TIME TO TRANSFER FROM THE MI CHOICE HOME AND COMMUNITY BASED WAIVER TO NURSING HOME STAY: A SURVIVAL ANALYSIS

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Biostatistics- Master of Science

2015

ABSTRACT

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Survival analysis is an important statistics technique that is used to study time to events. This study explores the application of survival analysis on time to nursing home placement among the elderly who are enrolled at the MI Choice Home and Community Based Waiver program. Nursing homes are one of the major settings to provide long-term care for the elderly, however are associated with high expenditures in public and private sectors, and often cause psychological, social, physical issues for the elderly. The MI Choice Waiver program is a Michigan Medicaid program that allows the elderly to remain at home to receive long-term cares. One of the primary goals of this waiver program is to avoid unnecessary long-term nursing home placement. This study provided an overview of characteristics of elderly waiver enrollees. This study next identified the risk profiles of the waiver clients at the time of their waiver enrollment on the duration to long-term nursing home placement with death as the competing risk. This analysis further incorporated nurse and social worker assessments during the stay at the waiver program to assess the effect of the cumulative hospitalization and the change of health conditions on the time to long-term nursing home placement.

ACKNOWLEDGEMENTS

I sincerely thank my outstanding thesis committee members. Dr. William Charles (Bill) Given has provided me with numerous insight into the complexity of this study. He really opened the door of big data analysis to me, and provided me valuable opportunities to learn and work with health system data. I really appreciate his help and support in the past year. Dr. Chenxi Li has provided me the much needed guidance on statistical analysis. He is very sophisticated on statistical theory and application. And he is a great teacher. Dr. Dorothy R. Pathak provided me with guidance on the interpretation of the numerous findings from this study, as well as a lot of useful advice during my enrollment in the biostatistics program. I would also like to thank MSU Institute of Health Policy, Dr. Kathleen Oberst, Dr. Hong Su An, Dr. Zhiying You, Karen Smith and Sha Yuan. They really help me to understand the complicated health care system in US, as well as the context for the waiver program. I would also like to thank the Michigan Department of Community Health (MDCH) for the data. Thanks to the Department of Epidemiology and Biostatistics, especially the first cohort of the biostatistics program for their support during these two years of study. Last but not least, I would like to thank all my friends and family, especially the two lovely little ones, Franklin and Ethan who bring in energy and joy for my days.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Introduction

1.1 Introduction of survival analysis

Survival analysis is a common statistical technique that studies the time duration until events of interest take place. Survival analysis could apply to many fields, such as medicine, biology, epidemiology, economics, and public health [1]. Examples are death times among breast cancer patients, times to kidney infections among dialysis patients, times to divorce from date of marriage, time to death among the elderly in a retirement community [1]. In the case when study subjects are exposed to multiple potential causes results in the event of interest, competing risks need to be included into the analysis. For example, in the study of elderly, death often is the competing risk for the events of interest [2].

The data for survival analysis could start from a same or different time origin, and observation will make through the study period until the occurrence of events of interest or censoring. Censoring data takes place when the exact time for event of interest is unknown. For example, left censoring occurs when we only know an individual experiences event of interest prior to the start of the study, right censoring occurs when the event of interest occurs after the last available observation time, or interval censoring indicates that we only known that the event takes place within a time interval [1].

Several key concepts are involved in a survival analysis. Let X be the time until events occur. The survival function is the probability of the study subjects surviving (event free) beyond time x. It is defined as $S(x) = P\ (X > x)$. The survival function is a nonincreasing function with a value of 1 at the origin and 0 at the infinity. The

complement of survival function is the distribution function, defined as $F(x) = P\ (X \leq x) = 1 - S\ (x)$. The density function therefore is $f(x) = F'(x) = \frac{d\ F\ (x)}{dx} = -\frac{d\ S(x)}{dx}$. The hazard rate is the instantaneous risk of event taking place at time x given that it has not occurred before x. The hazard function is hazard rates' function of time, defined as $h(x) = \lim_{\Delta x \to 0} \frac{P\ [\ x \leq X < x+\Delta x\ |X \geq x]}{\Delta x}$. For a continuous random variable x, $h\ (x) = \frac{f\ (x)}{S\ (x)}$. Note that h (x) is not a probability and is always $h\ (x) \geq 0$. The cumulative hazard function H (x) is $H\ (x) = \int_0^x h(u)du$. The relationship between cumulative hazard function and survival function can be shown as

$$S\ (x) = \exp(-\int_0^x h\ (u)du) = \exp\big(-H(x)\big), \qquad so\ that\ \ H(t) = -\log S(x)$$

Hazard ratio is a type of relative risk which takes the ratio of hazard rates between the two levels of an explanatory variable at a certain time point.

1.2 Application of survival analysis to data from MI Choice waiver program

1.2.1 Growing elderly population and need for long-term care

More and more Americans need long term care as the elderly population is growing. In 2010, the number of people aged 65 reached 40.3 million, or 13% of the total population; and people aged 85 or older reached 5.8 million according to 2010 US census [3]. It is projected that people age 65 and older will comprise 20% of the total U.S. population and there will be 19 million people aged 85 or older in 2050 [4]. Due to the increasing population of elderly, the number of individuals using long-term care services in any settings is projected to increase to 27 million in 2050 compared to 13 million in 2000 according to US Census Bureau.

The elderly seek long-term care from three sources: 1) family and informal

caregivers (such as family members, partners, and friends), 2) home and community-based care, and 3) nursing facilities. With smaller family sizes and geographic dispersion of the elderly and their children, family care has become a more limited source for elderly care.

On the other hand, although the older population is increasing, the proportion of elderly living in nursing home (NH) has been dropping. According to the Census report in 2006, there were 1.8 million total nursing home residents in the US. The proportion of Americans aged 75 and older living in nursing homes decreased from 10.2% in 1990 and 8.1% in 2000 to 7.4% in 2006. Less than 16% of the population aged older than 85 was in nursing home in 2006, compared to 21% in that age group in 1985, according to the National Nursing Home Survey. Possible reasons for decreasing institutionalization may be better health of the elderly and more choices for long term care.

At the same time, trends toward community-based services as opposed to nursing home placement were the result of the Olmstead case. In 1999, the US Supreme Court upheld the right of individuals with disability to receive care and services in the community whenever possible. States are also directing greater resources to options of home and community-based long-term services. In 2007, National Medicaid spends 43% of long-term care expenditures on home- and community-based service compared to 13% in 1990 (Source: KCMU and Urban Institute analysis of HCFA/CMS-64 data. Includes all populations served, including elderly, disabled and MR/DD population)

1.2.2 Avoid unnecessary nursing home placement

Many efforts have been made to avoid unnecessary nursing home placement, as institutionalization may lead to psychological, social and physical burdens, as well as poor medical outcomes. Elderly may prefer to remain in the community. In 1999 June, Olmstead decision affirmed the right of individual with disabilities to live in their community as opposed to an institution whenever possible.

Nursing home care is very costly. The average cost of nursing home care is more than $67,000 a year and as high as $100,000 in some areas, according to the 2006 MetLife Market Survey of Nursing Home and Home Care Costs. As estimated in 2001, nursing home costs in the US were $98.9 billion per year, Medicaid paid $47.5 billion and Medicare paid $11.7 billion (Centers for Medicare and Medicaid services, 2003) [5].In 2005, Medicaid was the primary payment source for 65.4% of NH residents [6]. In 2010, a semi-private and a private room in nursing home cost $6235 per month and $6965 per month respectively[7].

The elderly who stay in nursing homes for short-term durations usually have different care/ goals from people who require long-term stays. Short-term nursing home stays (ST-NH) (weeks or a few months) are often related to rehabilitation from a hospital stay, recovery from illness, injury or surgery, or a terminal medical condition. ST-NH residents return to the community, transfer to long-term nursing home care or die after a short stay in the facility. Long-term nursing home (LT-NH) residents stay for many months or years, often related to chronic medical conditions, chronic severe pain, permanent disabilities, dementia, or long term need for help with daily activities or need for supervision. Among NH applicants from the community, about 42.7% will become permanent NH residents. The longer one stays in NH, the less likelihood for the patient

to return to the community [8-12]. Less than 10% of NH residents staying in a NH for 90 or more days will return to the community [13]. Many studies have used 90 days as the standard cutoff to distinguish short-term versus long-term nursing home stay. For example, Arling et al. [14], Muramatsu et al. [15], Kasper et al. (Kaiser Commission on Medicaid and the Uninsured 2007) , and Liu K et al. [16] defined long-term nursing home placement as of 90 days or longer stay.

1.2.3 MI Choice waiver program

The MI Choice Home and Community-based Services waiver was approved under section 1915 (c) of the Social Security Act by the Centers for Medicare & Medicaid Services (CMS). The 1915 (c) waiver is one of the state program options for Home and Community Based Services (HCBS), which allows states to provide long term care services in home and community based settings through the Medicaid Program. The MI Choice program, simply known as the waiver program, is run by the Medical Services Administration of the Michigan Department of Community Health. It started in1992 as the Home and Community Based Services for the Elderly and Disabled (HCBS/ED) waiver program. To be eligible, applicants need to meet income and asset criteria in order to receive Medicaid covered services. The eligible waiver participants usually are aged 65 and older, or disabled individuals aged 18 and older who meet a nursing facility level of care. All eligible clients must receive less than 300% of the supplemental security income level, and have less than $2,000 liquid assets. Eligible participants in the waiver, instead of going to nursing homes can remain at home and receive Medicaid-covered care services analogous to those provided in nursing homes. These services include transition services, living supports, nursing

serving and meals on wheels. The waiver participants also regularly receive social and medical assessments from health professionals. The waiver participants may exit the waiver program any time for reasons such as relocation out of state, nursing home placement or death.

1.2.4 Predictors for nursing home (NH) placement

One of the primary goals of waiver program is to provide long-term community-based care and avoid nursing home placement of elderly.

Andersen's framework has demonstrated the use of health service as an outcome of an individual's predisposing, enabling, and need characteristics [17]. Nursing home placement would be a function of individual's predisposing, enabling, and need characteristics in the Andersen's framework [17].

Luppa et al. [18] reviewed 36 studies of NH placement. Among those, at least 75% studies consistently show age, housing (not own house), ethnicity (white), self-rated health status (low), functional impairment, cognitive impairment, dementia, prior NHP, high number of prescriptions are predictors for NH placement with strong evidence; employment status (unemployed), low contracts in social network, low activity level, diabetes are predictors for NH placement with moderate evidence, and marital status with weak evidence. Inconsistent findings are shown with other potential predictors for NH placement: gender (male), living arrangement (living alone), education (low), income, stroke, hypertension, arthritis, respiratory diseases, incontinence, depression and previous hospitalization. It should be noted that majority of these studies used variables at baseline, and fail to not show the association between the change of baseline characteristics and risk of NH placement.

Similar findings were shown in another meta-analysis on 12 studies with logistic or Cox regression models [19]. In the Cox regression results, earlier NH placement is associated with older ages, ethnicity (white), health conditions (presentation of diabetes, high blood pressure, cancer, and stroke), and falls. Later NH placement is associated with being married, homeowner, female gender, and spouse present.

In addition, Tomiak et al [20] has demonstrated need factors including several specific medical conditions have great impact on nursing home placement in the elderly residents from Manitoba, Canada. Kasper et al. [21] studied the changes in the types of living arrangement could influence the timing for NH placement. Schulz et al. [22] shows that medication management service in a state Medicaid home and community-based waiver program could effectively reduce NH placement.

In summary, the predictors for NH placement suggested in the literatures could be categorized into predisposing, enabling, and need characteristics in the Andersen's framework [17]. Predisposing factors include demographics, social structures prior to the medical conditions, such as age, gender, and race. Enabling factors include ability to access medical care, such as income. Need factors include functions or health factors such as activities of daily living (ADL) and medical conditions. However, there is still limited evidence in the literatures on how utilization of hospital would influence long-term NH placement.

The specific aims of this study are:

Aim 1. Describe the characteristics of the MI Choice waiver elderly population including predisposing, enabling, and need factors.

Aim 2. Identify the predictive risk factors at the time of program enrollment for long-term nursing home transfer.

Aim 3. Assess how utilization of hospitalization and how change of the conditions of waiver elderly during their stay in the program impacts the duration to long-term NH placement.

2. Study design

The aims for this study are to describe the profiling of the elderly in MI choice waiver program and to identify the characteristics of waiver elderly that are associated with high risk of long term nursing home placement.

2.1 Study population

The study population is waiver program participants who are aged greater than 65 and have at least one enrollment during 10/1/2010 – 9/30/2014. We followed up the study population by tracing their activities reflected in the program eligibility data, assessment data and Medicaid claims data. If a waiver enrollee does not have nursing or social worker assessments within 30 days of waiver enrollment, he/she would be excluded from the study, as we're interested in the predictive ability of the baseline characteristics of participants, and assessment performed after 30 days since enrollment may reflect changes of baseline characteristics due to the waiver services activities.

2.2 Data source

Waiver program eligibility data, Medicaid eligible data, waiver social worker and nurse assessment data, and nursing home claim data are integrated for the survival analysis. Beneficiaries participating in the MI Choice (waiver) program are identified from program eligibility table from MI Choice data and Medicaid eligible data. Socio demographic data (such as age, gender, and race) and death date are obtained from Medicaid eligible tables. Waiver assessment including social worker and nursing assessment data are used to assess the socio-economic, medical conditions and hospital utilization of the participants. Waiver close status table from the MI Choice data

are used to identify closure of waiver programs. Medicaid nursing facility claims are linked to track the utilization of nursing home facility.

