1987/88, did not start care until fiscal 1988/89.

Table 4-1 : Service Utilization Patterns by Type of Care for Home/Community Care and Residential Care

Pattern[1]	Percent of Total Patterns[2]	Mean Length of Stay (Days)[3]	Percent Distribution of Length of Stay[4]					
			0-6 months	7-12 months	1-2 years	2-3 years	3-5 years	5-10 years
1. Community/ Died	24.7	1083	11.96	15.19	19.11	12.66	20.13	20.95
2. Community		874	21.84	14.49	19.42	11.11	17.49	15.65
Facility/Died		875	22.42	11.40	17.68	13.82	21.93	12.75
Total	16.2	1749	2.03	4.25	9.66	12.17	24.93	46.96
3. Community/ Still Active	9.5	3650	0	0	0	0	0	100
4. Facility/Died	9.3	1280	7.73	12.77	11.60	14.62	25.88	27.39
5. Community/ No Care	7.1	1744	0	7.24	17.32	9.43	18.86	47.15
6. Community		1924	6.75	5.83	7.06	6.75	13.19	60.43
Facility/Still Active		1726	1.84	3.99	14.72	14.72	25.15	39.57
Total	5.1	3650	0	0	0	0	0	100

[1] Where clients were only in one state and either continued in care, died, or received no subsequent care, the statistics in this table are organized in one row which represents information about the initial state of the client. Where clients were in more than one state, the sequence of states is represented vertically and the row entitled 'Total' represents information on the total stay of the client in care.

[2] Figures in column two represent the percent of total patterns for Home/Community Care and Residential Care clients.

[3] Where more than one state exists, the number for the 'Total' row, represents the vertical addition of the time spent in each state.

[4] Where more than one state exists, the row total represents the distribution of time for the overall length of stay.

Table 4-1 (continued)

Pattern	Percent of Total Patterns	Mean Length of Stay (Days)	Percent Distribution of Length of Stay					
			0-6 months	7-12 months	1-2 years	2-3 years	3-5 years	5-10 years
7. Community		1079	0	8.47	31.75	19.58	24.34	15.87
No Care/Died		680	32.28	16.40	15.34	11.11	17.99	6.88
Total	3.0	1759	0	0.53	11.64	14.29	26.98	46.56
8. Community		962	0	9.04	36.72	20.90	22.03	11.30
No Care		354	46.33	29.38	11.86	5.65	5.08	1.69
Facility/Died		837	16.95	12.99	20.34	18.64	22.60	8.47
Total	2.8	2153	0	0	2.26	7.34	23.73	66.67
9. Community		1435	0	9.47	21.89	13.02	21.30	34.32
No Care		833	20.12	19.563	20.12	11.24	14.20	14.79
Community/ Still Active		1382	1.78	6.51	23.67	13.02	21.30	33.73
Total	2.6	3650	0	0	0	0	0	100
10. Community		809	18.92	14.19	25.00	14.19	16.89	10.81
Facility		50	93.92	1.35	3.38	0.68	0.68	0
Community		224	66.22	13.51	12.16	5.41	2.03	0.68
Facility/Died		721	25.68	13.51	20.27	14.19	18.92	7.43
Total	2.3	1804	0	3.38	9.46	9.46	30.41	47.30

It should be noted that in the analysis that follows, states represent actual continuous time in a given state. For example, if someone is in a community state for three years, they actually received care for the three year period. A different approach is used in the analysis of Markovian modelling. In that approach states are recorded at one fixed point in time such as at the end of each fiscal year. Thus, someone who is in the community state for three years in the Markovian approach may have been in care in the community for three years. However, it is also technically possible for them to have moved to one of the other states and moved back to the original state within a given one year period. This is because one only records the state of a person at the end of each one year period.

As noted above, Table 4-1 presents the first layer of analysis, data on the 10 most common patterns of care using four states. The most common pattern (24.7 percent) was to be admitted to home/community care and to die. As can be seen, the average length of stay for persons in this pattern was 1,083 days or about three years. Almost one half of the people in this cohort died in the first two years. The second most common pattern was to enter home/community care, move to facility care and die. The average length of stay in the home/community phase and the residential phase were 874 and 875 days, respectively, for a total of 1,749 days in care (almost five years). The third most common pattern (9.5 percent) was to enter home/community care and to remain in care for the full 10 years of the study (3,650 days).

Table 4-2 presents the second layer of analysis, that is, data on the movement of clients across the five levels of care used in British Columbia (Personal Care (PC), Intermediate Care 1 (IC1), Intermediate Care 2 (IC2), Intermediate Care 3 (IC3) and Extended Care (EC)). It presents data on the 10 most common patterns of movement across care levels regardless of the type of care (home/community or residential). As can be seen, each of the patterns accounted for a fairly small proportion of care trajectories. The top three patterns were for clients at levels 1, 2 and 5 to enter care and die.

The final set of tables provide data on the third layer of analysis, that is, on both the type and level of care for the ten most common patterns. Initially, Adult Day Care services and Direct Care (professional home care nursing, PT and OT) were included as separate states. However, there are relatively few adult day care clients and there were relatively few clients who only received professional home based services over the long term. Thus, Adult Day Care and Direct Care clients have been merged into the community state, by level of care.

Table 4-3 provides data on the 10 most common care patterns by type and level of care. As can be seen from Table 4-3, even the most common patterns accounted for a very small proportion of all possible patterns. This clearly documents the fact, noted earlier, that there was no small number of common patterns of care.

Table 4-2: Service Utilization Patterns by Level of Care

Pattern[1]	Percent of Total Patterns[2]	Mean Length of Stay (Days)[3]	Percent Distribution of Length of Stay[4]					
			0-6 months	7-12 months	1-2 years	2-3 years	3-5 years	5-10 years
1. Level 1/ Died	6.9	984	10.48	15.95	21.18	15.95	20.73	15.72
2. Level 2/ Died	5.0	730	19.57	23.91	21.43	10.87	15.22	9.01
3. Level 5/ Died	4.7	1003	14.72	17.06	14.72	12.71	23.08	17.73
4. Level 1/ No Care	4.6	1716	0	6.06	18.18	8.75	21.55	45.45
5. Level 1		983	14.94	12.03	21.99	12.45	22.41	16.18
Level 2/ Died		516	32.78	16.18	22.82	18.26	7.47	2.49
Total	3.8	1499	3.32	6.22	16.60	9.54	29.05	35.27
6. Level 1/ Still Active	3.2	3650	0	0	0	0	0	100
7. Level 1		2221	0.65	1.94	7.10	5.81	13.55	70.97
Level 2/Still Active		1429	0.65	5.16	19.35	21.29	24.52	29.03
Total	2.4	3650	0	0	0	0	0	100

[1] Where clients were only in one state and either continued in care, died, or received no subsequent care, the statistics in this table are organized in one row which represents information about the initial state of the client. Where clients were in more than one state, the sequence of states is represented vertically and the row entitled 'Total' represents information on the total stay of the client in care.

[2] Figures in column two represent the percent of total patterns for clients overall.

[3] Where more than one state exists, the number for the 'Total' row, represents the vertical addition of the time spent in each state.

