WAITING TIME TO HEALTH SERVICES

BY
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A Practicum Submitted to the Faculty of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of

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Department of Statistics

University of Manitoba

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Of

MASTER OF SCIENCE

Contents

List of Figures

List of Tables

Abstract

We analyze the waiting time for key medical diagnose and treatment service, using the Canadian Community Health Survey (CCHS) database. The waiting time is modeled by the generalized exponential distribution which is specified by a vector of covariates of patients' backgrounds. Important covariates are selected and the best fitted distribution function is determined. The parameters of the fitted distribution function are estimated and the model is validated.

Acknowledgements

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I also would like to thank Statistics Canada and the Research Data Center (RDC) for supplying database and for their financial support.

The Manitoba Graduate Scholarship (MGS) awarded to me was crucial to the successful completion of this practicum.

Finally, I am grateful to my husband and my son for their joy, love and support.

Chapter 1 Introduction

1.1 Background

Patient waiting time for key diagnoses and treatment service is one of the most frequently mentioned, important health issues. It is especially of concern for those patients who have less urgent or non-urgent medical problems. The issue of waiting times is often interested and discussed in the media as the public believes that some selected health care services should be provided rapidly.

The Canadian Community Health Survey (CCHS) collects information on waiting times for key diagnoses and treatment service and access to 24 hours a day, 7 days a week first contact health services. This survey contains much useful information, including patient experiences, acceptance and perceptions of waiting for care.

The CCHS operates on a two-year collection cycle. The first year of the survey cycle "x.1" is a large sample, general population health survey, designed to provide reliable estimates at the health region level. The cycle 3.1 was released on June 13, 2006 and covers all data collected from January to December 2005. The second year of the survey cycle ".2" has a smaller sample and is designed to provide provincial level results on specific focused health topics.

The CCHS is a cross-sectional survey that covers approximately 98% of the Canadian population aged 12 or older. A total of approximately 68,000 respondents include 119 Health Regions (HRs) covering the whole country. In total, after removing the out-of-scope units, the overall response rate is 78.9% for the CCHS Cycle 3.1.

1.2 Canadian Community Health Survey Description

1.2.1 Data sources

Data are collected directly from survey respondents. Responding to this survey is voluntary. The voluntary sample may over represent people with strong opinions. The CCHS questions are designed for computer-assisted interviewing (CAI).

Respondents were asked about their use of first contact services. Information on access to specialized services includes:

- experience of respondents requesting referral to see and care from a medical specialist such as a cardiologist, allergist, etc. to obtain diagnostics for new illness or condition;
- experience of respondents requesting non-emergency surgery such as cardiac surgery, joint replacement surgery, etc.;
- experience of respondents requesting and waiting for selected diagnostic tests: MRIs, CAT scans and angiographies.

Respondents were asked about their experiences of and opinions on accessing these services including waiting times, acceptability of the waiting time and economic, psychological, medical, and the other impact of the wait on the respondent.

1.2.2 Target population

The CCHS targets persons aged 12 years or older who are living in private dwellings in the ten provinces and the three territories. Persons living on Indian Reserves or Crown lands, residents of institutions, full-time members of the Canadian Armed Forces and residents of certain remote regions are excluded from this survey. The CCHS targets approximately 98% of the Canadian population aged 12 or older.

1.2.3 Sampling design

This is a sample survey with a cross-sectional design. A total of approximately 68,000 respondents covering 119 Health Regions (HRs) are interviewed. Given relatively equal importance to the HRs and the provinces, the sample was allocated among the provinces according to their respective populations and the number of HRs they cover, each province's sample was allocated among its HRs proportionally to the square root of the estimated population in each HR.

1.2.4 Weighting scheme

Each person in the sample "represents" several other persons not in the sample. For example, in a simple random 2% sample of the population, each person in the sample represents 50 persons in the population. In the terminology used here, it can be said that each person has a weight of 50. In order for estimates produced from survey data to be representative of the covered population, and not just the sample itself, we must incorporate the survey weights in calculations. A survey weight is given to each person, which corresponds to the number of persons in the entire population that are represented by the respondent.

1.3 Background on waiting times in Canada

Waiting time for health services has been an important issue is Canada for a long time. As earlier as in 1990, an article entitled "Canadians cross border to save their lives" appeared in the Wall Street Journal. It exposed the fact that many Canadians in Ontario went to the United States for open-heart surgery due to long waiting time for in Canada in the late 1980s. The general problem, together with important lessons and issues, are analyzed in depth, and solutions and implications for reform are proposed (Naylor 1991).