2.3 Identification of events

The event of interest is long-term nursing home (LT-NH) placement (> 90 days nursing facility stay). The waiver eligible individuals have been linked to nursing facility service claims data. Total Length of stay in a nursing facility is calculated. Length of stay longer than 90 days is used to distinguish short-term skilled nursing facility stay from custodial care long-term nursing home (LT-NH) stay.

The waiver elderly were observed since their first enrollment anytime between 10/1/2010 and 9/30/2014. Among 8232 waiver elderly, 812 (9.86%) entered long-term nursing home, and 2153 (26.15%) died during the observation period, 5267 (63.98%) were censored due to close of waiver program (16.29%), loss of follow up (1.18 %), end of study period (46.5%). Among those participants who are censored at the end of the study period, 98.3% (3762/3829) are still in the waiver program (Table 1).

Table 1. Events and censoring

Description			# of clients (%) N total=8232
Event of interest	Long term nursing home placement (LT-NH)		812 (9.86)
Competing risk	Death		2153 (26.15)
Censor (Non-LT-NH)	Closure of waiver program		1341 (16.29)
	Loss of follow-up		97 (1.18)
	End of study	Remain waiver	3762 (45.70)
		Non-waiver	67 (0.81)

Therefore, the study population can be divided into three main groups based on their outcomes, 1) long term nursing home placement (LT-NH) (total 812 waiver elderly,

9.86%), 2) death (total 2153 waiver elderly, 26.15%) , 3) censored (non-LT-NH) (total 5267 waiver elderly, 63.98%).

2.4 Selection of independent variables

Variables are chosen to represent predisposing, enabling and need characteristics of the waiver population. Predisposing variables describe factors such as demographics, social structures. Predisposing variables include age, gender, race, education, and marital status. Enabling variables describe ability to access medical care and help, such as living arrangement. Need characteristics are those variables that represent functional status or health conditions that require treatment. Need factors include activities of daily living (ADLs), instrumental activities of daily living (IADLs), and number of medications, specific medical conditions (such as cancer, diabetes, etc). Number of hospitalization is assessed using the information of number of overnight hospitalization in last 90 days in the assessment data.

2.5 Statistical analysis

The data for the following analysis are constructed using SAS 9.4. The nonparametric analysis is performed using SAS Macro %CIF. The Cox regression models with time fixed variables or time varying variables are performed using SAS PHREG procedure. The hazard ratios for all levels comparisons are obtained using the HAZARDRATIO statement in the SAS PHREG.

3. Descriptive statistics and nonparametric survival analysis

3.1 Cumulative incidence function (CIF) for survival analysis with competing risk

Analysis of cumulative incidence function (CIF) provides a useful overview for survival data with competing risks. Cumulative incidence function can be estimated nonparametrically using SAS Macro % CIF [23]. At the presence of competing risks, cause specific hazard function $h_k(t)$ describes the instantaneous rate of failure due to cause k given that subject did not fail from any causes before time t [23].

$$h_k(t) = \lim_{\Delta t \to 0} \frac{P\ (t < T < t + \Delta t, \delta = k | T \geq t)}{\Delta t}, k = 1,2,..,K$$

Cumulative incidence function $F_k(t)$describes the probability of failure due to cause k prior to time t.

$$F_k(t) = P\ (T\ \leq t, \delta = k), k = 1,2, \dots, K$$

And cumulative incidence function $F_k(t)$ can be estimated as[24]

$$F_k(t) = \sum_{t_j \leq t} \hat{S}_{(t_{j-1})} \frac{d_{kj}}{n_j}$$

To estimate the above, the cumulative hazard function $H_k(t)$for cause k can be estimated by the Nelson-Aalen estimator

$$\widehat{H_k}(t) = \sum_{t_j \leq t} \frac{d_{kj}}{n_j}$$

Where d_{kj} is number of failures due to cause k and n_j is number of subjects at risk at time t_j.

Overall survival function S (t) should use the overall survival Kaplan-Meier estimator $\hat{S}_{(t)}$ treating all causes of failures as failures. One important note for analysis of competing risk is that a Kaplan-Meier estimator with the competing risks as

censoring, $\widehat{S_k(t)} = \prod t_j \leq t \left(1 - \frac{d_{kj}}{n_n}\right)$, is not interpretable and should not be used to estimate cumulative incidence function[23].

To compare the effects of a certain variable on the cumulative incidence function, the null hypothesis is that cumulative incidence over time are the same across different levels of the variables. For example, to compare whether cumulative incidence of event k for female $F_k^F(t)$is different from cumulative incidence of event k for male $F_k^M(t)$, is to compare as $F_k^F(t) = F_k^M(t)$. This should be distinguished from comparing cause specific hazard of female and male, which is $h_k^F(t) = h_k^M(t)$. At the presence of competing risks, $h_k^F(t) = h_k^M(t)$ does not suggest $F_k^F(t) = F_k^M(t)$[23].

The following statement shows an example to use %CIF macro to perform the Grey's test for the difference of cumulative incidence functions of gender (group=gender, male vs. female) on time to nursing home (event=2).

%*CIF* (data=sur, time=time, status=status, event=2, censored=0, group=gender, options=plotcl nocifest);

3.2 Descriptive statistics on the profiles of waiver elderly

Table 2 describes the basic profiling of the study population and shows results from tests of cumulative incidence function among different levels of each variable. Approximately 70% of the waiver participants are aged older than 65. Among these waiver elderly, 74% are female, 74.5% are white, 67% are divorced or widowed or separated, 25% are living alone, 80% have hypertension, 66% have arthritis, 70% have incontinence, half of them have depression, 37% have mental function behavior. However, majority of them don't have disease of cancer (82%), Alzheimer (80%), diabetes (62%), stroke (74%), COPD (70%), dementia (62%), hip fracture (97%).

To compare the CIF among different levels of variables, Gray's tests are performed. The CIF for LT-NH is computed nonparametrically by treating LT-NH as the event and death as censored, while the CIF for death is computed nonparametrically by treating death as the event and LT-NH as censored. P value smaller than 0.05 will suggest that there is significant difference of CIF among different levels of a variable. For example, the CIF of LT-NH for clients are significant different among different races ($p<0.0001$).

Table 2. Characteristics of waiver elderly at the time of program enrollment

Characteristics		LT-NH #clients (col %)	Non-LT-NH #clients (col%)	Death #clients (col%)	Total #clients (col%)	Gray's Test for CIF of LT-NH (Chisq (p-value))	Gray's Test for CIF of Death (Chisq (p-value))
Age	65-74	220	1745	532	2497	3.19 (0.20)	77.7 (<.0001)
		27.09	33.13	24.71	30.33		
	75-84	323	1968	761	3052		
		39.78	37.36	35.35	37.07		
	85+	269	1554	860	2683		
		33.13	29.5	39.94	32.59		
Gender	Female	593	3980	1529	6102	0.82 (0.36)	19.79 (<.0001)
		73.03	75.56	71.02	74.13		
	Male	219	1287	624	2130		
		26.97	24.44	28.98	25.87		

Table 2 (cont'd)

Race		0	3	0	3	21.71 (<.0001)	95.9 (<.0001)
		0	0.06	0	0.04		
	Black	109	1247	255	1611		
		13.42	23.68	11.84	19.57		
	Other	35	328	122	485		
		4.31	6.23	5.67	5.89		
	White	668	3689	1776	6133		
		82.27	70.04	82.49	74.50		
Marital Status		63	265	170	498	4.57 (0.10)	14.33 (0.0008)
		7.76	5.03	7.9	6.05		
	Never married	58	443	126	627		
		7.14	8.41	5.85	7.62		
	Divorced/widowed/separated	518	3566	1421	5505		
		63.79	67.7	66	66.87		
	married	173	993	436	1602		
		21.31	18.85	20.25	19.46		
Living arrangement		80	473	156	709	5.37 (0.07)	68.6 (<.0001)
		9.85	8.98	7.25	8.61		
	alone	204	1394	400	1998		
		25.12	26.47	18.58	24.27		
	With non-relatives	271	1432	826	2529		
		33.37	27.19	38.37	30.72		
	With relatives (spouse/ child/ other relatives)	257	1968	771	2996		
		31.65	37.36	35.81	36.39		
Hypertension		8	43	23	74	0.45 (0.50)	1.26 (0.26)
		0.99	0.82	1.07	0.90		
	Not-present	162	998	425	1585		
		19.95	18.95	19.74	19.25		
	Present	642	4226	1705	6573		
		79.06	80.24	79.19	79.85		

Table 2 (cont'd)

Arthritis		9	47	26	82	2.19 (0.14)	13.6 (0.0002)
		1.11	0.89	1.21	1.00		
	Not-present	284	1674	765	2723		
		34.98	31.78	35.53	33.08		
	Present	519	3546	1362	5427		
		63.92	67.32	63.26	65.93		
COPD (Chronic obstructive pulmonary disease)		10	51	25	86	6.79 (0.009)	75.1 (<.0001)
		1.23	0.97	1.16	1.04		
	Not-present	606	3825	1391	5822		
		74.63	72.62	64.61	70.72		
	Present	196	1391	737	2324		
		24.14	26.41	34.23	28.23		
Incontinence (bowel/bladder)		8	54	27	89	0.989 (0.32)	13.7 (0.0002)
		0.99	1.03	1.25	1.08		
	Not-present	190	1473	474	2137		
		23.4	27.97	22.02	25.96		
	Present	614	3740	1652	6006		
		75.62	71.01	76.73	72.96		
Hip Fracture		8	51	26	85	1.41 (0.24)	1.42 (0.23)
		0.99	0.97	1.21	1.03		
	Not-present	795	5132	2088	8015		
		97.91	97.44	96.98	97.36		
	Present	9	84	39	132		
		1.11	1.59	1.81	1.60		
Cancer		38	168	78	284	2.17 (0.14)	86.6 (<.0001)
		4.68	3.19	3.62	3.45		
	Not-present	678	4436	1672	6786		
		83.5	84.22	77.66	82.43		
	Present	96	663	403	1162		
		11.82	12.59	18.72	14.12		
Diabetes		10	46	25	81	2.12(0.15)	9.19 (0.0024)
		1.23	0.87	1.16	0.98		
	no	485	3267	1389	5141		
		59.73	62.03	64.51	62.45		
	yes	317	1954	739	3010		
		39.04	37.1	34.32	36.56		

Table 2 (cont'd)

Stroke		37	170	77	284	0.004 (0.95)	2.76 (0.096)
		4.56	3.23	3.58	3.45		
	Not-present	587	3865	1594	6046		
		72.29	73.38	74.04	73.45		
	Present	188	1232	482	1902		
		23.15	23.39	22.39	23.10		
Depression		11	46	26	83	8.67 (0.003)	0.34 (0.56)
		1.35	0.87	1.21	1.01		
	Not-present	368	2759	1089	4216		
		45.32	52.38	50.58	51.21		
	Present	433	2462	1038	3933		
		53.33	46.74	48.21	47.78		
Alzheimer		9	46	25	80	3.14 (0.076)	2.64 (0.10)
		1.11	0.87	1.16	0.97		
	Not-present	683	4612	1830	7125		
		84.11	87.56	85	86.55		
	Present	120	609	298	1027		
		14.78	11.56	13.84	12.48		
Dementia		9	45	23	77	7.98 (0.0047)	1.25 (0.26)
		1.11	0.85	1.07	0.94		
	Not-present	462	3353	1298	5113		
		56.9	63.66	60.29	62.11		
	Present	341	1869	832	3042		
		42	35.49	38.64	36.95		
Mental function		8	56	27	91	7.587 (0.0059)	12.46 (0.0004)
		0.99	1.06	1.25	1.11		
	No behavior present	462	3348	1256	5066		
		56.9	63.57	58.34	61.54		
	Behavior present	342	1863	870	3075		
		42.12	35.37	40.41	37.35		
* Blanks are missing values							

3.3 Nonparametric analysis of cumulative incidence for LT-NH placement and death

Nonparametric cumulative incidence over time gives an overview on the occurrence of events over time for subjects with different profiling. Table 3 summarizes the significant factors for increased cumulative incidence. White people, absence of

COPD, presence of depression, dementia and mental disorder are significantly associated with higher cumulative incidence for LT-NH placement over time (Table 3 and Figure 1). Age greater than 85, male, being white and other race compared to black, being married or separated compared to never married, living with others or relatives compared to living alone, presence of COPD, incontinence, cancer, presence of mental functions are significantly associated with higher cumulative incidence of death (Table 3) .The increased cumulative incidence of LT-NH placement for waiver elderly with no COPD than those with COPD could be due to the competing risk of death. Waiver elderly with COPD died before their chance to get into LT-NH. The similar scenario for COPD has been found in the later analysis.