[4] Where more than one state exists, the row total represents the distribution of time for the overall length of stay.

Table 4-2 (continued)

Pattern	Percent of Total Patterns	Mean Length of Stay (Days)	Percent Distribution of Length of Stay					
			0-6 months	7-12 months	1-2 years	2-3 years	3-5 years	5-10 years
8. Level 3/ Died	2.4	646	17.53	27.27	20.78	16.23	12.99	5.19
9. Level 2		776	23.18	14.57	21.85	11.92	16.56	11.92
Level 3/ Died		458	40.40	21.19	17.88	8.61	8.61	3.31
Total	2.4	1235	5.96	11.26	18.54	17.22	19.21	27.81
10. Level 1		1021	5.11	13.14	23.36	18.98	24.82	14.60
Level 2		566	23.36	14.60	31.39	17.52	10.95	2.19
Level 3/ Died		394	39.42	24.09	21.90	7.30	4.38	2.92
Total	2.1	1981	0	0	7.30	10.95	28.47	53.28

Table 4-3: Service Utilization Patterns by Type and Level of Care - Overall

Overall								
Pattern[1]	**Percent of Total Patterns[2]**	**Mean Length of Stay (Days)[3]**	**Percent Distribution of Length of Stay[4]**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Community Level 1/ Died	6.6	984	10.40	16.08	21.28	15.84	20.57	15.84
2. Community Level 1/ No Care	4.6	1724	0	6.14	18.09	8.53	21.16	46.08
3. Community Level 2/ Died	3.7	650	21.76	24.69	23.01	9.62	14.64	6.28
4. Community Level 1/Still Active	3.2	3650	0	0	0	0	0	100
5. Facility Level 5/ Died	3.2	1123	9.76	17.07	11.22	13.66	27.32	20.98
6. Community Level 1		1032	13.30	11.17	21.28	12.77	24.47	17.02
Community Level 2/ Died		484	36.70	14.36	22.34	18.09	6.91	1.60
Total	2.9	1516	4.26	5.85	15.96	8.51	28.72	36.70

[1] Where clients were only in one state and either continued in care, died, or received no subsequent care, the statistics in this table are organized in one row which represents information about the initial state of the client. Where clients were in more than one state, the sequence of states is represented vertically and the row entitled 'Total' represents information on the total stay of the client in care.

[2] Figures in column two represent the percent of total patterns for clients overall.

[3] Where more than one state exists, the number for the 'Total' row, represents the vertical addition of the time spent in each state.

[4] Where more than one state exists, the row total represents the distribution of time for the overall length of stay.

Table 4-3 (continued)

Pattern	Percent of Total Patterns	Mean Length of Stay (Days)	Percent Distribution of Length of Stay					
			0-6 months	7-12 months	1-2 years	2-3 years	3-5 years	5-10 years
7. Community Level 1		2300	0.72	2.17	4.35	5.80	13.04	73.91
Community Level 2/Still Active		1350	0.72	5.80	21.01	22.46	23.91	26.09
Total	2.2	3650	0	0	0	0	0	100
8. Community Level 1		1055	0	6.74	40.45	14.61	22.47	15.73
No Care/ Died		841	19.10	17.98	12.36	16.85	25.84	7.87
Total	1.4	1896	0	0	6.74	8.99	30.34	53.93
9. Community Level 3/ Died	1.3	446	27.91	29.07	24.42	11.63	5.81	1.16
10. Community Level 2		709	26.39	13.89	22.22	13.89	13.89	9.72
Community Level 3/ Died		335	54.17	19.44	9.72	8.33	8.33	0
Total	1.1	1044	11.11	13.89	19.44	19.44	15.28	20.83

Table 4-4 presents the most common pattern for each of the 10 possible states (facility and community by the five levels of care) in this more detailed analysis. As can be seen, for each of the 10 starting states (e.g., community level 1, community level 2, facility level 3, etc.) the most common pattern was to enter that state and die. This is a striking finding and further research into why these results were obtained is clearly required. Part of the reason may be that clients enter into care due to some form of health crisis. As people admitted to continuing care are generally frail and elderly, the outcome of a health crisis may well be death. It would be important to find out what other factors may have contributed to these deaths. If there are delays in getting people into care, perhaps enhanced preventive initiatives would assist people in receiving care earlier and avoiding death.

Table 4-4: Most Common Pattern by Type and Level of Care

Level	% Community/Died	% Facility/Died
1	20.5	N/A
2	29.3	35.5
3	36.8	32.3
4	40.8	53.2
5	54.0	92.3

Detailed tables on patterns related to the type and level of care are presented in Appendix A. Table 1 in Appendix A provides data on patterns of care for people who started their care in the community, by level of care. For level one, none of the top 10 patterns of care include a move to facility. However, at higher starting levels of care, there is a general trend toward an increasing proportion of clients with patterns which involve moves to facilities.

Table 2 in Appendix A provides data on patterns of care for people who are initially admitted to facility care. While there were a few care patterns which involved people moving between facility care and community care, there were no top 10 patterns, at any level of care, for people going from facility care to community care. In the vast majority of cases, people who entered facility care remained in facility care.

Given that a significant proportion of people who started care in the 1987/88 and 1988/89 fiscal years died, we conducted a second set of analyses on people who did not die. Table 4-5 presents data on the 10 most common patterns, and the percentage of cases these patterns accounted for, for three levels of analysis: community/facility, level of care, and type and level of care. While the analysis comparing community and facility does indicate some degree of movement from community based services to facility care, the more detailed analysis of type and level of care indicates that most of the common care trajectories are for patterns within the community sector. This may be attributed to the relatively high percentage of clients who were admitted into care who were home care clients at level one. The data on levels of care, in Table 4-5, indicates that over a 10 year period relatively few clients moved more than one level of care. Finally, there are a relatively high proportion of clients in the no care group. Further research is required to determine what actually happened to these clients.

Table 4-5: Patterns of Care for Clients Who Did Not Die

Pattern Number	Patterns by Community/ Facility	Percent of Patterns	Pattern by Level of Care	Percent of Pattern	Patterns by Type and Level of Care	Percent of Pattern
1	Community/Still Active	28.7	Level 1/No Care	14.1	Community Level 1/No Care	13.9
2	Community/No Care	21.6	Level 1/Still Active	9.8	Community Level 1/Still Active	9.8
3	Community	15.4	Level 1	7.3	Community Level 1	6.5
	Facility/Still Active		Level 2/Still Active		Community Level 2/Still Active	
4	Community	8.0	Level 1	5.7	Community Level 1	2.8
	No Care		Level 2		Community Level 2	
	Community/Still Active		Level 3/Still Active		Community Level 3/Still Active	
5	Community	4.6	Level 2/No Care	2.5	Community Level 1	2.1
	No Care				No Care	
	Community/No Care				Community Level 1/No Care	
6	Community	3.0	Level 1	2.0	Community Level 1	1.8
	No Care		No Care		No Care	
	Facility/Still Active		Level 1/No Care		Community Level 1/Still Active	

Table 4-5 (continued)