Canadian health care system is publicly funded and waiting to health services vary substantially from region to region, and from hospital to hospital. To address the important issues of long waiting time, the Western Canada Waiting List Project

(www.wcwl.org) developed standard measures to improve waiting time in 5 clinical areas: MRI scanning, hip and knee replacement, cataract surgery, general surgery procedures and children's mental health (Hadorn et. al. 2000).

However survival analysis has not been found to analyze waiting times. This is to be attempted in my practicum.

1.4 Scope of this project

The objectives of this research project include analyzing the CCHS cycle 3.1 database, finding an appropriate statistical model that best describes and measures the waiting time for key diagnostic and treatment services, and identifying the key factors that affect the patient waiting time. Patients' covariates are also included in the modeling of the distribution.

The practicum is organized as follows. In Chapter 2, we define the variables that are included in our analysis. In Chapter 3, we briefly review some survival data analysis methods and a concise comparison of those methods is given. In Chapter 4, data analysis is conducted to determine the best fitted distribution function and the parameters of the fitted distribution function are estimated. An overall summary and conclusions are given in chapter 5. In chapter 6, we discuss some potential issues that may exist and suggest further extensions of the method.

Chapter 2 Variable Specifications

We are interested in understanding the patients' waiting time for key diagnostic and treatment services. We statistically analyze the available data set to understand three important objectives:

1. Patients' waiting time to access service from a medical specialist;
2. Patients' waiting time to receive a non-emergency surgery;
3. Patients' waiting time to receive some selected diagnostic tests.

The variables used in our model are explained in detail as follows.

2.1 Common variables for all three objectives

(1) Variable name: DHHE_AGE

Description: This variable indicates the age of the respondent.

Data type: Categorical

Values taken: see appendix 7.2.1

(2) Variable name: DHHE_SEX

Description: This variable indicates the respondent's gender.

Data type: Categorical

Values taken: see appendix 7.2.1

(3) Variable name: GEOE_PRV

Description: This variable indicates the province of residence of the respondent.

Data type: Categorical

Values taken: see appendix 7.2.1

(4) Variable name: WTSE_S3M

Description: This is the sampling weight and corresponds to the number of people in the entire population that are represented by the respondent.

Data type: numerical

2.2 Variables describing access to service from a medical specialist

(1) Variable name: WTMZ_01

Description: This variable indicates whether the respondent visit to medical specialist for a diagnosis or a consultation for a new illness or condition in the past 12 months.

Data type: Categorical

Values taken: see appendix 7.2.2

(2) Variable name: WTMZ_02

Description: This variable indicates the type of health condition about which the respondent needs to see a medical specialist.

Data type: Categorical

Values taken: see appendix 7.2.2

(3) Variable name: WTMZ_03

Description: This variable indicates the person who referred the respondent to a medical specialist.

Data type: Categorical

Values taken: see appendix 7.2.2

(4) Variable name: WTMZ_04

Description: This variable indicates whether the respondent already visited a medical specialist.

Data type: Categorical

Values taken: see appendix 7.2.2

(5) Variable name: WTMZ_07A

Description: This variable indicates the length of wait that passed between the moment the respondent and his or her doctor decided that the respondent should see a medical specialist and when the actual visit with the specialist took place.

For this variable, the number of waiting days has only been considered for a respondent 15 years and older who consulted a medical specialist due to a new health related problem during the past 12 months.

Data type: Mixed.

Values taken: see appendix 7.2.2

(6) Variable name: WTMZ_07B

Description: This variable indicates the reporting unit for length of wait to see a specialist.

Data type: Categorical

Values taken: see appendix 7.2.2

(7) Variable name: WTMZ_08A

Description: This variable indicates the length of time that passed between the moment the respondent and his or her doctor decided the respondent should see a specialist and when the survey interview took place. For this variable, the number of waiting days has only been considered for respondents 15 years and older who were referred to a specialist due to a new health related problem during the past 12 months, but who did not see the specialist with whom they had an appointment.

Data type: Mixed.

Values taken: see appendix 7.2.2

(8) Variable name: WTMZ_08B

Description: This variable indicates the reporting unit for length of waiting time to see a specialist.

Data type: Categorical

Values taken: see appendix 7.2.2

2.3 Variables describing the waiting time for non-emergency surgery

(1) Variable name: ACCZ_20

Description: This variable indicates whether the respondent required non-emergency surgery in the past 12 months. Non-emergency surgery includes any surgery not provided in an emergency, such as cardiac surgery, joint surgery, caesarean sections and cataract surgery, but excludes laser eye surgery.