Table 3. Summary of significant factors for higher cumulative incidence function (nonparametric method)

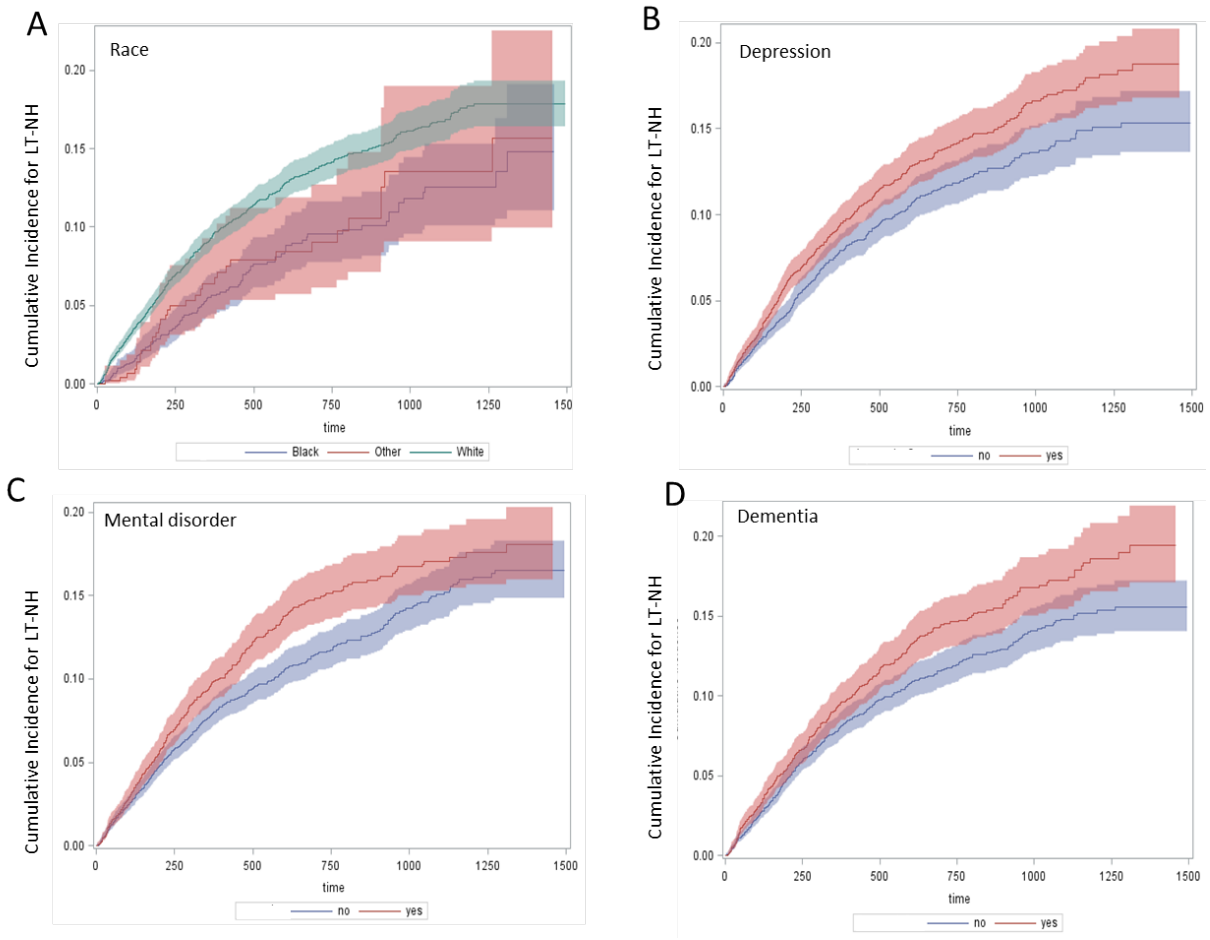
Significant risk factors for higher CIF of long-term nursing home placement	Significant risk factors for higher CIF of death
	Age (85+)
	Gender (M)
Race (White)	Race (White and other vs. Black)
	Marital Status (Yes and other vs. no)
	Living arrangement (other vs. relative vs. alone)
	Arthritis (NOT present)
COPD (NOT present)	COPD (present)
	Incontinence (present)
	Cancer (present)
	Diabetes (NOT present)

Table 3 (cont'd)

Depression (present)	
Dementia (present)	
Mental disorders (Behavior present)	Mental disorders (Behavior present)

Here are some examples on the cumulative incidence of long-term nursing home placement by different profiles. Cumulative incidence at time t measures the probability of having events prior to time t. For example, about 17% of the waiver elderly who have presented mental function behavior at the baseline will experience LT-NH placement by day 900 since enrollment, while about 14% of the waiver elderly without mental function behavior will experience LT-NH placement for the same length of time (Figure 1). The color area indicates 95% confidence interval of the corresponding cumulative incidence curve. Note that estimators from this nonparametric method have not adjusted for other variables such as age, race. Mental functions, which are assessed by the social worker, describe whether behaviors related to mental disorder in perception, memory, thinking, emotion are present. Dementia which affected memory, attention, problem solving are recorded in the nurse assessment for the disease diagnosis. Mental functions and dementia reflect similar conditions for the waiver clients however from different perspectives. The presence of mental functions behavior and the diagnosis of dementia are associated with greater cumulative incidence of nursing home placement.

Figure 1. Nonparametric analysis of cumulative incidence for long-term nursing home placement



3.4 Summary of activities of daily living (ADLs) and instrumental activities of daily living (IADLs) and their relationship

Besides socio demographic and disease conditions, literatures also suggest that ADLs and IADLs predicts nursing home placement [5, 25-27] . ADLs and IADLs are often used to assess the extent of disability of elderly and their dependency of living at home and community. ADLs and IADLs profiles are described here for the elderly waiver. ADLs refer to basic daily self-care activities. Total nine items of ADLs are assessed among waiver elderly shown in the table 4. IADLs refer to activities that

people perform beyond their basic function, such as shopping, housework, which allows an individual live independently in a community. Total eight items of IADLs are assessed as shown in the table 5. Many elderly could live independently with good ADLs while they need help with some items of IADLs.

Table 4 and 5 illustrate the profiling of ADLs and IADLs for the waiver participants, ordered by the percentage of dependency in the study population. More than half of the waiver elderly need help for bathing, dress, transfer among surfaces, toilet use, while 11% of the waiver participants need assistance for eating. Majority of waiver elderly need help with most of the IADL's. More than 90% of the waiver participants need assistance to perform housework, shopping, transportation, meal preparation and stairs use, while phone use is activity with least dependency. Moreover, the proportion of dependency on ADLs or IADLs is increasing with increased age. This would indicate the importance of adjusting for age when assessing effect of ADLs and IADLs on LT-NH placement.

Table 4. Activities of daily living (ADLs) by age

ADLs (total 9 items) (ordered by the % of dependency among the population)		Age			
		65-74	75-84	85+	Total
Bathing	.	25	42	19	86
		1	1.38	0.71	1.04
	0	530	594	364	1488
		21.23	19.46	13.57	18.08
	1	1942	2416	2300	6658
		77.77	79.16	85.72	80.88
Dress	.	26	41	18	85
		1.04	1.34	0.67	1.03
	0	905	1113	836	2854
		36.24	36.47	31.16	34.67

Table 4 (cont'd)

	1	1566	1898	1829	5293
		62.72	62.19	68.17	64.30
Mobility Transferring (moving to and between surfaces)	.	26	40	17	83
		1.04	1.31	0.63	1.01
	0	1003	1216	956	3175
		40.17	39.84	35.63	38.57
	1	1468	1796	1710	4974
		58.79	58.85	63.73	60.42
Toilet Use (how uses the toilet room)	.	25	41	18	84
		1	1.34	0.67	1.02
	0	1198	1385	1062	3645
		47.98	45.38	39.58	44.28
	1	1274	1626	1603	4503
		51.02	53.28	59.75	54.70
Toilet Transfer (moving on and off toilet)	.	26	40	17	83
		1.04	1.31	0.63	1.01
	0	1241	1450	1170	3861
		49.7	47.51	43.61	46.90
	1	1230	1562	1496	4288
		49.26	51.18	55.76	52.09
Manage personal hygiene	.	25	43	20	88
		1	1.41	0.75	1.07
	0	1527	1692	1329	4548
		61.15	55.44	49.53	55.25
	1	945	1317	1334	3596
		37.85	43.15	49.72	43.68
Moves between locations (locomotion-how moves between locations on same floor)	.	26	41	18	85
		1.04	1.34	0.67	1.03
	0	1546	1849	1524	4919
		61.91	60.58	56.8	59.75
	1	925	1162	1141	3228
		37.04	38.07	42.53	39.21
Mobility in bed (how changes of lying positions, etc: turns from side to side)	.	26	40	20	86
		1.04	1.31	0.75	1.04
	0	1613	2012	1688	5313
		64.6	65.92	62.91	64.54
	1	858	1000	975	2833
		34.36	32.77	36.34	34.41

Table 4 (cont'd)

Eat	.	25	42	17	84
		1	1.38	0.63	1.02
	0	2255	2683	2317	7255
		90.31	87.91	86.36	88.13
	1	217	327	349	893
		8.69	10.71	13.01	10.85
* 0 indicates independent (independent, independent with setup help, supervision); 1 indicates dependence with assistance to different extent; . indicates missing.					

Table 5. Instrumental activities of daily living (IADLs) by age

IADLs Performance (total 8 items) (ordered by the % of dependency)		Age			
		65-74	75-84	85+	Total
Housework	.	24	41	17	82
		0.96	1.34	0.63	1.00
	0	37	37	25	99
		1.48	1.21	0.93	1.20
	1	2436	2974	2641	8051
		97.56	97.44	98.43	97.80
Shopping	.	26	42	17	85
		1.04	1.38	0.63	1.03
	0	53	52	17	122
		2.12	1.7	0.63	1.48
	1	2418	2958	2649	8025
		96.84	96.92	98.73	97.49
Transportation	.	25	42	20	87
		1	1.38	0.75	1.06
	0	114	86	34	234
		4.57	2.82	1.27	2.84
	1	2358	2924	2629	7911
		94.43	95.81	97.99	96.10
Meal preparation	.	24	42	17	83
		0.96	1.38	0.63	1.01
	0	146	134	93	373
		5.85	4.39	3.47	4.53
	1	2327	2876	2573	7776

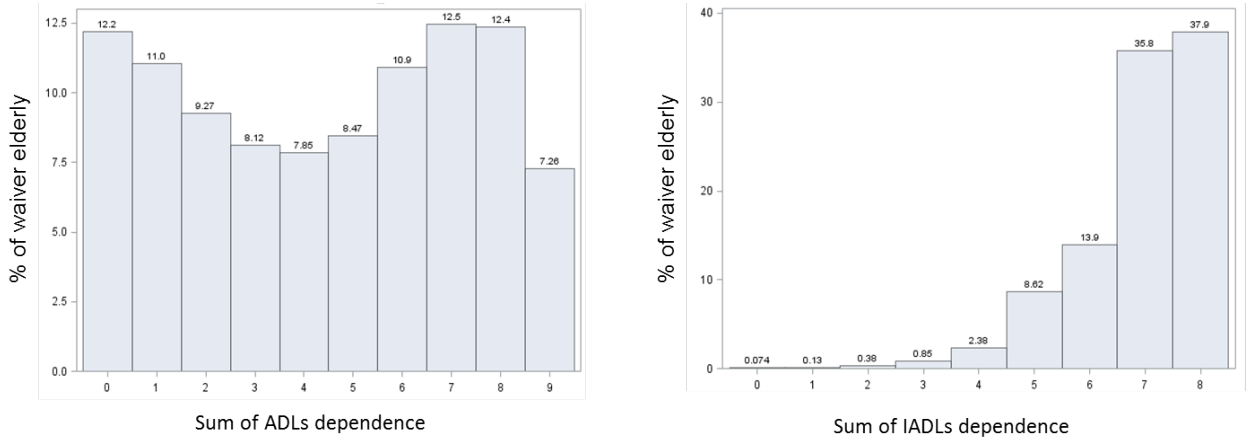
Table 5 (cont'd)

		93.19	94.23	95.9	94.46
Stair use	.	25	43	18	86
		1	1.41	0.67	1.04
	0	209	295	178	682
		8.37	9.67	6.63	8.28
	1	2263	2714	2487	7464
		90.63	88.93	92.69	90.67
Manage Finance	.	25	42	18	85
		1	1.38	0.67	1.03
	0	624	369	166	1159
		24.99	12.09	6.19	14.08
	1	1848	2641	2499	6988
		74.01	86.53	93.14	84.89
Manage Medication	.	26	42	17	85
		1.04	1.38	0.63	1.03
	0	611	488	262	1361
		24.47	15.99	9.77	16.53
	1	1860	2522	2404	6786
		74.49	82.63	89.6	82.43
Phone Use	.	26	42	19	87
		1.04	1.38	0.71	1.06
	0	1739	1715	1211	4665
		69.64	56.19	45.14	56.67
	1	732	1295	1453	3480
		29.32	42.43	54.16	42.27
* 0 indicates independent (independent, independent with setup help, supervision); 1 indicates dependence with assistance to different extent; . indicates missing.					

Sum score of ADLs and sum score of IADLs were calculated respectively by summing the number of ADLs items of dependency or summing of the number of IADLs items of dependency. For example, if a waiver elderly need assistant for bathing and toilet use but is independent for the other 7 items of ADLs, this waiver elderly has the sum of ADLs of 2. About 12.2% of waiver elderly can independently perform all 9 items of ADLs, their sum scores of ADLs therefore are 0; while approximate half of the waiver

elderly have more than 5 ADL's items dependent on help, and their sum scores of ADLs are 5 or larger. For IADLs performance, 90% of waiver elderly need assistance for more than 4 IADLs performance (Figure 2), their sum scores of IADLs are 4 or larger.