Pattern Number	Patterns by Community/ Facility	Percent of Pattern	Pattern by Level of Care	Percent of Pattern	Patterns by Type and Level of Care	Percent of Pattern
7	Facility/Still Active	2.7	Level 2	2.0	Community Level 1	1.7
			Level 3/Still Active		Community Level 2	
					Community Level 3	
					Facility Level 3/Still Active	
8	Community	2.3	Level 1	1.8	Community Level 1	1.6
	No Care		Level 3/Still Active		Community Level 2/No Care	
	Community					
	Facility/Still Active					
9	Community	2.3	Level 2/Still Active	1.8	Community Level 1	1.0
	Facility/No Care				No Care	
					Community Level 2/Still Active	
10	Community	1.5	Level 1	1.8	Community Level 1	1.0
	Facility		No Care		Community Level 3/Still Active	
	Community		Level 1/Still Active			
	Facility/Still Active					

SECTION C: PREDICTING SERVICE UTILIZATION PATTERNS

5. A BRIEF EXPLANATION OF MARKOVIAN MODELLING

Markovian modelling begins with a predetermined list of possible states into which all clients are classified. From historical data, the probability that a client in state A moves to state B within one time period is computed. The set of all the probabilities of state-to-state moves is called the transition probability matrix. If one has computed these probabilities from the beginning (time zero) to the end of the first year, one can do a simple forecast of the number of clients in each state at the end of year 2 by simply applying this transition probability matrix to the number of people by state at the end of year 1.

For example, assume that at the end of year 1 there were sixty people who were WELL and forty people who were SICK of a non-fatal illness. By examining their states of health at the beginning (time zero) we find that over the course of the first year 80% of those who were WELL at the beginning stayed WELL while 20% became SICK. Of those who were SICK at the beginning, 60% became well and 40% stayed SICK. These probabilities can be arranged into the following transition probability matrix:

Table 5-1: Example of a Transition Probability Matrix

		TO	
		WELL	**SICK**
FROM	**WELL**	0.80	0.20
	SICK	0.60	0.40

To compute the number of people WELL or SICK at the end of year 2, we apply these probabilities to the number of people in each state at the end of year 1. So, of the 60 people who were WELL at the end of year 1, 80%, or 48 people, remain WELL and 20%, or 12 people become SICK. Of the 40 people who were SICK at the end of year 1, 60%, or 24 people, become WELL and 40%, or 16 people, stay SICK.

Thus, as noted in Table 5-2, at the end of year 2 there would be 72 WELL people and 28 SICK people. If one believes that the probability of people changing states remains constant over time, one can compute the number of people by state for years 3,4, etc. as noted above, each time building on the number of WELL and SICK people at the end of the previous period, but each time using the same probability matrix.

Table 5-2: Example of a Forecast by Markovian Analysis

	WELL	**SICK**
End of Year 1	60	40
End of Year 2	72	28
End of Year 3	74.4	25.6
End of Year 4	74.88	25.12

In this particular example in which nobody dies, a steady-state balance in the number of people in each of the two states is becoming evident by the end of year 3. The estimates made of the number in each state depends on the number of probability estimates. The more the number of states, the more the number of probabilities to be estimated. This is a simple example of an application of Markovian analysis as a forecasting tool. Whether one would choose to use this method or not would depend on the accuracy of forecasts made with it.

6. CLASSIFICATION OF CLIENTS IN THE BC CONTINUING CARE SYSTEM

In British Columbia, Canada, many long term care services are available through the government's Continuing Care System. Clients may be provided services either at home or in a facility. The six basic state codes in this study are noted in Table 6-1.

Table 6-1: Description of States

Code	Description
A	Adult Day Care
D	Home Nursing Care
ASSD NC	Assessed No Care
Expired	Dead
H	Home/homemaker
F	Facility

Both H and F were further divided into five levels requiring increasing care: level 1 for personal care, levels 2-4 for intermediate care, and level 5 for extended care. These five levels were assessed similarly for both home and facility care; so F2 would be “facility level 2” and H2 would be “home, or community, level 2.” This caused the total number of states to rise to 14. Table 6-2 presents an overview of the actual number of clients by state and year. The same data are presented schematically in Figure 6-1.

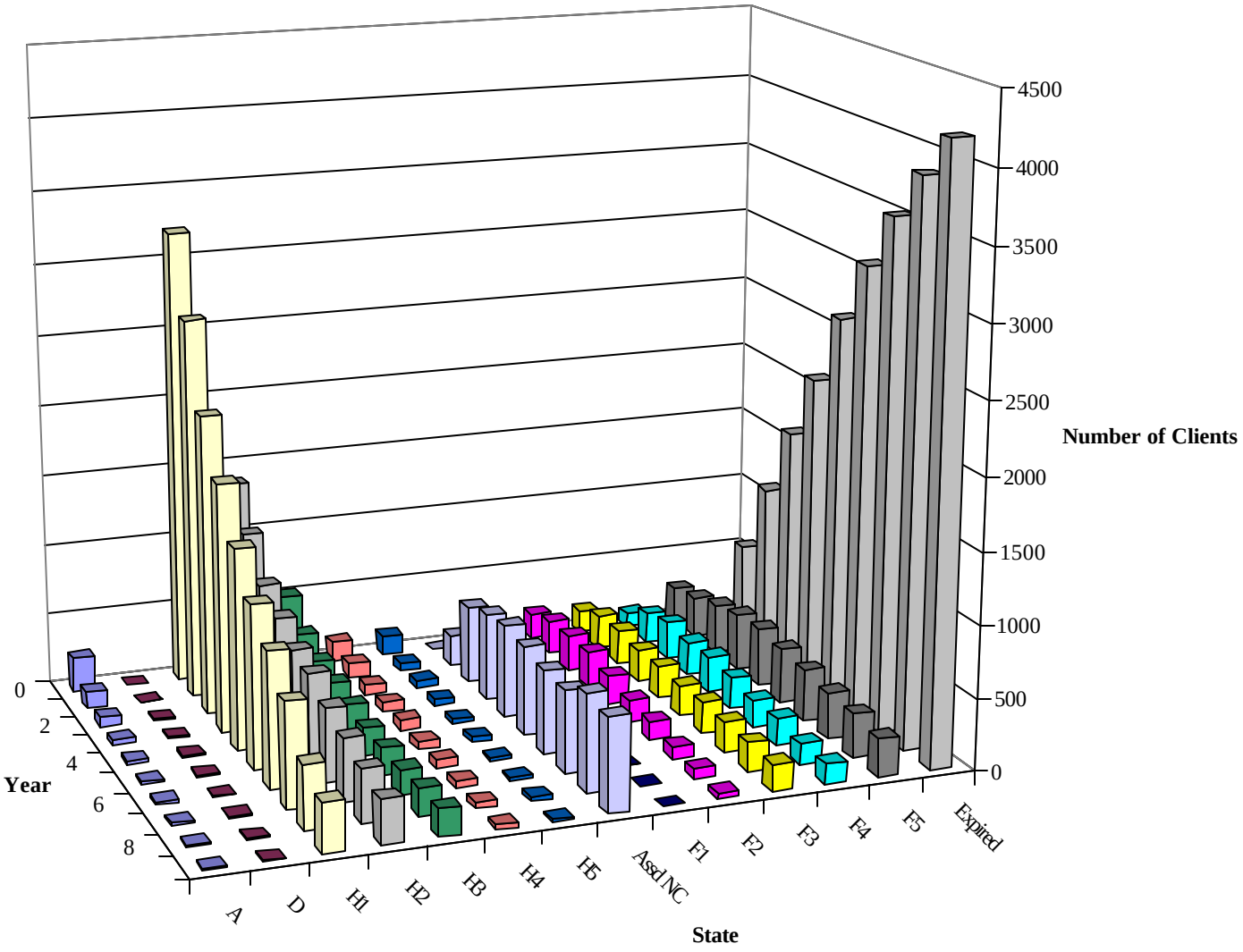
The first few years were years of rapid change while the last few years were times of modest change. This provides a more balanced test of the robustness of various forecasting methods.