Data type: Categorical

Values taken: see appendix 7.2.3

(2) Variable name: WTMZ_16

Description: This variable indicates the type of surgery the respondent required.

Data type: Categorical

Values taken: see appendix 7.2.3

(3) Variable name: WTMZ_18

Description: This variable indicates whether the surgery required an overnight hospital stay.

Data type: Categorical

Values taken: see appendix 7.2.3

(4) Variable name: WTMZ_19

Description: This variable indicates whether the respondent experienced difficulties getting the surgery.

Data type: Categorical

Values taken: see appendix 7.2.3

(5) Variable name: WTMZ_20A

Description: This variable indicates whether the respondent experienced difficulty getting an appointment with a surgeon.

Data type: Categorical

Values taken: see appendix 7.2.3

(6) Variable name: WTMZ_20B

Description: This variable indicates whether the respondent experienced difficulty getting a diagnosis.

Data type: Categorical

Values taken: see appendix 7.2.3

(7) Variable name: WTMZ_20C

Description: This variable indicates whether the respondent waited long for a diagnostic test.

Data type: Categorical

Values taken: see appendix 7.2.3

(8) Variable name: WTMZ_20D

Description: This variable indicates whether the respondent waited long for a hospital bed to become available.

Data type: Categorical

Values taken: see appendix 7.2.3

(9) Variable name: WTMZ_20E

Description: This variable indicates whether the respondent waited long for surgery.

Data type: Categorical

Values taken: see appendix 7.2.3

(10) Variable name: WTMZ_20F

Description: This variable indicates whether the respondent could not receive a service because it is not available in the area.

Data type: Categorical

Values taken: see appendix 7.2.3

(11) Variable name: WTMZ_20G

Description: This variable indicates whether the respondent experienced difficulty of transportation to have a surgery.

Data type: Categorical

Values taken: see appendix 7.2.3

(12) Variable name: WTMZ_20H

Description: This variable indicates whether the respondent experienced difficulty in language communication.

Data type: Categorical

Values taken: see appendix 7.2.3

(13) Variable name: WTMZ_20I

Description: This variable indicates whether the respondent experienced difficulty due to lack of cost.

Data type: Categorical

Values taken: see appendix 7.2.3

(14) Variable name: WTMZ_20J

Description: This variable indicates whether the respondent experienced difficulty relating to personal or family responsibilities.

Data type: Categorical

Values taken: see appendix 7.2.3

(15) Variable name: WTMZ_20K

Description: This variable indicates whether the respondent experienced difficulty due to general deterioration of health.

Data type: Categorical

Values taken: see appendix 7.2.3

(16) Variable name: WTMZ_20L

Description: This variable indicates whether the respondent experienced appointment cancellation or deferral by a surgeon or hospital.

Data type: Categorical

Values taken: see appendix 7.2.3

(17) Variable name: WTMZ_20M

Description: This variable indicates whether the respondent experienced difficulty

of leaving the house due to health problems.

Data type: Categorical

Values taken: see appendix 7.2.3

(18) Variable name: WTMZ_20N

Description: This variable indicates whether the respondent experienced other types of difficulties.

Data type: Categorical

Values taken: see appendix 7.2.3

(19) Variable name: WTMZ_21A

Description: This variable indicates the length of wait between the decision of a surgery and the day of the surgery.

Data type: Mixed.

Values taken: see appendix 7.2.3

(20) Variable name: WTMZ_21B

Description: This variable indicates the reporting unit for length of waiting to surgery.

Data type: Categorical

Values taken: see appendix 7.2.3

(21) Variable name: WTMZ_22

Description: This variable indicates whether the surgery required overnight hospital stay.

Data type: Categorical

Values taken: see appendix 7.2.3

(22) Variable name: WTME_23A

Description: This variable indicates the length of time that the respondent had been waiting since the respondent and the surgeon decided to go ahead with the surgery.

Data type: Mixed.

Values taken: see appendix 7.2.3

(23) Variable name: WTMZ_23B

Description: This variable indicates the reporting unit for length of time for waiting to surgery.

Data type: Categorical

Values taken: see appendix 7.2.3

(24) Variable name: WTMZ_26

Description: This variable indicates whether the respondent's surgery was cancelled or postponed at any time.

Data type: Categorical

Values taken: see appendix 7.2.3

(25) Variable name: WTMZ_27A

Description: This variable indicates whether the respondent's surgery was cancelled or postponed by the respondent himself / herself.

Data type: Categorical

Values taken: see appendix 7.2.3

(26) Variable name: WTMZ_27B

Description: This variable indicates whether the respondent's surgery was cancelled or postponed by the surgeon.