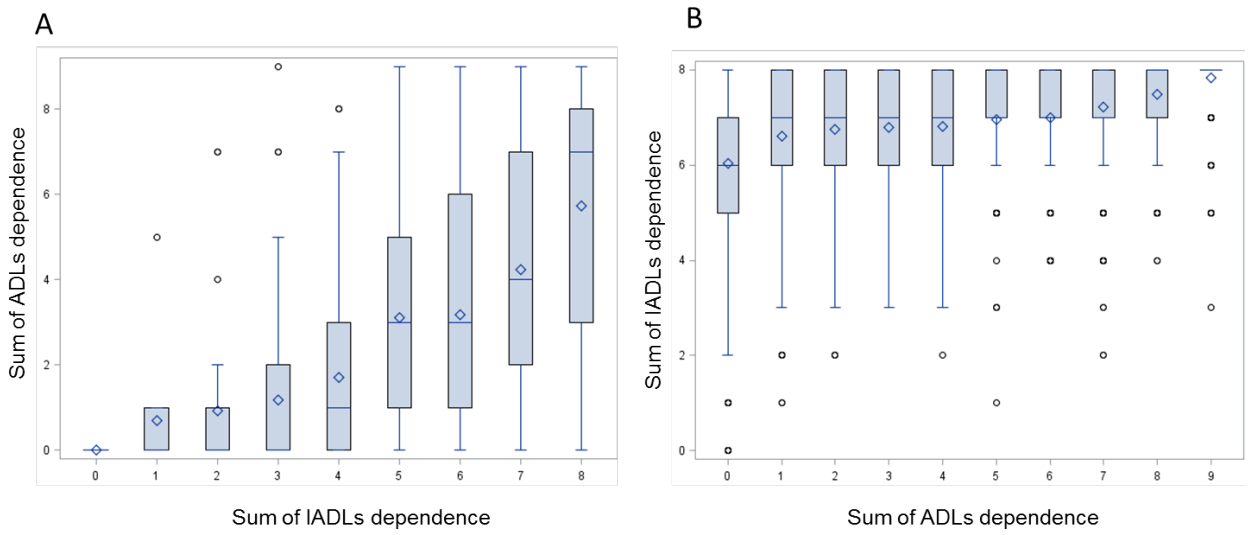
Figure 2. The distribution of sum ADLs and sum IADLs for the waiver elderly



To illustrate the relationship between IADLs and ADLs, Figure 3A and 3B respectively shows the possible distribution of total score of ADLs for a waiver elderly with a certain sum score of IADLs, and the distribution of total score of IADLs for a waiver elderly with a certain sum score of ADLs. The average of sum score of ADLs is positively correlated with the sum score of IADLs, while the average of sum score of IADLs generally remain high regardless of the sum score of ADLs (Figure 3A).In another word, the sum scores of IADLs do not depend on the sum score of ADLs. For example, for a waiver elderly with sum IADLs score of 0, he/she will have sum score of ADLs of 0 (Figure 3 A); for a waiver elderly with sum ADLs score between 1 to 4, they are expected to have an average sum score of IADLs of 7 (Figure 3B). These suggest that waiver elderly who are able to perform IADLs without assistance tend to be capable

for all ADLs; waiver elderly who are incapable of one or more ADLs usually need assistance to perform most of the IADLs (more than 7 items of IADLs).

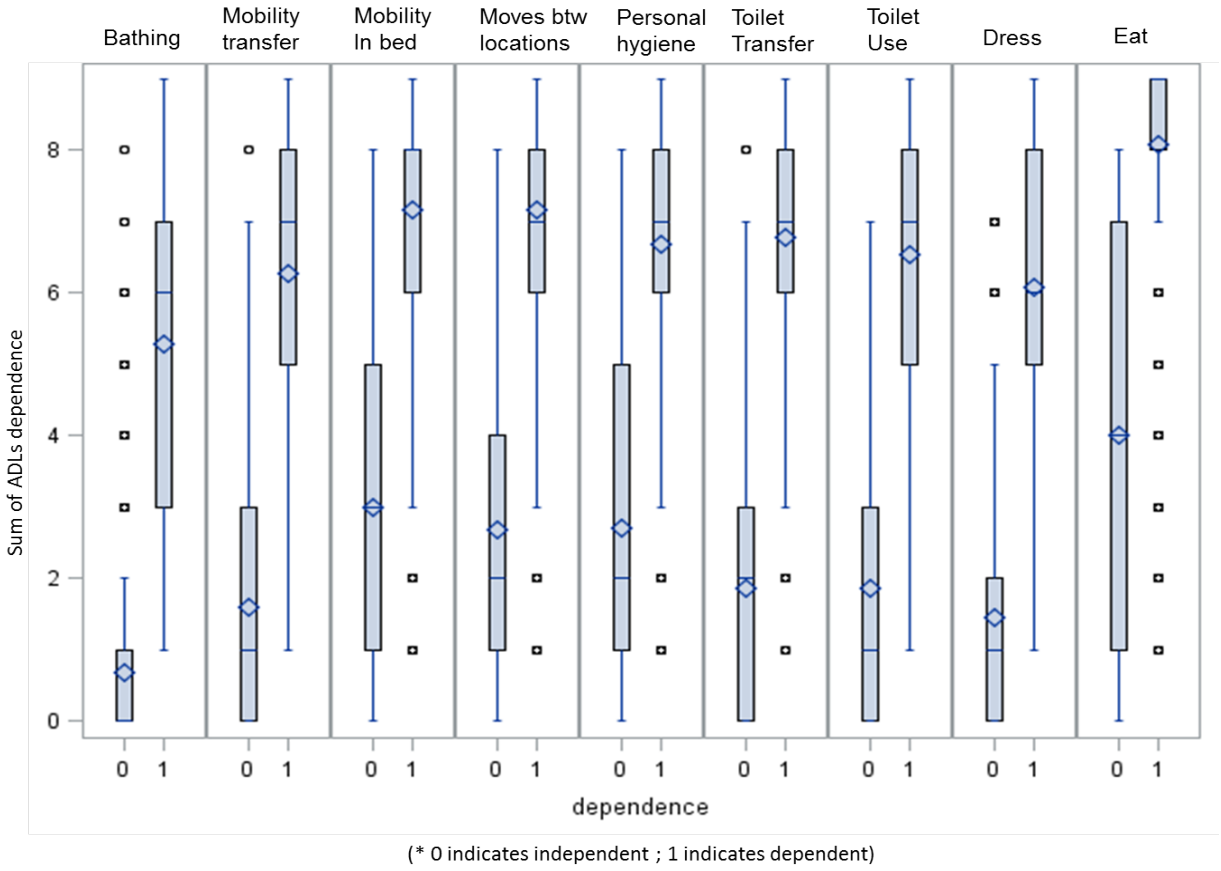
Figure 3. Relationship between sum ADLs and sum IADLs



Previous study has suggested hierarchical relationship among ADLs and IADLs, although not all activities are assessed in the previous study, the hierarchical order has been suggested: shopping, transportation, bathing, dressing, transferring and feeding [28]. To illustrate the hierarchical relationship among different ADLs for the waiver elderly population, the distribution of sum score of ADLs on each separate ADLs' item among the waiver elderly is analyzed. Among those ADLs items, incapability of eating shows extremely high sum score of ADLs (Figure 4), which may suggest that inability of eating are highly associated with low capability for other items of ADLs. In contrast, being able to bath independently shows a low sum score of ADLs (Figure 4), which suggests that ability of bathing independently indicates higher ability of other items of ADLs. Whether an elderly could bath or eat therefore may indicate his/her ability to

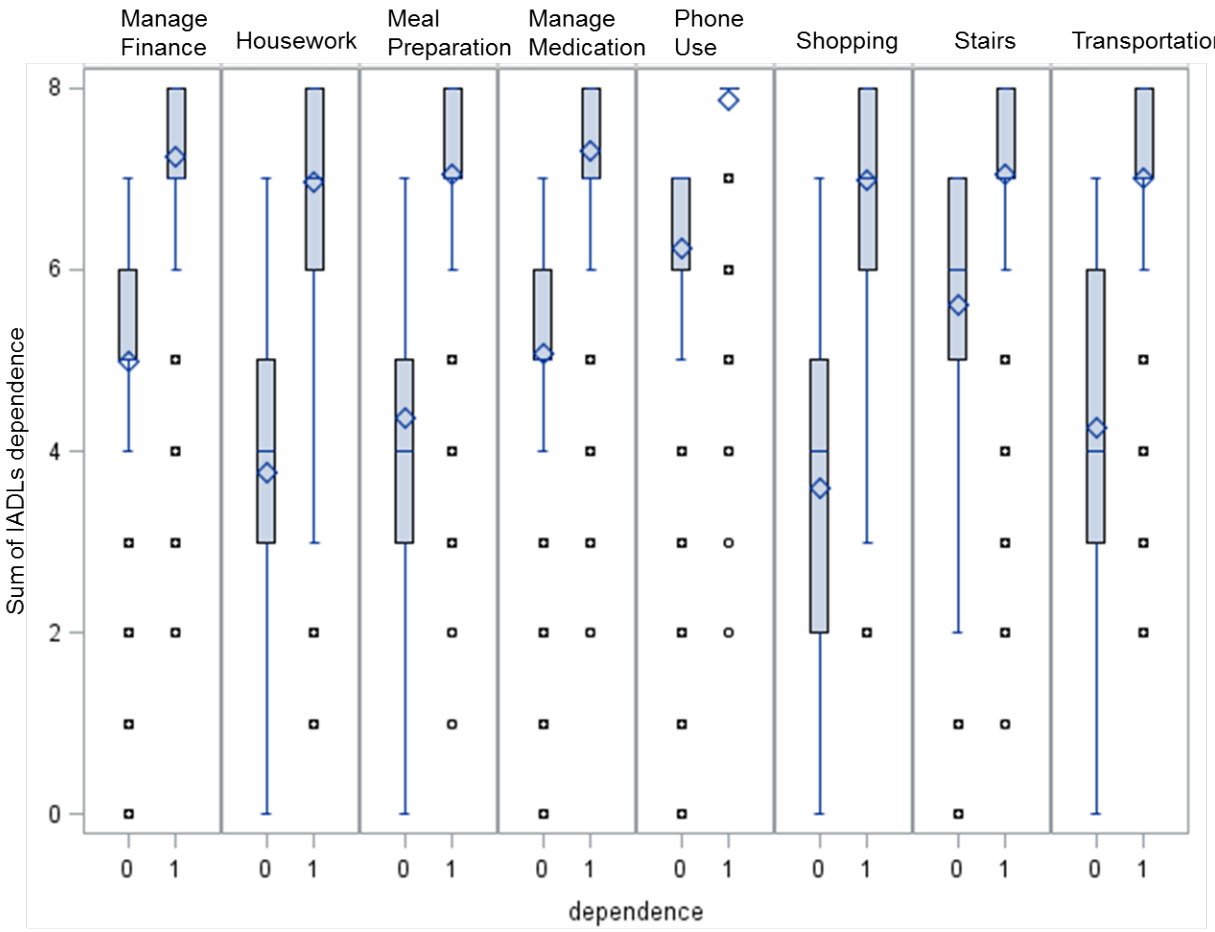
perform other items of ADLs. This suggest independency on bathing may serve as an indicator of low ADLs sum score and dependency on eating may serve as an indicator of high ADLs sum score.

Figure 4. Distribution of sum ADLs by ADLs' items



Similarly, the hierarchical relationship among IADLs is assessed. Figure 5 shows potential indicators of high score of IADLs. Among IADLs items, incapability to use phone independently has a general higher IADLs sum score than the other IADLs items (Figure 5). This suggests that incapability to use phone may indicate incapability to perform other IADLs items independently.

Figure 5. Distribution of sum IADLs by IADLs' items



(* 0 indicates independent ; 1 indicates dependent)

As literatures often evaluate on total score of ADLs and IADLs and its association with NH transfer risk, the composition of the total score, the effect of a single ADLs item and IADLs item as well as the hierarchical relationship among them have been ignored. Here, it would be of interest to see whether a single ADL or IADL could influence the risk of LT-NH placement in the following analysis. Also the correlation among the ADLs and IADLs will allow us to consider the overall disability levels of the subjects from the status of a single item of ADLs or IADLs.

4. Semi-parametric proportional hazards regression with fixed covariates

4.1 Overview of Cox proportional hazards regression model

Cox proportional hazards regression model (Cox 1972) is one of the most often used model that allows analyzing time to events with a set of explanatory variables. The basic model for Cox proportional hazards model is $h\,(t|z) = \ h_0\,(t)\exp(\beta^t\,Z)$, where $h_0\,(t)$ is an undefined baseline hazard rate, β is the parameter vector, and Z is a set of covariates.

The Cox model has a feature of proportional hazards, such that the hazard ratio is a constant.

$$HR = \frac{\widehat{h_0}\,(t)\exp(\sum_{i=1}^{p}\widehat{\beta_i}Z_i^*)}{\widehat{h_0}\,(t)\exp(\sum_{i=1}^{p}\widehat{\beta_i}Z_i)} = \ \exp(\sum_{i=1}^{p}\beta_i(Z_i^* - Z_i))$$

For example, if Z_1 indicates the treatment effect, Z_1=1 indicates treatment and Z_1=0 indicates control, then the hazard ratio of treatment over control will be $HR = \frac{h\,(t|Z)}{h\,(t|Z_i^*)} = \exp(\beta_1)$.