Table 6-2: Actual Number of Clients by State and Year

	Year										
State	**0[1]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Average**
A	241	119	68	37	28	18	18	19	19	11	**57.8**
D	0	2	7	13	14	11	9	10	8	7	**8.1**
H1	3198	2676	2099	1740	1404	1135	941	731	449	337	**1471**
H2	1390	1128	880	758	658	617	511	438	367	306	**705.3**
H3	521	361	288	256	225	193	188	178	190	191	**259.1**
H4	139	106	69	70	72	53	57	51	38	34	**68.9**
H5	139	59	57	47	33	34	25	24	24	19	**46.1**
Assd NC	0	219	547	614	650	629	584	570	681	651	**514.5**
Expired	0	638	1172	1688	2172	2687	3130	3539	3880	4185	**2309.1**
F1	75	95	82	52	35	27	12	4	2	1	**38.5**
F2	177	238	253	255	203	154	134	92	70	44	**162**
F3	156	239	247	225	228	213	226	215	202	188	**213.9**
F4	99	213	265	235	250	226	190	190	148	143	**195.9**
F5	249	291	350	394	412	387	359	323	306	267	**333.8**
Total	**6384**	**6384**	**6384**	**6384**	**6384**	**6384**	**6384**	**6384**	**6384**	**6384**	**6384**

[1]Distribution at admission to care

Figure 6-1: Actual Number of Clients by State and Year



7. COMPARISON OF PREDICTIVE METHODS

A number of common forecasting techniques were chosen for comparison with Markovian analysis. The criterion used to compare the results was the weighted absolute percentage error. To illustrate this criterion, assume you had a two-state system at the end of year 2 with 40 people in state A and 60 in state B. Your forecast for the end of year 3 was 45 in state A and 55 in state B, but the actual numbers from your historical data were 47 and 53 , leading to errors of -4.4% and +3.64% respectively. If it is the size of the error which is important, but not the direction of the error, it is appropriate to do the evaluation based on the absolute value of the errors, 4.4% and 3.64%. When these are weighted by the number of people in each state initially and then divided by the total number of people ((4.4*40+3.64*60)/100), the result is the weighted absolute percentage error or, in this case, 3.96%.

The methods were evaluated on their forecast accuracy over the first six years.

The fifteen methods are briefly described below. The first nine non-Markovian methods only use the information on the number of clients in each state each year from Table 6-2. In general, these are popular simple forecasting methods.

1. "Same as last year." Each year, the forecast assumes that the number in each state will be identical to the number the previous year for that state.

2. "Two-year moving average." Starting in year 2, the forecast is the average of the previous two actual values. So, if at the beginning there were 1390 in state H2 and at the end of year 1 there were 1128, the forecast for the end of year 2 would be (1390+1128)/2 = 1259.

3. "Three-year moving average." Starting in year 3, the forecast is the average of the previous three actual values, So, if at the beginning, there 1390 in state H2, at the end of year 1 there were 1128, and at the end of year 2 there were 880, the forecast for the end of year 3 would be (1390+1128+880)/3 = 1132.7

4. "Same percentage change as last year." Starting in year 2, if the percentage gain was 11% between the beginning and the end of year 1, one would forecast an 11% gain to the end of year 2.

5. "Three-year trend." Starting in year 3, a linear regression was performed over the actual values in the previous three years. For year 3 this would be at the beginning, at the end of year 1 and at the end of year 2.

6. "Four-year trend." Starting in year 4, a linear regression was performed over the actual values in the previous four years. For year 4, this would be at the beginning, and at the ends of years 1-3.

7. "Two-year exponential smoothing, a=0.3." In exponential smoothing a new forecast depends on the previous forecast plus some adjustment for the error made in the previous forecast. The adjustment factor is a which has a value between 0.0 and 1.0. The forecaster tries various values

of a in order to find a best fit. For two-year exponential smoothing , the new forecast equals the previous forecast plus a x (the actual value last period - previous forecast). Thus if the previous forecast was low, this raises or smooths the value of the new forecast. In this case, the smoothing factor, a, is 0.3. So, if the actual value last period was 12 and the previous forecast was 10, the new forecast would be 10 + 0.3*(12-10) = 10.6.

8. "Two-year exponential smoothing, a=0.6."

9. "Two-year exponential smoothing, a=0.8."

The next six forecasting methods are Markovian methods, based on the transition probability matrices. Since we have nine years of actual data on 6384 individual clients, we were able to get actual transition probability matrices for each pair of adjacent years. Because there are so many states, 14 in all, the actual transition probability matrices are cumbersome. An example of the actual transition probability matrix from the beginning to the end of year 1 is provided in Appendix B. In this matrix, the probability of a client in H1 staying in H1 is 0.763.

10. "Same as last transition." Since the actual probability of a client in H1 staying in H1 the first year is 0.763, that same value is used as the forecast for the next year.

11. "Two-year moving average." Starting in year 3, since the actual probability of a client in H1 staying in H1 the first year is 0.763 and the actual probability in year two is 0.765, the forecast probability for year 3 would be 0.764.

12. "Three-year moving average." Starting in year 4, since the actual probability of a client in H1 staying in H1 the first year is 0.763, and the probabilities in years 2 and 3 are 0.765 and 0.793 respectively, the forecast probability for year 4 would be 773.7.

13. "Same percentage change in probability." If the probability of a client in H1, staying in H1 in the first transition probability matrix went up 20% in the second transition probability matrix, one would forecast the next probability to be 20% larger.

14. "Three-year regression." Starting in year 3, a linear regression would be performed for each transition probability through the last three actual data points. Initially, this would be at the beginning, the end of year 1, and the end of year 2. Since this would occasionally create negative values, the negative values were set to zero and the remaining values normalized to sum to 1.0 so there would be no shrinkage in the number of clients (recalling that expired patients comprise a state) over time.

15. "Four-year regression." Starting year 4, a linear regression would be performed for each transition probability through the last 4 actual data points. Initially, this would be at the beginning and at the end of the first 3 years. Since this would occasionally create negative values, the negative values would be handled as with the previous method.