Data type: Categorical

Values taken: see appendix 7.2.3

(27) Variable name: WTMZ_27C

Description: This variable indicates whether the respondent's surgery was cancelled or postponed by the hospital.

Data type: Categorical

Values taken: see appendix 7.2.3

(28) Variable name: WTMZ_27D

Description: This variable indicates whether the respondent's surgery was cancelled or postponed by others.

Data type: Categorical

Values taken: see appendix 7.2.3

2.4 Variables describing selected diagnostic tests

(1) Variable name: ACCZ_30

Description: This variable indicates whether the respondent required MRI, CT Scan, angiography tests which was available to the public in a non-emergency situation in the past 12 months.

Data type: Categorical

Values taken: see appendix 7.2.4

(2) Variable name: WTMZ_30

Description: This variable indicates the type of tests (MRI, CT Scan, angiography) the respondent required.

Data type: Categorical

Values taken: see appendix 7.2.4

(3) Variable name: WTMZ_31

Description: This variable indicates the respondent's type of health problems required for diagnostic tests.

Data type: Categorical

Values taken: see appendix 7.2.4

(4) Variable name: WTMZ_32

Description: This variable indicates whether the respondent already had the test.

Data type: Categorical

Values taken: see appendix 7.2.4

(5) Variable name: WTMZ_33

Description: This variable indicates the location of test.

Data type: Categorical

Values taken: see appendix 7.2.4

(6) Variable name: WTMZ_35

Description: This variable indicates whether the respondent was in the hospital at the time of the test.

Data type: Categorical

Values taken: see appendix 7.2.4

(7) Variable name: WTMZ_36

Description: This variable indicates whether the respondent experienced any difficulty in getting the test.

Data type: Categorical

Values taken: see appendix 7.2.4

(8) Variable name: WTMZ_37A

Description: This variable indicates whether the respondent experienced any difficulty in getting a referral.

Data type: Categorical

Values taken: see appendix 7.2.4

(9) Variable name: WTMZ_37B

Description: This variable indicates whether the respondent experienced difficulty in getting an appointment.

Data type: Categorical

Values taken: see appendix 7.2.4

(10) Variable name: WTMZ_37C

Description: This variable indicates whether the respondent waited long to get an appointment.

Data type: Categorical

Values taken: see appendix 7.2.4

(11) Variable name: WTMZ_37D

Description: This variable indicates whether the respondent waited long to get tested (in-office waiting).

Data type: Categorical

Values taken: see appendix 7.2.4

(12) Variable name: WTMZ_37E

Description: This variable indicates whether the respondent experienced any difficulty due to service not available at the time of request.

Data type: Categorical

Values taken: see appendix 7.2.4

(13) Variable name: WTMZ_37F

Description: This variable indicates whether the respondent experienced difficulty due to service not available in the area.

Data type: Categorical

Values taken: see appendix 7.2.4

(14) Variable name: WTMZ_37G

Description: This variable indicates whether the respondent experienced transportation difficulties.

Data type: Categorical

Values taken: see appendix 7.2.4

(15) Variable name: WTMZ_37H

Description: This variable indicates whether the respondent experienced language difficulties.

Data type: Categorical

Values taken: see appendix 7.2.4

(16) Variable name: WTMZ_37I

Description: This variable indicates whether the respondent experienced financial difficulties.

Data type: Categorical

Values taken: see appendix 7.2.4

(17) Variable name: WTMZ_37J

Description: This variable indicates whether the respondent experienced general deterioration of health.

Data type: Categorical

Values taken: see appendix 7.2.4

(18) Variable name: WTMZ_37K

Description: This variable indicates whether the respondent experienced difficulty in finding out where to get information.

Data type: Categorical

Values taken: see appendix 7.2.4

(19) Variable name: WTMZ_37L

Description: This variable indicates whether the respondent experienced difficulty in leaving house due to health problem.

Data type: Categorical

Values taken: see appendix 7.2.4

(20) Variable name: WTMZ_37M

Description: This variable indicates whether the respondent experienced other types of difficulties.

Data type: Categorical

Values taken: see appendix 7.2.4

(21) Variable name: WTMZ_38A

Description: This variable indicates the length of wait between the day of making the decision for a test and the actual day of the test.

Data type: Mixed.

Values taken: see appendix 7.2.4

(22) Variable name: WTMZ_38B

Description: This variable indicates the reporting unit for length of wait to the test.

Data type: Categorical

Values taken: see appendix 7.2.4

(23) Variable name: WTME_39A

Description: This variable indicates the length of time that the respondent had been waiting since the respondent and the doctor decided to go ahead with the test.