Therefore, the coefficient in the Cox model can be interpreted into hazard ratio after exponential transformation. A positive coefficient indicates that the explanatory variable with 1 unit increase are associated with increased risks of event occurrence, while a negative coefficient indicates that the explanatory variable with 1 unit increase are associated with decreased risk of event occurrence.

The maximum likelihood estimates β are obtained by maximizing the partial likelihood

$$L\,(\beta) = \prod_{i=1}^{D}\frac{\exp[\,\sum_{k=1}^{p}\beta_k Z_{(i)k}]}{\sum_{j\,\in R\,(t_i)}\exp[\,\sum_{k=1}^{p}\beta_k Z_{jk}]}$$

where $t_1 < t_2 <..< t_D$ are the ordered event and Z_{ik} is the kth covariate associated with the subjects who failed at t_i and the risk set $R\ (t_i)$ are subjects who haven't censored or experienced event at time just prior to t_i. [1]

In the presence of competing risk, the traditional Cox regression model can be used to model cause-specific hazard of interest with competing risk events as censored observation [29].

To construct the semi-parametrical Cox regression model on time to long-term nursing home, the assessment data obtained within 30 days before/after waiver enrollment are used for the input of fixed covariates. Death is considered as the competing risk and is treated as the right censoring data in the Cox regression model. The goal for this analysis is to identify the predictors of long-term nursing home placement at the time of waiver enrollment.

4.2 Model variable selection

Stepwise selection is one of the common techniques for variables selection. The initial model includes basic socio demographic variables, which are age, race, gender, marriage status, living arrangement; disease conditions variables, which are hypertension, arthritis, chronic obstructive pulmonary disease (COPD), incontinence, hip fracture, dementias, cancer, diabetes, stroke, depression, Alzheimer, dementia and mental disorder; nine ADL items which are bathing, dress, eat, mobility transferring , toilet use, toilet transfer, manage personal hygiene, moves between locations, mobility in bed; eight IADL performance items including housework, shopping, transportation, meal preparation, stair use, manage finance, manage medication, and phone use.

The criterions for a variable to enter the model is p-value less or equal than 0.25, for a variable to stay in the model is p-value less or equal to 0.1. Possible confounding factors, such as age, gender, race and the previous long term care history, living arrangement, marriage are forced to be included in the model. After stepwise selection, COPD, mental function, ability to move between locations, ability to use phone, bathing, perform stairs climbing and interaction between living arrangements and bathing, interaction between living arrangements and phone use are selected into the model.

A model that used sum score of ADLs and sum score of IADLs to replace the nine ADL items and eight IADL items are also tested. The sum score of IADLs and sum score of ADLs have not reached the significant levels to remain in the final model. Instead, the potential indicators for sum score of ADLs (such as bating) and indicators of sum score of IADLs (such as phone use) have been selected into the model as shown above.

4.3 Test assumption of proportional hazard

There are multiple ways to test proportional hazard assumption, for example, plotting Kaplan-Meier curves with the stratum of the covariates, modeling with time dependent covariates or performing supremum tests. Supremum tests compared the actual value of cumulative martingale residuals with the resample stimulation process under the PH assumption. In SAS, the ASSESS statement in PROC PHREG will give the results of evaluating the PH assumption for each covariate[30].

Supremum tests have been performed to test the proportional hazard assumption of the model. The test results showed that variables race and live arrangement have violated the PH assumption. Next, with race as the stratum in the

model, supremum test reveals that PH assumption of live arrangement remains valid. Another way to test PH assumption is to test the interaction between the covariates and time. For example, the PH assumption of Age as the continuous variable can be checked by verifying the significance of its interaction with time in the model. As the result, no significant interaction between age and time is identified.

With race as the stratum, supremum tests showed that all covariates in the model are valid for PH assumption.

4. 4 Stratified Cox regression model

One way to handle violation of PH assumption is to treat the variable (Z*) of PH assumption violation as the strata. The stratified Cox model could be expressed as

$$h_g(t, Z) = h_{0g} \exp(\beta_1 Z_1 + \cdots + \beta_p Z_p)$$

g= 1, ...,k strata defined from the variable (Z*).

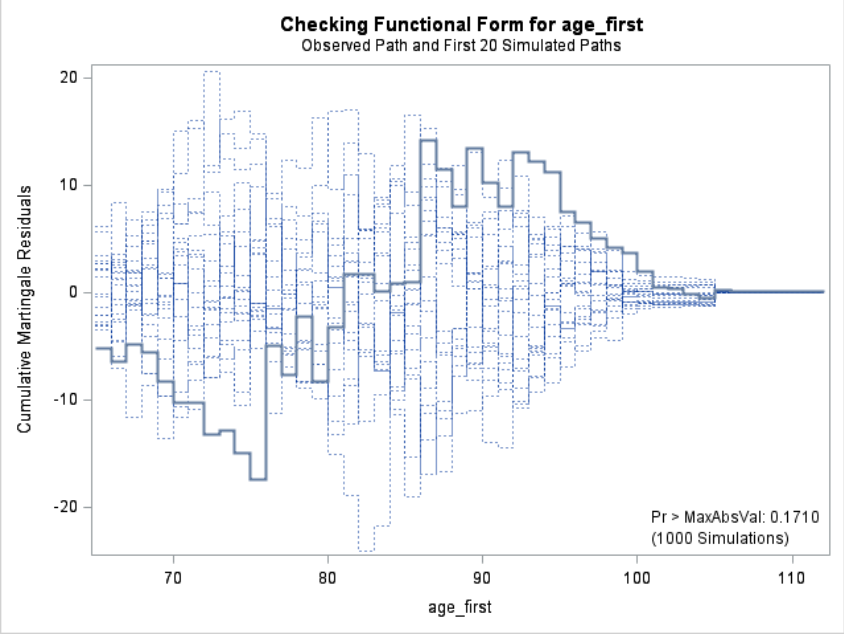
In the stratified cox model, same coefficients are applied to each stratum, while the baseline hazard function could vary for each stratum. One important assumption here to use the same estimates for different stratum is that there is no interaction between the strata and covariates.

As shown above, race has been treated as the strata in the Cox model due to its violation of PH assumption. To test interaction between covariates and race in our data, interaction term between race and other covariates besides the main effects of the covariates are included in the model. Type 3 tests suggest that the slopes of variables (history of long term care and mental) depends on race, in another word, history of long term care and mental have different effect on time to LT-NH on different race strata. Strata specific estimate will be used for these two variables.

4.5 Check functional form of continues variables

Supremum test could also be used to test the proper functional form for continuous variable [30]. The curve of cumulative martingale residuals of age at the enrollment has no significant difference from the simulated paths (p =0.17), which suggest that the form of age is proper for the model (Figure 6).

Figure 6. Supremum test for testing functional form of age



* “age_first” is the age at the time of waiver program enrollment.

4.6 Model assessment.

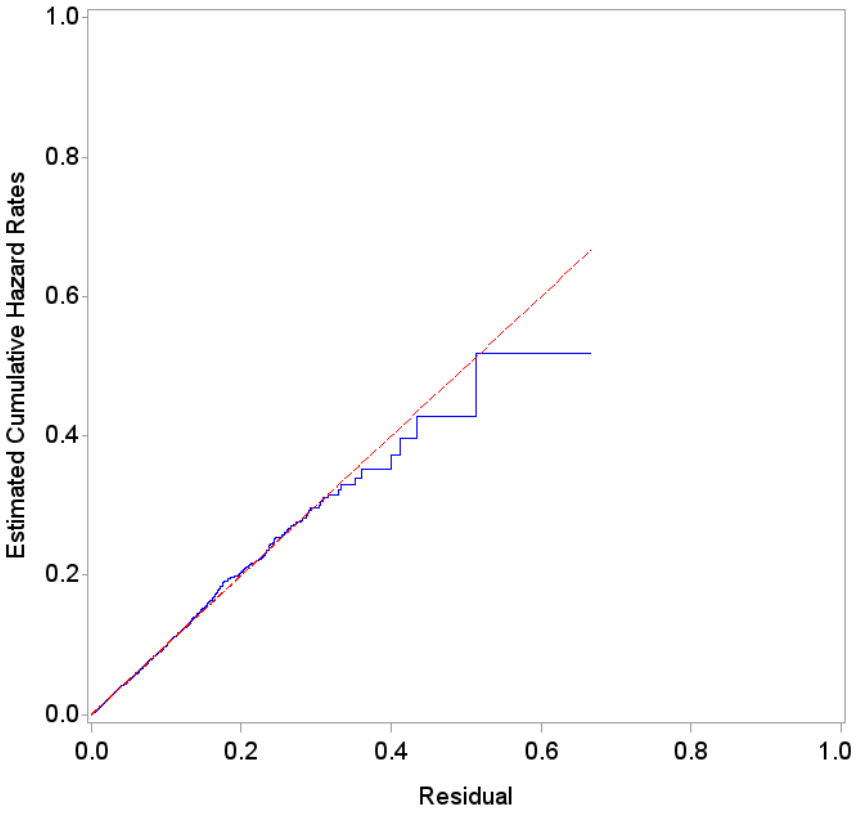
4.6.1 Cox-Snell residuals

Cox-Snell residuals, also known as generalized residuals, are the negative log of the survival estimate for the subjects. Note the estimator of cumulative hazard is $\widehat{\mathrm{H}} = -\log \hat{S}(t|z)$ and the estimator of survival is $\hat{S}(t|z) = \exp\left(\widehat{\mathrm{H}_0}\exp(\hat{\beta}Z)\right)$. The ith

Cox-Snell residual thus is $r_i = \widehat{H_0}(x_i)exp\left(\widehat{\beta^T} z_i\right) = -\log \hat{S}\,(x_i|z_i)$. Also note that S (X) is uniformly distributed on [0, 1] and – log S(X) = H(X) is exponentially distributed with 1. Therefore, if the fitted model is correct, the Cox-Snell residuals should have an exponential distribution. That is, if the graph of Cox-Snell residuals is a straight line through the origin and with a slope of 1, this would suggest a model of good fit [1, 31].

Here, Cox-Snell residuals from the fitted model are plotted (Figure 7), the majority of the residuals fall in the straight line through origin and with a slope of 1, which suggest that the Cox regression model for time to long-term nursing home replacement is a good fit.

Figure 7: Analysis Cox-Snell residuals to check goodness of fit for the model



4.6.2 Identification of outliers

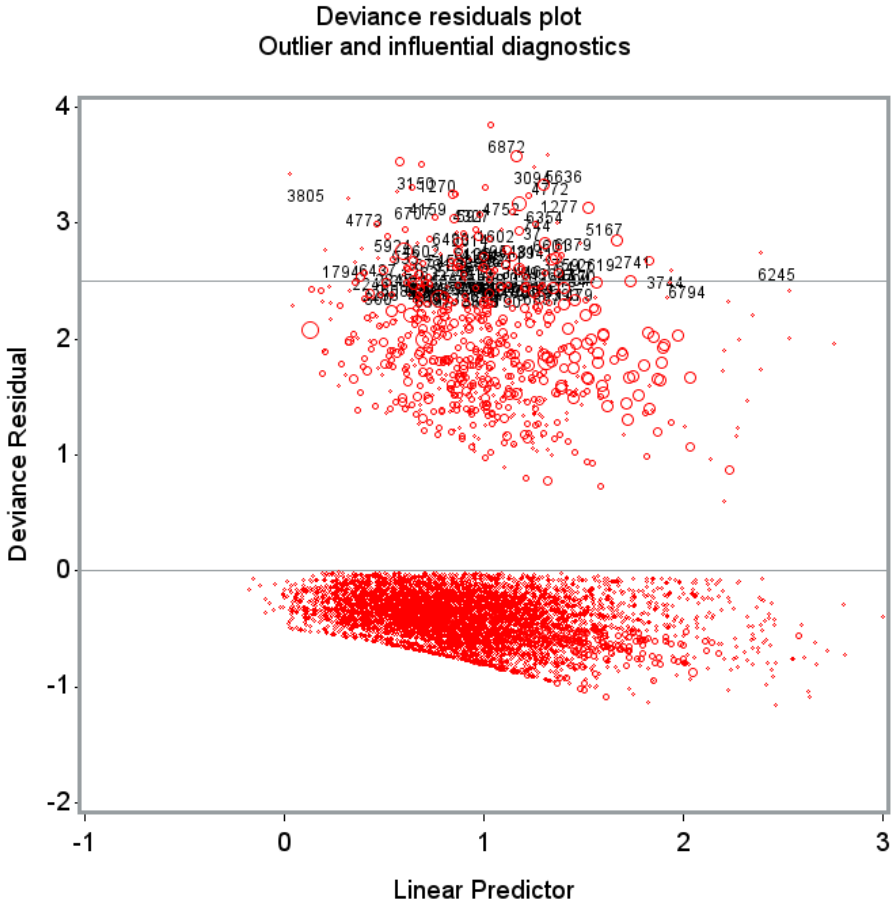
Analysis of deviance residuals enables detection of outliers and analysis of LMAX allows detection influential data. Deviance residuals are transformed from Martingale residuals. Martingale residuals are defined as $\widehat{M_i} = \delta_i - \widehat{H_0}(t_i)exp\left(\widehat{\beta_1}Z_{1i} + \cdots + \widehat{\beta_k}Z_{ki}\right)$, where δ_i is the event indicator for subject i, $\widehat{H_0}(t_i)$ is the estimated cumulative hazard for subject i, and $\widehat{\beta_1}Z_{1i} + \cdots + \widehat{\beta_k}Z_{ki}$ is the estimated coefficients with the observed covariates for subject i. As martingale residuals are not symmetrically distributed, deviance residuals are symmetrically distributed around 0 with a standard deviation of 1.0 and therefore allow using large standard deviation to define outliers [1, 31].