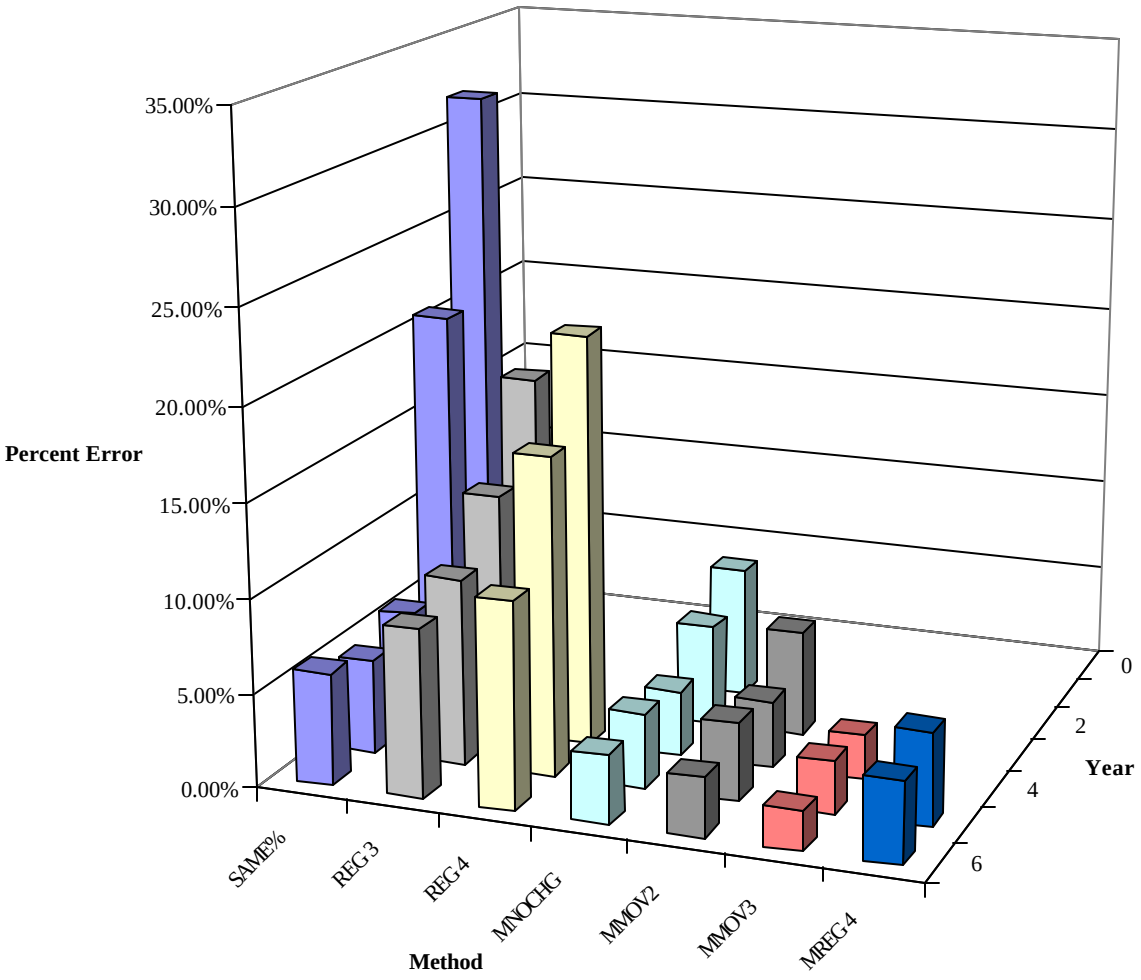
The results of the application of these methods to historical data for the first six years are shown in Table 7-1. The results for some of the best methods, based on average errors in the first six years, are shown in Figure 7-1.

Table 7-1: Prediction Method by Weighted Average Absolute Percent Error

		Year							
Prediction Method		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**Average Error**
1. Same as last year	**NOCHG**	n.a.	29%	29%	20%	18%	16%	15%	**21.2%**
2. 2-year moving avg	**MOV2**	n.a.	n.a.	46%	35%	28%	25%	23%	**31.4%**
3. 3-year moving avg	**Mov 3**	n.a.	n.a.	n.a.	58%	45%	36%	34%	**43.3%**
4. Same % change as last yr	**SAME%**	n.a.	n.a.	32%	21%	6%	5%	6%	**14.0%**
5. 3-year regression	**REG 3**	n.a.	n.a.	n.a.	18%	13%	10%	9%	**12.5%**
6. 4-year regression	**REG 4**	n.a.	n.a.	n.a.	n.a.	22%	17%	11%	**16.7%**
7. 2-yr exp smooth. Alpha=0.3	**ES0.3**	n.a.	n.a.	53%	60%	61%	58%	53%	**57.0%**
8. 2-yr exp smooth. Alpha=0.6	**ES0.6**	n.a.	n.a.	42%	37%	34%	29%	26%	**33.6%**
9. 2-yr exp smooth, Alpha=0.8	**ES0.8**	n.a.	n.a.	35%	27%	24%	21%	19%	**25.2%**
10. same as last transition	**MNOCHG**	n.a.	n.a.	7.0%	5.4%	3.5%	4.0%	3.6%	**4.7%**
11. 2-yr moving avg	**MMOV2**	n.a.	n.a.	n.a.	5.7%	3.6%	4.2%	3.1%	**4.1%**
12. 3-yr moving avg	**MMOV3**	n.a.	n.a.	n.a.	n.a.	2.4%	2.8%	2.1%	**2.4%**
13. Same %change in prob.	**MSAME%**	n.a.	n.a.	n.a.	8.0%	6.6%	6.0%	6.5%	**6.8%**
14. 3-yr regression	**MREG 3**	n.a.	n.a.	n.a.	n.a.	6.3%	3.6%	5.5%	**5.1%**
15. 4-yr regression	**MREG 4**	n.a.	n.a.	n.a.	n.a.	n.a.	5.0%	4.3%	**4.7%**

Figure 7-1: Better Forecasting Methods

SAME%	Same % change as last year
REG 3	3-year regression
REG 4	4-year regression
MNOCHG	Markovian - Same as last transition
MMOV2	Markovian - 2-year moving average
MMOV3	Markovian - 3-year moving average
MREG 4	Markovian - 4-year regression



The best four methods were all from the set of Markovian methods. Indeed, all six of the Markovian methods were better over the first six years than any of the non-Markovian methods. Within the set of Markovian methods, the three-year moving average method (#12) was best, followed by the two-year moving average (#11), the four year regression, (#15), and "same as last transition" (#10). All six Markovian methods had less than 7% average errors with the three-year moving average method having only a 2.4% average error.

Figure 7-1 shows the first six years of errors for the best four Markovian methods and the three best non-Markovian methods. The errors for all three of the non-Markovian methods decreased quickly after the first few years in which they were applied. Table 7-2 shows us the average error over years 7-9 for each of the 15 methods. These were years with modest changes in numbers in each state.

The top four methods are the same as they were for the first six years. Except for a switching of the 3rd and 4th best methods, their ranking is the same.