The deviance residuals from the fitted model are plotted to identify potential outliers (Figure 8). The size of the bubbles is proportional to LMAX statistic. The large bubbles are considered as the influential observations. Observations with standard deviation larger than 2.5 can be considered as outliers. Analysis of total 97 outlier observations revealed that all of them are subjects who transfer to LT-NH. The average time for these outliers to transfer to LT-NH is 40.8 days with 32.0 days as the standard deviation, while the average time for those who are not outlier to transfer to LT-NH is 340.5 days with 265.5 days as the standard deviation. In addition, the estimates for the coefficient of all covariates are very similar between the Cox model for sub-population after removal of outliers and the Cox model for the whole study population including the outliers. The Cox model fit based on Cox-Snell residuals improve only slightly when excluding the outliers. These all suggest that these outliers have minor effect on the

Cox model. As no artificial error has been detected from these outliers, these outliers will remain in the final Cox model.

To find out the unique characteristics of these outliers from the other LT-NH residents, a logistics regression model was used. This logistics regression model divided the waiver elderly who were transferred to LT-NH (total 812 of them) into two groups 1) outliers LT-NH residents (97 subjects) 2) the other LT-NH residents (715 subjects). This model analyzed variables including age, gender, race, history of long-term care, living arrangement, marriage, medical conditions (mental function, stroke, COPD, hypertension, arthritis, hip fracture, Alzheimer, dementia, cancer, diabetes, incontinence, depression), the number of medication, sum score of ADLs and sum score of IADLs. Results have revealed that among those waiver elderly who were transferred to LT-NH, a waiver elderly who have a greater sum score of ADLs at the time of waiver program enrollment (OR: 1.19, 95% CI (1.08, 1.31)) have greater odds to become a outlier in the Cox model illustrated above. Except the sum ADL scores, the other variables in the model cannot significantly distinguish the outliers and the other LT-NH residents among the waiver elderly.

Figure 8: Analysis of deviance residuals to diagnosis outliers and influential data



4.7 Interpretation of results

Final model for modeling time to LT-NH is a COX regression model stratified according to race with stratum specific estimates for history of long-term care and mental function as assessed respectively by interaction term between the stratum and long-term care and interaction term between the stratum and mental function. Table 6 gives out a summary of events and censoring data for black, white and other race. Table 7 and table 8 show the model statistics.

Table 6. Summary of the number of event and censored values					
Stratum	Race	Total	Event (LT-NH)	Censored	Percent Censored
1	Black	1369	88	1281	93.57
2	Other	419	27	392	93.56
3	White	5188	551	4637	89.38
Total		6976	666	6310	90.45

Table 7. Model fit statistics		
Criterion	Without Covariates	With Covariates
-2 LOG L	10079.158	9984.035
AIC	10079.158	10022.035

Table 8. Testing global null hypothesis of the model			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	95.1228	19	<.0001
Score	96.0852	19	<.0001
Wald	93.8849	19	<.0001

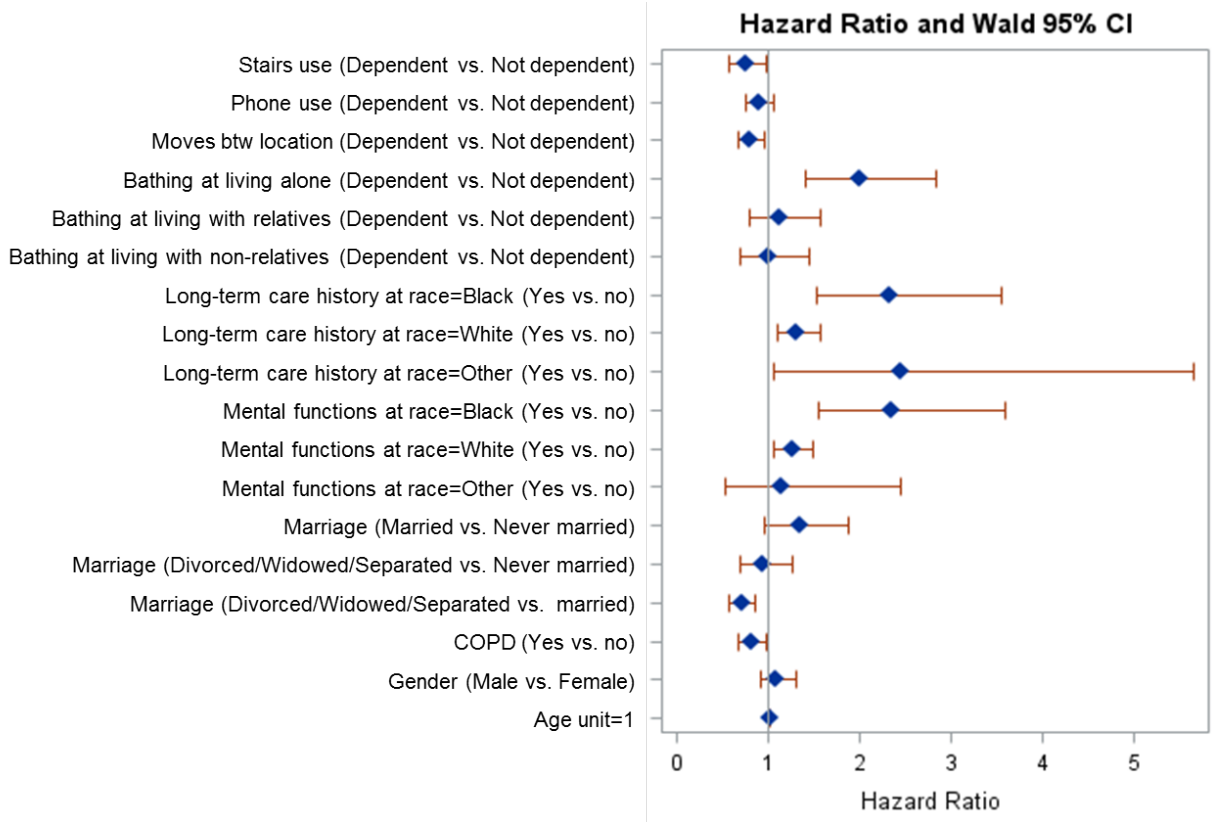
The results are summarized as the below (Table 9). Hazard ratios are the ratio of cause specific hazard for LT-NH placement at the two levels of a variable given that the subject has not experienced death and LT-NH at a certain time point.

Table 9. Cause specific hazard ratio from Cox regression model with fixed covariates					
Parameter		Hazard Ratio	p-value	95% Hazard Ratio Confidence Limits	
age		1.009	0.0725	0.999	1.019
Gender	M vs. F	1.079	0.4109	0.901	1.292
History of Long Term Care (At Race of Other)	Yes vs. No	2.444	0.0366	1.057	5.651

Table 9 (cont'd)

History of Long Term Care (At Race of White)	Yes vs. No	1.305	0.0038	1.090	1.564
History of Long Term Care (At Race of Black)	Yes vs. No	2.323	<.0001	1.520	3.550
Living arrangement	Living with non-relatives vs. with relatives	1.169	0.242	0.899	1.519
Living arrangement	Living with non-relatives vs. alone	1.032	0.811	0.796	1.338
Living arrangement	Living with relatives vs. alone	0.883	0.339	0.684	1.139
Marriage	Divorced/widowed/separated vs. never married	0.930	0.6408	0.687	1.260
Marriage	married vs. never married	1.332	0.0929	0.953	1.860
Marriage	Divorced/widowed/separated vs. married	0.699	.	0.569	0.858
Mental (At Race of Other)	Presence vs. Absence	1.127	0.7637	0.518	2.449
Mental (At Race of White)	Presence vs. Absence	1.250	0.0124	1.049	1.489
Mental (At Race of Black)	Presence vs. Absence	2.346	<.0001	1.537	3.580
COPD	Presence vs. Absence	0.804	0.0208	0.669	0.967
Bathing (ADL's)	Dependent vs. Independent	1.302	0.017	1.048	1.618
Bathing (at live with other) (ADL's)	Dependent vs. Independent	0.994	.	0.684	1.445
Bathing (at live with relative) (ADL's)	Dependent vs. Independent	1.113	.	0.792	1.565
Bathing (at live alone) (ADL's)	Dependent vs. Independent	1.995	.	1.405	2.834
Moves Btw Location (Locomotion - How moves between locations on same floor) (ADL's)	Dependent vs. Independent	0.797	0.0115	0.668	0.950
Phone Use (IADL's performance)	Dependent vs. Independent	0.895	0.2016	0.755	1.061
Stairs Use (IADL's performance)	Dependent vs. Independent	0.740	0.0284	0.566	0.969

Figure 9: Cause specific hazard ratio of risk factors for long-term nursing home placement



Previous history of long-term care turns out to be a strong indicator for long term nursing home placement. For white people, clients with long term care history have 1.3 fold higher risks than clients without long-term care history given that they haven't experienced either death or LT-NH. For black or other race, those with long term care history have 2.3 fold and 2.4 fold higher risks than clients without long term care history respectively.

Mental function describes the periodic disordered thinking or awareness, which could change over the day. The presence of behaviors associated with the disordered thinking is associated with a significant higher risk for long-term nursing home

placement compared to the absence of disordered behaviors among white and black people.

The presence of chronic obstructive pulmonary (COPD) disease is associated with 20% less risks to LT-NH transfer. About 28% of waiver clients have COPD.

About 81% of waiver participants need assistance for bathing. Among waiver participants who live alone (24.3% of the study population), clients who need assistance for bathing has about two fold higher risks (HR: 1.99, 95%CI (1.4, 2.8)) than clients who can bath independently. For waiver clients who live with relatives or other people, they're more likely to have help for bathing, and therefore bathing does not play a significant role for the time to long term nursing home placement for them. Another ADL item, moving between locations with assistance is associated with less risk of long-term nursing home placement. Dependency of stairs use as one of the IADL's performance items also shows less risks of LT-NH placement at the time when both death and LT-NH haven't occurred.

Marriage is complicated. Waiver elderly with divorced, separated, or widowed status have less risk to long term nursing home placement, compared to waiver elderly with current married status (HR: 0.699, 95% CI: (0.569,0.858)). By assessing other assessments after the program enrollment, the married clients at the baseline didn't change their marital status (remain married) during the observation periods.

Previous study has shown that marriage has different effect on the risk of nursing home placement between males and females. If considered the same model except including interaction between marriage and gender, the interaction marriage and gender showed significant effect. Nevertheless it's consistent that male and female who are

divorced, separated, or widowed status have decreased risk to long term nursing home placement, compared to those with current married status. Males who are divorced, separated, or widowed have higher risks of nursing home placement compared to males who never married, while the opposite effect is observed in female (Table 10).

Table 10. Cause specific hazards ratios for marriage

Description	Hazard Ratios	95% Wald Confidence Limits	
Marriage (Divorced/widowed/separated vs. Married) For Males	0.714	0.523	0.974
Marriage (Divorced/widowed/separated vs. Never married) For Males	2.289	1.151	4.549
Marriage (Married vs. never married) For Males	3.207	1.596	6.444
Marriage (Divorced/widowed/separated vs. Married) For Females	0.722	0.558	0.934
Marriage (Divorced/widowed/separated vs. Never married) For Females	0.654	0.470	0.911
Marriage (Married vs. Never married) For Females	0.906	0.614	1.337

About 65% of married elderly are living with their spouses or relatives (Table 11). One possibility is that having two elderly at the same family may have created much burden for the whole family or helpers, resulting in a nursing home placement Inconsistent results for the effect of marriage on nursing home placement are found in the literature.

Table 11. Relationship between marriage and living arrangement						
		Marriage				
		(missing)	Never married	Divorced/widowed/separated	Married	Total
Living arrangement	(missing)	38 7.63	73 11.64	487 8.85	111 6.93	709
	Alone	132 26.51	183 29.19	1626 29.54	57 3.56	1998
	With non-relatives	151 30.32	255 40.67	1741 31.63	382 23.85	2529
	With relatives	177 35.54	116 18.50	1651 29.99	1052 65.67	2996

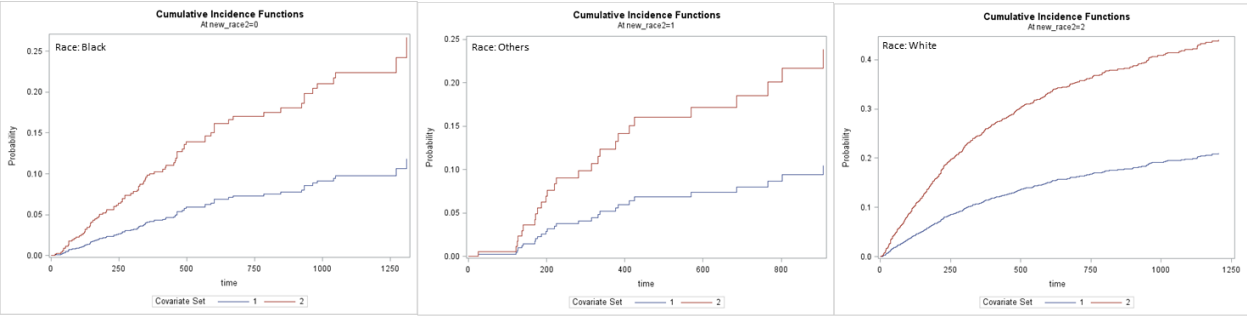
4.8 Fine and Gray methods for cumulative incidence of LT-NH placement over time

In contrast to the Cox-specific hazard model, Fine and Gray (1990) use subdistribution hazard to model cumulative incidence function when competing risks are present. Partial likelihood of Cox-specific hazard model excludes risk set for subjects who have experienced a competing risk before event time Xi [29]. In contrast, partial likelihood of subdistribution model includes subjects who are at risk for the event of interest as well as those subjects who experienced the competing risk before event time X but with a weight. Cox-specific hazard model and subdistribution hazard model can yield different results. The hazard obtained from the sub-distribution method will not have the same interpretation as cause-specific hazard from the cox-specific hazard model [32].