Table 7-2: Average Errors in Years 7-9

Year:		7	8	9	Average Error
1. Same as last year	**NOCHG**	14%	17%	11%	**14.0%**
2. 2-year moving avg	**MOV2**	23%	28%	21%	**24.0%**
3. 3-year moving avg	**Mov 3**	34%	41%	35%	**36.7%**
4. Same % change as last yr	**SAME%**	4%	8%	7%	**6.3%**
5. 3-year regression	**REG 3**	4%	9%	9%	**7.3%**
6. 4-year regression	**REG 4**	7%	8%	8%	**7.7%**
7. 2-yr exp smooth. Alpha=0.3	**ES0.3**	55%	63%	56%	**58.0%**
8. 2-yr exp smooth. Alpha=0.6	**ES0.6**	26%	31%	24%	**27.0%**
9. 2-yr exp smooth, alpha=0.8	**ES0.8**	19%	23%	16%	**19.3%**
10. same as last transition	**MNOCHG**	3.4%	7.3%	3.6%	**4.8%**
11. 2-yr moving avg	**MMOV2**	3.2%	7.7%	1.9%	**4.2%**
12. 3-yr moving avg	**MMOV3**	2.2%	5.1%	1.2%	**2.8%**
13. Same %change in prob.	**MSAME%**	6.1%	7.1%	8.8%	**7.3%**
14. 3-yr regression	**MREG 3**	3.8%	7.1%	5.5%	**5.5%**
15. 4-yr regression	**MREG 4**	2.9%	7.3%	4.4%	**4.9%**

8. CONCLUSIONS

In the research in Section B, it was initially expected that there would be four to six common trajectories or patterns of movement which would account for a significant portion of all patterns. It was also assumed that people would progress through the system of care in a certain logical manner, entering at a low level of care in the community, moving up one or two care levels, then moving to a facility where they would move up through one or two care levels and then pass away.

This was most definitely not the case. There was a very wide variety of care trajectories, none with a large percentage of the clients. Within the ten years of data available to us, the most common pattern was to enter the system at a given level and type of care and die without any changes in the level and type of care. The implications of these two results must be considered by clinicians, planners and policy makers.

For those who entered care in the community at level one, none of the top ten patterns of care included a move to a facility. However, at higher starting levels of care, there was more of a trend toward clients having patterns which involved moves to a facility. In the vast majority of cases, those who entered care in a facility remained in facility care until they passed away or until the end of the ten years of data available to us.

In the research in Section C, the small errors produced by the Markovian methods suggest that serious consideration should be given to implementation of these methods for practical decision making.

The higher ranking of the Markovian methods in contrast to the non-Markovian methods both in times of rapid change and in times of modest change shows the robustness of Markovian methods. Further testing would be useful to determine whether the superiority of the Markovian methods extended to forecasts two or more years ahead and whether it extends to more sophisticated Markovian techniques.

Markovian methods of analysis have sometimes been criticized because they require large amounts of data. The BC Continuing Care System is of sufficient size that this was not an issue in this study. Further testing should be done to establish whether effective forecasts can be made for smaller jurisdictions such as some of the Health Regions within British Columbia.

In terms of policy, further research is required to determine what factors led to the high proportion of deaths noted in this study. This is critical in order to determine if early intervention and admission to care may have saved lives. In terms of planning, this study indicates that Markovian modelling may be a preferred method of projecting future resource utilization in long term care and home care programs.

BIBLIOGRAPHY

Boult, C., Kane, R.L., Louis, T.A., & Ibrahim, J.G. (1991). Forecasting the Number of Future Disabled Elderly Using Markovian and Mathematical Models. *Journal of Clinical Epidemiology, 44*(9), 973-980.

Caro, J.J., & Huybrechts, K.F. (1999). Stroke Treatment Economic Model (Stemp): Predicting Long Term Costs from Functional Status. *Stroke, 30*(12), 2574-2579.

Chamberlayne, R.., Green, B., Barer, M.L., Hertzman, C.C., Lawrence, W.J., & Sheps, S.B. (1998). Creating a Population-based Linked Health Database: a New Resource for Health Services Research. *Canadian Journal of Public Health, 89*(4), 270-273.

Gillen, P., Spore, D. Mor, V. & Freiberger, W. (1996). Functional and Residential Status Transitions Among Nursing Home Residents. *Journals of Gerontology. Series A, Biological Sciences & Medical Sciences, 51*(1), M29-36.

Grover, S.A., Coupal, L., Zowall, H., Rajan, R., Trachtenberg, J., Elhilali, M., Chetner, M., & Goldenberg, L. (2000). The Clinical Burden of Prostate Cancer in Canada: Forecasts from the Montreal Prostate Cancer Model. *Canadian Medical Association Journal, 162*(7), 977-983.

Kinosian, B.P., Stallard, S., Lee, J.H., Woodbury, M.A., Zbrozek, A.S., & Glick, H.A. (2000). Predicting 10-year Care Requirements for Older People with Suspected Alzheimer's Disease. *Journal of the American Geriatrics Society, 48,* 631-638.

Lane, D., Uyeno, D., Stark, A., Gutman, G., & McCashin, B. (1987). Forecasting Client Transitons in British Columbia's Long-term Care Program. *Health Services Research, 22*(5), 671-706.

Lane, D., Uyeno, D., Stark, A., Kliewer, E., & Gutman, G. (1985). Forecasting Demand for Long-term Care Services. *Health Services Research, 20*(4), 435-460.

Appendix A:

Detailed Tables on Patterns of Utilization for Types and Levels of Care

Table 1: Service Utilization Patterns by Type and Level of Care - Home/Community

Pattern[1]	Percent of Total Patterns[2]	Mean Length of Stay (Days)[3]	Percent Distribution of Length of Stay[4]					
			0-6 months	7-12 months	1-2 years	2-3 years	3-5 years	5-10 years
1. Community Level 1/ Died	20.5	984	10.40	16.08	21.28	15.84	20.57	15.84
2. Community Level 1/ No Care	14.2	1724	0	6.14	18.09	8.53	21.16	46.08
3. Community Level 1/Still Active	10.0	3650	0	0	0	0	0	100
4. Community Level 1		1032	13.30	11.17	21.28	12.77	24.47	17.02
Community Level 2/ Died		484	36.70	14.36	22.34	18.09	6.91	1.60
Total	9.1	1516	4.26	5.85	15.96	8.51	28.72	36.70

[1] Where clients were only in one state and either continued in care, died, or received no subsequent care, the statistics in this table are organized in one row which represents information about the initial state of the client. Where clients were in more than one state, the sequence of states is represented vertically and the row entitled 'Total' represents information on the total stay of the client in care.

[2] Figures in column two represent the percent of total patterns for Home/Community clients.

[3] Where more than one state exists, the number for the 'Total' row, represents the vertical addition of the time spent in each state.

[4] Where more than one state exists, the row total represents the distribution of time for the overall length of stay.