Applying Fine and Gray subdistribution hazard method [29] on the established stratified Cox regression model, predicted cumulative incidence for waiver elderly with

different profiles can be obtained. Figure 10 shows the cumulative incidence functions of long-term nursing home placement for waiver elderly who are Caucasian or African American or other races with and without long-term nursing home history. Waiver elderly with long-term care history are predicted to have high cumulative incidence over time over all races. Cumulative incidence over time for subjects with different covariates set can be estimated similarly.

Figure 10. Predictions of cumulative incidence for waiver elderly with and without long-term care history



Covariate Set 1: No long-term care history at aged 80, female, never married, living arrangement with relatives, no mental disorder, no COPD, independent of bathing, move btw location, phone use and stairs use;
Covariate Set 2: Have long-term care history at aged 80, female, never married, living arrangement with relatives, no mental disorder, no COPD, independent of bathing, move btw location, phone use and stairs use;

5 Time dependent covariates

5.1 Time dependent covariates in Cox regression model

The values of time dependent variables (TVC) are updated over time, denoted by $Z_2(t)$. Let z_2* (t) be the function that specified the values of TVCs. Also let Z_1 be the time invariant variables. In Cox regression model, the relationship between hazard and TVC is $h\left(t \left| Z_1, Z_2(t)\right.\right) = h_0(t) \exp\left(\beta_1 Z_1 + \beta_2 Z_2(t)\right)$ [1].

Waiver participants usually receive nurse and social workers assessments after a period of time. To take into account the change of socio status, health conditions and ADLs, IADLs, assessments data over time are integrated into the analysis using counting process style syntax. Except age, gender, race as the time independent variables, other variables from the assessments will be updated over time based on the assessment date.

5.2 Model variable selection

The initial full model includes number of hospitalization and all other variables that are contained in the initial model for cox regression model with fixed covariates. Except age, gender, race as the time independent variables, other variables (selected into the model, including hospitalization number, history of long term care, live arrangement, marriage, mental, COPD, hypertension, arthritis, Alzheimer, dementias, cancer, depression, continence, number of medication, ADL items (ability to move between location, eat , dress , interaction between live arrange and eat or dress) , IADL items (ability to performance housework, phone use, stair climbing, shopping, transportation, and the interaction between live arrange and phone use, shopping or transportation) are updated from multiple assessments and therefore are time

dependent variables. These variables are selected into the model after stepwise selection.

5.3 Test PH assumption

To test PH assumption, variables interaction terms with time are constructed. Variables including Number of hospitalization, dementia, arthritis, continence, number of medication in the past 7 days, housework performance, phone use performance have been detected to violate PH assumption. Overall proportionality test (Table 12) has shown violation of PH assumption of the model.

Table 12. Proportionality test for TVC model

Label	Wald Chi-Square	DF	Pr > ChiSq
Proportionality test	390.2842	22	<.0001

5.4 Robust hypothesis testing

With the violation of PH assumption, the actual values of the coefficient estimates are not valid to interpret and therefore hazard ratio obtained from the model did not reflect the true hazard ratio of the covariates. However, using sandwich variance estimate still provides valid hypothesis tests on the effect of the covariates, as well as the sign of the estimates[33]. A positive sign of coefficient indicates increased risk associated with the explanatory covariate, while a negative sign of coefficient indicates decreased risk associated with the explanatory covariate.

The greater cumulative number of hospitalizations, having history of long term care, presence of dementia, incontinence, greater number of medication in use are associated with increased risk of long term nursing home placement. Marriage status results are consistent with the fixed covariates model, in which being currently married

is associated with greater risk of nursing home placement compared to being never married. Living with others or relatives lower the risk of LT-NH placement compared to living alone (Table 13).

Predictors of increased risk of death include cumulative number of hospitalization, age, race other than black, history of long term care, cancer, the number of medication in use, failure to eat and dress independently. Opposite effect of hypertension, cancer, and dependency of eating have been observed for the competing risk of death than for LT-NH placement.

Table 13. Robust hypothesis testing for TVC model estimates

		Sandwich Variance Estimate for LT-NH as the event			Sandwich Variance Estimate for death as the event		
Parameter		Parameter Estimate	Pr > ChiSq	Hazard Ratio	Parameter Estimate	Pr > ChiSq	Hazard Ratio
Sum hospitalization		0.02389	0.0471	1.024	0.02482	<.0001	1.025
Age		-0.00173	0.8332	0.998	0.02592	<.0001	1.026
Gender	M vs. F	0.05957	0.6796	1.061	0.14134	0.0651	1.152
Race	Other race vs. black	0.00565	0.9857	1.006	0.40906	0.0217	1.505
Race	White vs. black	0.31546	0.0819	1.371	0.62101	<.0001	1.861
Long-term care history	Yes vs. no	0.40494	0.0008	1.499	0.21074	0.0013	1.235
Living arrange	Live with non-relatives vs. alone	-0.41435	0.0083	0.661	0.09074	0.2831	1.095
Living arrange	Live with relatives vs. alone	-0.30515	0.0374	0.737	0.07272	0.3754	1.075
Marriage	Divorced/widowed/separated Vs. never married	0.17871	0.4568	1.196	0.09549	0.5089	1.100
Marriage	Married vs. never married	0.61610	0.0181	1.852	0.03929	0.8036	1.040
Mental	Mental disordered vs. no mental disordered	0.00165	0.9881	1.002	0.07491	0.2462	1.078

Table 13 (cont'd)

COPD	Presence vs. Absence	-0.17526	0.2111	0.839	0.38440	<.0001	1.469
Hypertension	Presence vs. Absence	-0.32955	0.0174	0.719	0.14521	0.0947	1.156
Arthritis	Presence vs. Absence	-0.25189	0.0508	0.777	-0.20460	0.0023	0.815
Alzheimer	Presence vs. Absence	0.18953	0.2625	1.209	0.03608	0.7010	1.037
Dementia	Presence vs. Absence	0.30367	0.0118	1.355	-0.01610	0.8181	0.984
Cancer	Presence vs. Absence	-0.41074	0.0175	0.663	0.33443	<.0001	1.397
Depression	Presence vs. Absence	0.11106	0.3705	1.117	-0.09214	0.1445	0.912
Incontinence	Presence vs. Absence	0.31275	0.0299	1.367	-0.02751	0.7122	0.973
No of Medication	One unit increase	0.07424	0.0190	1.077	0.05529	0.0035	1.057
Eat (ADL's)	Dependent vs. Independent	-0.58415	0.0044	0.558	0.32245	<.0001	1.381
Moves Btw Location (ADL's)	Dependent vs. Independent	-0.19243	0.1292	0.825	0.09930	0.1085	1.104
Dress (ADL's)	Dependent vs. Independent	0.17408	0.1519	1.190	0.22911	0.0017	1.257
Housework (IADL's performance)	Dependent vs. Independent	-0.55151	0.2193	0.576	-0.61493	0.0084	0.541
Phone Use (IADL's performance)	Dependent vs. Independent	-0.17852	0.1493	0.837	0.07533	0.2621	1.078
Stairs Use (IADL's performance)	Dependent vs. Independent	0.14569	0.4515	1.157	0.20404	0.1428	1.226
Shopping (IADL's performance)	Dependent vs. Independent	-0.59148	0.0980	0.554	0.45591	0.0975	1.578
Transportation (IADL's performance)	Dependent vs. Independent	0.47811	0.2291	1.613	0.13325	0.5382	1.143

6 Discussions

This study has provided a detailed description of the waiver program participants who are older than 65, and assessed their risk of nursing home placement with the presence of death as the competing risk. Nursing home placement is an outcome of predisposing, enabling and need factors of the elderly. This analysis assessed the association between the risks of LT-NH placement and predisposing factors (such as gender, race, age, history of long-term care, marriage), enabling factors (such as living arrangement), need factors (such as disease conditions, ADLs and IADLs). This analysis will also serve as an example of survival analysis application.

The survival model of time fixed variables and the survival model of time varying variables (TVC) consistently suggested that a predisposing factor, history of long-term care, and a need factor, presence of mental function behaviors, predicts increased risk for long-term nursing home placement for waiver clients aged over 65. These are consistent with findings in different populations [18, 19].

As enabling and need factors are likely to change over time during the stay in waiver program, this change could be captured in the social worker and nurse assessment of the waiver participants. The TVC model incorporated the time dependent variables, therefore allows evaluation of the changes of enabling and need factors on risk of nursing home placement. The model with TVC revealed that the occurrence of incontinence or dementia, change of living arrangement to living alone during the stay at waiver program are significantly associated with increased risks of LT-NH transfer, while these factors at the baseline did not show significant effect on LT-NH transfer in the time fixed variables model. The TVC model further showed that increased cumulative

number of hospitalization is significantly associated with earlier time to LT-NH placement. The TVC models however have some limitations due to the many violations of PH assumption. The TVC model is unable to obtain accurate estimates, and therefore hazard ratios obtained from the model are invalid. To test the effect of potential risk factors, robust sandwich variance estimates are used for the hypothesis tests to determine the effect of a certain covariate and the direction of the effect.

Disability in ADLs and IADLs are important need factors associating with increased risk of LT-NH placement [18]. Instead of using crude sum scores of ADLs and IADLs, this study illustrated the hierarchical relationships among ADLs items and IADLs items, and assessed the effect of individual ADLs' and IADLs' items on risk of nursing home placement. The model with fixed covariates revealed that independency of bathing is a significant predictive factor for decreased risk of nursing home placement. Note that waiver elderly who are able to bath independently usually have very low total score of ADLs. These suggest that the impact of bathing independency on the risk of LT-NH placement is possibly due to the overall low disability levels of the elderly. Similarly, waiver elderly who are dependent on eating have significantly increased risk of nursing home placement in the TVC model. This could be due to the overall greater disability levels of elderly who are incapable to eat independently, since dependency of eating is observed to be associated with extreme high ADLs score.

In the study of elderly, it's important to consider a threatening risk of death when analyzing other events of interest. Much of the literature analyzing time to nursing home placement failed to discuss the competing risk of death, as well as the validity and accuracy of their models. With the presence of competing risk, cause specific hazard

and cumulative incidence function are useful to measure of effect of risk factors on the time to event. Cautions should be made for survival function and cumulative hazard in the Cox model which could be no longer informative. When treating death as the right censoring, the cause specific survival function and cause specific cumulative hazard of LT-NH placement are not meaningful. Both cause specific cumulative hazard of death and cause specific cumulative hazard of LT-NH home placement should be included in the estimation of overall survival.

This study has explored the influence on time to LT-NH from the competing risk death and compared the predictive factors for LT-NH and death. Competing risk effect have been indicated when opposite effect on the two competing events is observed from a risk factor. For example, cancer is associated with increased risk of death, but related to decreased risk of LT-NH placement based on findings from the TVC model. Other variables such dependency of eating, COPD have also shown opposite effect on LT-NH placement compared to death. These findings are consistent with previous studies that suggest no relationship or inverse relationship between the presence of some medical conditions and nursing home placement [11, 20]. These could be possibly due to the fact that patients died from the diseases before ever having chance for entering a nursing home.

In summary, this study followed the waiver elderly population since their enrollment at the waiver program between 10/1/2010 and 9/30/2014. This study has identified predictive predisposing, enabling and need factors of waiver elderly at the program enrollment for risks of earlier time to LT-NH transfer, and assessed the relationship between the changes of enabling and need factors during the stay at waiver

program and the risk of LT-NH transfer. This study provided detailed view of the hierarchical relationship among individual ADLs and IADLs items and their individual influence on the time to LT-NH placement. This study analyzed LT-NH and death as two competing events, identified and compared the predictive factors for the time to nursing home placement and time to death. The model with time fixed variable at the time of program enrollment enables program regulators to identify waiver applicants with high risk of LT-NH transfer and death, while the model with time varying variables from the assessments after the enrollment enables identification of waiver participants with emerging risks of LT-NH transfer and death. This study could therefore facilitate the pre-admission assessment of applicants and after-admission assessment of participants at the waiver program, and guide future interventions for delaying LT-NH transfer and death.