Table 1 (continued)

Community Level 1 (cont.)								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
5. Community Level 1		2300	0.72	2.17	4.35	5.80	13.04	73.91
Community Level 2/Still Active		1350	0.72	5.80	21.01	22.46	23.91	26.09
Total	6.7	3650	0	0	0	0	0	100
6. Community Level 1		1055	0	6.74	40.45	14.61	22.47	15.73
No Care/ Died		841	19.10	17.98	12.36	16.85	25.84	7.87
Total	4.3	1896	0	0	6.74	8.99	30.34	53.93
7. Community Level 1		1056	8.82	14.71	19.12	13.24	26.47	17.65
Community Level 3/ Died		279	60.29	10.29	19.12	7.35	2.94	0
Total	3.3	1335	4.41	5.88	23.53	13.24	25.00	27.94
8. Community Level 1		1022	5.97	11.94	28.36	11.94	26.87	14.93
Community Level 2		568	28.36	13.43	25.37	16.42	13.43	2.99
Community Level 3/ Died		299	53.73	16.42	19.40	5.97	1.49	2.99
Total	3.2	1889	0	0	11.94	11.94	29.85	46.27

Table 1 (continued)

Community Level 1 (cont.)								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
9. Community Level 1		1838	1.69	3.39	11.86	6.78	25.42	50.85
Community Level 2		1053	8.47	16.95	16.95	13.56	25.42	18.64
Community Level 3/Still Active		759	3.39	11.86	44.07	20.34	18.64	1.69
Total	2.9	3650	0	0	0	0	0	100
10. Community Level 1		1084	0	9.09	38.64	13.64	22.73	15.94
No Care		680	22.73	18.18	22.73	13.64	18.18	4.55
Community Level 1/ No Care		737	22.73	9.09	29.55	4.55	29.55	4.55
Total	2.1	2501	0	0	2.27	0	9.09	88.64

Table 1 (continued)

Community Level 2								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Community Level 2/ Died	29.3	650	21.76	24.69	23.01	9.62	14.64	6.28
2. Community Level 2/Still Active		709	26.39	13.89	22.22	13.89	13.89	9.72
Community Level 3/ Died		335	54.17	19.44	9.72	8.33	8.33	0
Total	8.8	1044	11.11	13.89	19.44	19.44	15.28	20.83
3. Community Level 2/ No Care	5.8	1390	0	17.02	23.40	8.51	17.02	34.04
4. Community Level 2		498	36.11	13.89	33.33	5.56	8.33	2.78
Facility Level 2/ Died		611	30.56	13.89	16.67	22.22	13.89	2.78
Total	4.4	1109	8.33	16.67	13.89	19.44	22.22	19.44
5. Community Level 2/Still Active	3.7	3650	0	0	0	0	0	100
6. Community Level 2		834	0	13.79	34.48	27.59	20.69	3.45
No Care/ Died		683	41.38	10.34	17.24	6.90	13.79	10.34
Total	3.6	1517	0	0	27.59	20.69	17.24	34.48

Table 1 (continued)

Community Level 2 (cont.)								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
7. Community Level 2		591	20.00	12.00	44.00	4.00	16.00	4.00
Community Level 1/ Died		746	16.00	20.00	36.00	0	16.00	12.00
Total	3.1	1337	4.00	8.00	16.00	12.00	28.00	32.00
8. Community Level 2		501	17.39	17.39	39.13	26.09	0	0
Community Level 5/ Died		296	60.87	17.39	13.04	0	4.35	4.35
Total	2.8	797	8.70	26.09	17.39	21.74	17.39	8.70
9. Community Level 2		597	30.00	25.00	10.00	20.00	10.00	5.00
Community Level 4/ Died		155	75.00	10.00	15.00	0	0	0
Total	2.5	752	15.00	20.00	30.00	15.00	5.00	15.00
10. Community Level 2		575	15.00	25.00	30.00	15.00	10.00	5.00
Facility Level 2		746	30.00	5.00	20.00	15.00	20.00	10.00
Facility Level 3/ Died		382	40.00	30.00	15.00	5.00	10.00	0
Total	2.5	1703	0	0	10.00	15.00	35.00	40.00

Table 1 (continued)

Community Level 3								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Community Level 3/ Died	36.8	446	27.91	29.07	24.42	11.63	5.81	1.16
2. Community Level 3		431	39.29	17.86	17.86	17.86	7.14	0
Facility Level 3/ Died		680	25.00	21.43	14.29	21.43	7.14	10.71
Total	12.0	1111	3.57	10.71	17.29	28.57	28.57	14.29
3. Community Level 3		215	64.00	20.00	8.00	4.00	4.00	0
Facility Level 3		330	48.00	24.00	12.00	8.00	8.00	0
Facility Level 4		617	20.00	20.00	28.00	16.00	16.00	0
Facility Level 5/ Died		766	12.00	16.00	16.00	32.00	24.00	0
Total	10.7	1928	0	0	8.00	0	40.00	52.00
4. Community Level 3		467	37.50	12.50	31.25	6.25	12.50	0
Community Level 2/ Died		686	18.75	18.75	18.75	25.00	18.75	0
Total	6.8	1153	0	6.25	25.00	31.25	18.75	18.75

Table 1 (continued)

Community Level 3 (cont.)								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
5. Community Level 3		513	33.33	20.00	13.33	26.67	0	6.67
Community Level 4/ Died		244	66.67	13.33	6.67	6.67	6.67	0
Total	6.4	757	26.67	13.33	20.00	20.00	13.33	6.67
6. Community Level 3		295	53.33	20.00	20.00	0	6.67	0
Facility Level 3		645	20.00	20.00	6.67	33.33	20.00	0
Facility Level 4/ Died		453	33.33	20.00	20.00	20.00	6.67	0
Total	6.4	1393	0	0	20.00	20.00	33.33	26.67
7. Community Level 3		359	53.85	15.38	15.38	7.69	7.69	0
Community Level 5/ Died		142	69.23	23.08	7.69	0	0	0
Total	5.6	501	15.38	46.15	7.69	15.38	15.38	0
8. Community Level 3		194	69.23	15.38	7.69	7.69	0	0
Facility Level 3		421	46.15	15.38	23.08	7.69	0	7.69
Facility Level 5/ Died		531	61.54	7.69	7.69	0	15.38	7.69
Total	5.6	1146	7.69	15.38	7.69	30.77	15.38	23.08

Table 1 (continued)

Community Level 3 (cont.)								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
9. Community Level 3		611	7.69	38.46	30.77	7.69	7.69	7.69
Facility Level 5/ Died		877	38.46	7.69	15.38	0	15.38	23.08
Total	5.6	1488	0	15.38	15.38	15.38	7.69	46.15
10. Community Level 3		407	10.00	60.00	20.00	0	10.00	0
Community Level 4		159	70.00	20.00	10.00	0	0	0
Facility Level 4		498	30.00	20.00	30.00	0	20.00	0
Facility Level 5/ Died		705	30.00	20.00	20.00	10.00	10.00	10.00
Total	4.3	1769	0	0	0	30.00	10.00	60.00

Table 1 (continued)