APPENDIX

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Figure A.1. Flowchart to identify waiver elderly enrolled between 1Oct 2010 and 20Sep 2014

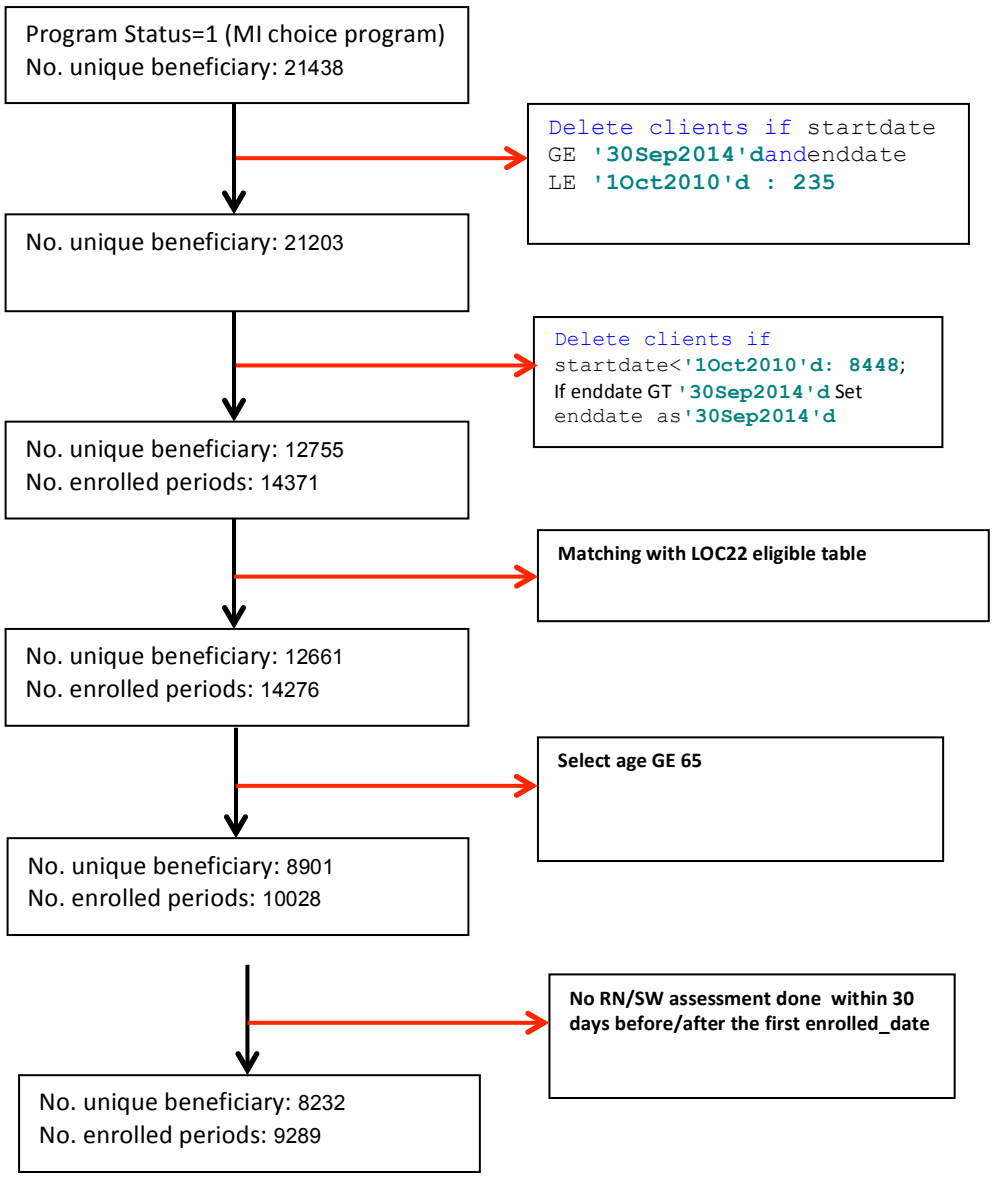

Figure A.2. Nursing home claims for waiver participants

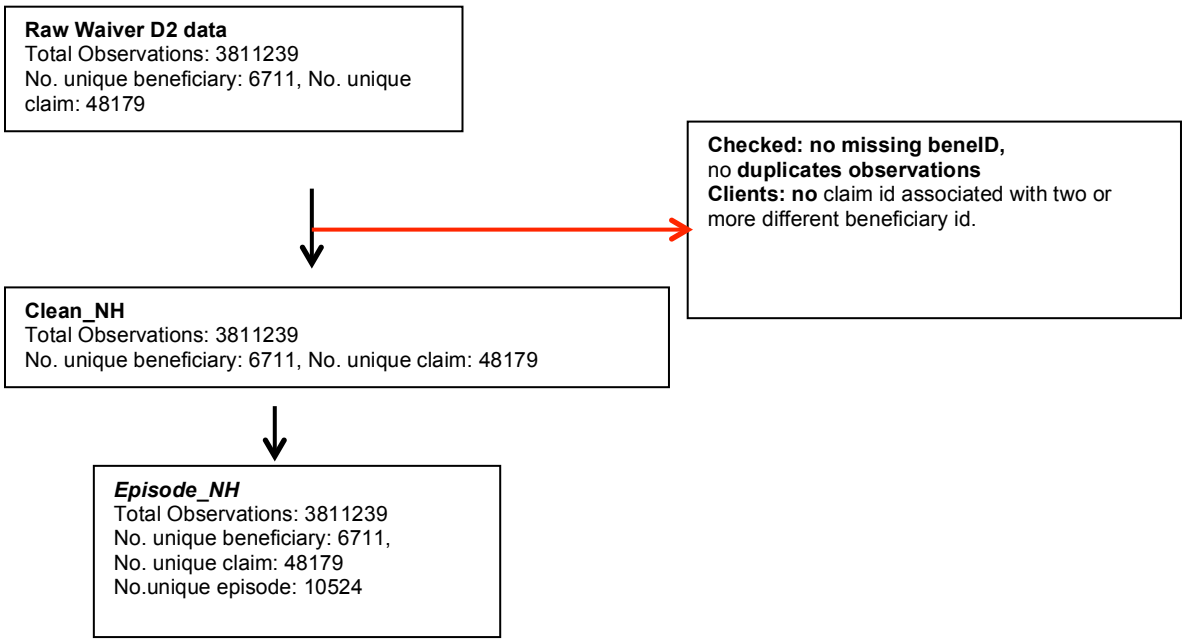

Table A.1 Processing variables

<table>
<tr><td>Baseline covariates (first assessment within 30d since enrollment</td><td>Comment
(Treated the variables as ..)</td><td>Variables sources
(From Code_book)</td></tr>
<tr><td>Age</td><td>ifage_first GE 65 and age_first LE 74thenage_class ='65-74' ;else
ifage_first GE 75 and age_first LE 84thenage_class ='75-84';else
ifage_first GE 85thenage_class='85+';</td><td></td></tr>
<tr><td>Gender</td><td>Female, Male</td><td></td></tr>
<tr><td>Race</td><td>if race=1thennew_race='White';else
if race=2thennew_race='Black';else
if race in (3,4,5,6,7,8,9) thennew_race='Others';else new_race='';</td><td>Eligible</td></tr>
<tr><td>Education</td><td></td><td></td></tr>
<tr><td>Marital Status</td><td>
Married (1,6)
Not married (0)
Other (2,3,4,5)</td><td>0 – Never Married, 1 - Married, 2-Widowed, 3-Separated, 4 - Divorced, 5 – Other, 6 – Partner/Significant Other</td></tr>
<tr><td>Living arrangement</td><td>Alone (1),
Family/Relative (2,3,4,5,6,7),
Others (8)</td><td>1=Alone, 2=With spouse/partner only, 3=With spouse/partner and other(s), 4=With child (not spouse/partner), 5= With parent(s) or guardian(s), 6=With sibling(s), 7=With other relatives, 8=With non-relative(s).</td></tr>
<tr><td>ADL</td><td>If variable in (0,1,2)
then variable =0 (NOT dependence)

If variable in (3,4,5,6,8)
then variable =1 (dependence)

For dress
if Dresses_Lower_Body2=1 or Dresses_Upper_Body2=1then dress=1 ;else
if Dresses_Lower_Body2=0
and Dresses_Upper_Body2=0
then dress=0;else dress=.;

sum_adl=sum(Mobility_In_Bed2,
Mobility_Transferring2,
Toilet_Use2,Toilet_Transfer2,
dress,eat,Bathing2,
Moves_Between_Locations2,
Manages_Personal_Hygiene2)

<table><tr><td colspan="8">Sum the items of ADL dependencies</td></tr><tr><td>N</td><td>Max</td><td>Min</td><td>Mean</td><td>P1</td><td>P25</td><td>p75</td><td>p99</td></tr><tr><td>8151</td><td>9</td><td>0</td><td>4</td><td>0</td><td>2</td><td>7</td><td>9</td></tr></table></td><td>RN assessment index 137-147
Including bathing (bathing), dressing (dresses lower body, dresses upper body), toileting (toilet transfer, toilet use), transferring (mobility in bed, mobility transferring, moves between locations, walks between locations), continence (manages personal hygiene), and feeding (how eats and drinks)
0= Independent, 1= Independent, setup help only, 2= Supervision, 3= Limited assistance, 4= Extensive assistance, 5= Maximal assistance, 6= Total dependence, 8= Activity did not occur</td></tr>
</table>

Table A.1 (cont'd)

<table>
<tr>
<td>IADL</td>
<td>If variable in (0,1,2)
then variable =0 (NOT dependence)

If variable in (3,4,5,6,8)
then variable =1 (dependence)

sum_iadl=sum(Meal_Prep_Performance2,
Housework_Performance2,
Manage_Finance_Performance2,
Manage_Medication_Performance2,
Phone_Use_Performance2,
Stairs_Performance2,
Shopping_Performance2,
Transportation_Performance2)

<table>
<tr><td colspan="8">Sum the items of IADL dependencies</td></tr>
<tr><td>N</td><td>Max</td><td>Min</td><td>Mean</td><td>P1</td><td>P25</td><td>p75</td><td>p99</td></tr>
<tr><td>8151</td><td>8</td><td>0</td><td>7</td><td>3</td><td>6</td><td>8</td><td>8</td></tr>
</table>
</td>
<td>RN assessment Index 121-136
Including preparing meals (meal prep performance, meal prep capacity), shopping (shopping performance, capacity), doing housework(housework performance, housework capacity), doing laundry, performing heavy chores(stairs performance, stairs capacity), managing money (manage finance performance, capacity), taking medications (manage medication performance, manage medications capacity), and using transportation (transportation performance, capacity), (phone use performance, phone use capacity)
Range values: 0= Independent, 1= Set-up help only, 2= Supervision, 3= Limited assistance, 4= Extensive assistance, 5= Maximal assistance, 6= Total dependence, 8= Activity did not occur - During entire period</td>
</tr>
<tr>
<td>No. medication</td>
<td>missing</td>
<td>RN index-201
0= 0, 1= 1, 2= 2, 3= 3, 4= 4, 5= 5, 6= 6, 7= 7, 8= 8, 9= 9 or more</td>
</tr>
<tr>
<td>Hypertension</td>
<td>No (0)
Yes (1,2,3)</td>
<td>RN index-16

0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment</td>
</tr>
<tr>
<td>Arthritis</td>
<td>No (0)
Yes (1,2,3)</td>
<td>RN assessment index-18
0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment</td>
</tr>
<tr>
<td>COPD (Chronic obstructive pulmonary disease)</td>
<td>No (0)
Yes (1,2,3)</td>
<td>RN assessment index-15
0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment</td>
</tr>
<tr>
<td>Incontinence (bowel/bladder)</td>
<td>ifBladder_Continence in (1,2,3,4,5,8) then Bladder_Continence2=1;else
ifBladder_Continence =0then Bladder_Continence2=0;
else Bladder_Continence2=.;

ifBowel_Continence in (1,2,3,4,5,8)
thenBowel_Continence2=1;else
ifBowel_Continence =0then Bowel_Continence2=0;
else Bowel_Continence2=.

Define continence
if Bladder_Continence2=1 or Bowel_Continence2=1then continence='Yes';else
if Bladder_Continence2=0 and Bowel_Continence2=0then continence='No';else continence=''</td>
<td>RN index-115-117 bladder/bowel
0= Continent, 1= Control with any catheter or ostomy over last 3 days, 2= Infrequently incontinent, 3= Occasionally incontinent, 4= Frequently incontinent, 5= Incontinent, 8= Did not occur - No urine output from bladder in last 3 days</td>
</tr>
<tr>
<td>Hip Fracture</td>
<td>No (0)
Yes (1,2,3)</td>
<td>RN assessment index-19
0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment</td>
</tr>
</table>

Table A.1 (cont'd)

cancer	No (0) Yes (1,2,3)	RN assessment index-39 0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment
diabetes	N (0) Yes (1,2,3)	RN assessment index-40 0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment
Stroke	No (0) Yes (1,2,3)	RN assessment index-25 0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment
Depression	No (0) Yes (1,2,3)	RN index-35 0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment
Alzheimer	No (0) Yes (1,2,3)	RN assessment index-22-23 0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment
Dementia	No (0) Yes (1,2,3)	RN assessment index-22-23 0= Not present, 1= Primary diagnosis(es), 2= Diagnosis present, receiving active treatment, 3= Diagnosis present, monitored but no active treatment
Mental disorders	'Behave_NOTconsis' (2) 'Behave_consis' (1) 'NO_Behave'(0) New_variable "mental" Yes (1,2) No (0)	RN Index-112 Mental function 0= Behavior not present, 1= Behavior present, consistent with usual functioning, 2= Behavior present, appears different from usual functioning
Number of hospitalization	If two assessments assess the periods overlapping for more than 45 days, number of hospitalization is considered as double counted in the assessments; if two assessments overlapped for less than 45 days, number of hospitalization will be the cumulative sum of the two assessments.	RN Index-12 Overnight Hospital stay 90 days. number of times during the LAST 90 DAYS

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