Community Level 4								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Community Level 4/ Died	40.8	347	35.00	35.00	25.00	0	5.00	0
2. Community Level 4		224	60.00	20.00	13.33	0	6.67	0
Facility Level 4		608	40.00	6.67	20.00	20.00	6.67	6.67
Facility Level 5/ Died		960	40.00	0	13.33	0	20.00	26.67
Total	30.6	1792	6.67	0	6.67	6.67	40.00	40.00
3. Community Level 4		408	42.86	7.14	28.57	21.43	0	0
Community Level 5/ Died		145	71.43	14.29	14.29	0	0	0
Total	28.6	553	35.71	14.29	14.29	14.29	21.43	0

Table 1 (continued)

Community Level 5								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Community Level 5/ Died	54.0	361	42.55	27.66	17.02	6.38	6.38	0
2. Community Level 5		300	42.50	30.00	17.50	2.50	7.50	0
Facility Level 5/ Died		866	25.00	7.50	20.00	12.50	22.50	12.50
Total	46.0	1166	7.50	5.00	27.50	15.00	22.50	22.50

Table 2: Service Utilization Patterns by Type and Level of Care - Facilities

Facility Level 2								
Pattern[1]	**Percent of Total Patterns[2]**	**Mean Length of Stay (Days)[3]**	**Percent Distribution of Length of Stay[4]**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Facility Level 2/ Died	35.5	933	15.38	28.21	12.82	10.26	15.38	17.95
2. Facility Level 2		638	17.65	17.65	23.53	17.65	23.53	0
Facility Level 3		584	29.41	11.76	29.41	17.65	0	11.76
Facility Level 4/ Died		548	23.53	23.53	29.41	11.76	5.88	5.88
Total	15.5	1770	0	5.88	5.88	23.53	23.53	41.18
3. Facility Level 2		740	13.33	20.00	26.67	6.67	26.67	6.67
Facility Level 4/ Died		666	26.67	6.67	13.33	33.33	20.00	0
Total	13.6	1406	6.67	0	20.00	0	33.33	40.00

[1] Where clients were only in one state and either continued in care, died, or received no subsequent care, the statistics in this table are organized in one row w hich represents information about the initial state of the client. Where clients were in more than one state, the sequence of states is represented vertically and the row entitled 'Total' represents information on the total stay of the client in care.

[2] Figures in column two represent the percent of total patterns for Facility clients.

[3] Where more than one state exists, the number for the 'Total' row, represents the vertical addition of the time spent in each state.

[4] Where more than one state exists, the row total represents the distribution of time for the overall length of stay.

Table 2 (continued)

Facility Level 2 (cont.)								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
4. Facility Level 2/ Died		630	35.71	14.29	14.29	14.29	14.29	7.14
Facility Level 3/ Died		922	7.14	28.57	28.57	0	14.29	21.43
Total	12.7	1552	0	7.14	21.43	0	21.43	50.00
5. Facility Level 2		259	50.00	21.43	21.43	7.14	0	0
Facility Level 4		793	14.29	7.14	35.71	7.14	35.71	0
Facility Level 5/ Died		610	35.71	21.43	14.29	0	28.57	0
Total	12.7	1662	0	0	7.14	7.14	35.71	50.00
6. Facility Level 2		408	36.36	18.18	27.27	9.09	9.09	0
Facility Level 3		466	36.36	9.09	27.27	27.27	0	0
Facility Level 4		464	18.18	36.36	18.18	27.27	0	0
Facility Level 5/ Died		465	18.18	36.36	27.27	0	18.18	0
Total	10.0	1803	0	0	0	9.09	54.55	36.36

Table 2 (continued)

Facility Level 3								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Facility Level 3/ Died	32.3	753	6.25	31.25	18.75	21.88	12.50	9.38
2. Facility Level 3		370	35.71	21.43	25.00	17.86	0	0
Facility Level 4		639	21.43	17.86	25.00	21.43	10.71	3.57
Facility Level 5/ Died		762	28.57	14.29	10.71	14.29	21.43	10.71
Total	28.3	1771	3.57	0	10.71	17.86	14.29	53.57
3. Facility Level 3		495	19.05	38.10	14.29	19.05	9.52	0
Facility Level 4/ Died		480	38.10	19.05	14.29	14.29	14.29	0
Total	21.2	975	0	4.76	28.57	28.57	28.57	9.52
4. Facility Level 3		924	27.78	11.11	16.67	5.56	22.22	16.67
Facility Level 5/ Died		632	27.78	5.56	22.22	38.89	0	5.56
Total	18.2	1556	5.56	11.11	11.11	11.11	22.22	38.89

Table 2 (continued)

Facility Level 4								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Facility Level 4/ Died	53.2	792	24.24	18.18	15.15	18.18	12.12	12.12
2. Facility Level 4		850	27.59	6.90	17.24	24.14	13.79	10.34
Facility Level 5/ Died		827	17.24	10.34	17.24	13.79	37.93	3.45
Total	46.8	1677	0	10.34	3.45	13.79	31.03	41.38

Facility Level 5								
Pattern	**Percent of Total Patterns**	**Mean Length of Stay (Days)**	**Percent Distribution of Length of Stay**					
			0-6 months	**7-12 months**	**1-2 years**	**2-3 years**	**3-5 years**	**5-10 years**
1. Facility Level 5/ Died	92.3	1123	9.76	17.07	11.22	13.66	27.32	20.98
2. Facility Level 5/ Still Active	7.7	3650	0	0	0	0	0	100

Appendix B:

The Actual Transition Probability Matrix from the Beginning to the End of Year 1

The Actual Transition Probability Matrix from the Beginning to the End of Year 1

	A	D	H1	H2	H3	H4	H5	NC	Exp.	F1	F2	F3	F4	F5	Total
A	0.427	0.004	0.025	0.066	0.025	0.025	0.004	0.046	0.100	0.017	0.041	0.083	0.091	0.046	1.000
D	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
H1	0.001	0.000	0.812	0.056	0.012	0.003	0.001	0.041	0.048	0.009	0.009	0.003	0.002	0.002	1.000
H2	0.003	0.000	0.045	0.631	0.050	0.009	0.005	0.032	0.123	0.004	0.040	0.028	0.019	0.012	1.000
H3	0.008	0.000	0.013	0.075	0.430	0.050	0.008	0.033	0.175	0.004	0.023	0.106	0.046	0.031	1.000
H4	0.000	0.000	0.000	0.043	0.094	0.345	0.029	0.029	0.245	0.000	0.007	0.014	0.122	0.072	1.000
H5	0.014	0.000	0.014	0.058	0.043	0.022	0.281	0.022	0.288	0.000	0.007	0.022	0.000	0.230	1.000
Assd NC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
Expired	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	1.000
F1	0.000	0.000	0.000	0.027	0.000	0.000	0.000	0.013	0.080	0.720	0.133	0.013	0.013	0.000	1.000
F2	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.028	0.130	0.006	0.559	0.119	0.113	0.040	1.000
F3	0.006	0.000	0.000	0.000	0.013	0.000	0.000	0.006	0.122	0.000	0.109	0.481	0.212	0.051	1.000
F4	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.020	0.192	0.000	0.030	0.081	0.586	0.071	1.000
F5	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004	0.233	0.000	0.004	0.016	0.016	0.719	1.000