Data type: Mixed.

Values taken: see appendix 7.2.4

(24) Variable name: WTMZ_39B

Description: This variable indicates the reporting unit for length of time waiting to the test.

Data type: Categorical

Values taken: see appendix 7.2.4

(25) Variable name: WTMZ_42

Description: This variable indicates whether the respondent's test was cancelled or postponed at any time.

Data type: Categorical

Values taken: see appendix 7.2.4

(26) Variable name: WTMZ_43

Description: This variable indicates the reason for the respondent's test being cancelled or postponed.

Data type: Categorical

Values taken: see appendix 7.2.4

Chapter 3 Survival Data Analysis Methods

3.1 Basic concepts of survival analysis

Data collected on the time to an event are known as **survival data**. Survival data are generally not symmetrically distributed. The histogram of the survival times of a group of similar individuals will typically tend to be positively skewed and survival times are frequently censored. When the end-point of interest has not been observed for that individual, the survival time of the individual is said to be right **censored**.

To analyze survival data, there are two functions of core interest: the survivor function and the hazard function. The **survivor function,** $S(t)$, is used to represent the probability that an individual survives beyond time t, that is,

(3.1) $$S(t)=P(T\geq t)=1-F(t).$$

Let I_A be the indicator function of A. The **mean residual lifetime** is

(3.2) $$m(t)=E(T-t\mid T\geq t)=\frac{\int_0^\infty (u-t)I_{\{u\geq t\}}f(u)du}{\int_t^\infty f(u)du}=\frac{\int_t^\infty (u-t)f(u)du}{\int_t^\infty f(u)du}.$$

Let $w=u-t$ and $dv=f(u)du$, so that $dw=du$ and $v=-S(u)$,

and hence $$m(t)=\frac{\int_t^\infty w\,dv}{\int_t^\infty dv}=\frac{wv\big|_t^\infty-\int_t^\infty v\,dw}{\int_t^\infty dv}=\frac{(u-t)[-S(u)]\,\big|_t^\infty-\int_t^\infty -S(u)\,du}{v\big|_t^\infty}$$

$$=\frac{-S(u)(u-t)\,\big|_t^\infty+\int_t^\infty S(u)\,du}{-S(u)\,\big|_t^\infty}=\frac{\int_t^\infty S(u)\,du}{S(t)}\quad,\quad \text{where: } \lim_{x\to\infty}S(x)(x-t)=0$$

The mean survival time, or the expected value of the lifetime is,

(3.3) $$E(t)=m(0)=\frac{\int_0^\infty S(u)\,du}{S(0)}=\int_0^\infty S(t)\,dt\,.$$

However, since the histogram of the survival times of a group of similar individuals typically tends to be positively skewed, a more appropriate and tractable measure of center of the distribution is the median survival time, which is the value $\tilde{t}$ such that $S(\tilde{t})=0.5$

The **hazard function** is the conditional probability that an individual dies instantaneously after time t given that the individual has survived to that time t. It represents the instantaneous death rate for an individual surviving to time t as is given by

(3.4) $$h(t)=\lim_{\Delta t\to 0}P(t\le T<t+\Delta t\,|\,T\ge t)=\lim_{\Delta t\to 0}\frac{P(t\le T<t+\Delta t)}{P(T\ge t)\Delta t}$$

$$=\lim_{\Delta t\to 0}\frac{F(t+\Delta t)-F(t)}{S(t)\Delta t}=\frac{f(t)}{S(t)}\,.$$

Survival analysis is the statistical study of survival data. It requires that data correspond to the time from a well defined time origin until the occurrence of some particular event of end-point. Survival time can be defined broadly as the time to the occurrence of a given event. In our project, the events are the moment that a patient receives a medical service, so the lengths of waiting to receive the medical service are regarded as survival time. Statistical methods of survival data analysis are considered to be nonparametric if the survival distribution is completely unknown in its form, parametric if the distribution of survival times has a known form but with unknown parameters. An initial step in the analysis of a set of survival data is to present numerical or graphical summaries of the survival times for individuals in a particular group. We are interested in finding a distribution that describes the waiting time of the patients.

3.2 Graphical methods for survival distribution fitting

We need to find a distribution that fits the data well. Several kinds of graphs (including the survival distribution versus time, the cumulative hazard function versus time, and the log cumulative survival versus log time) are plotted from which the possible candidates of appropriate survival distributions are hypothesized. Then parametric tests are used to statistically examine the goodness-of-fit of the hypothesized distributions.

3.2.1 Survival distribution for accessing service from a medical specialist

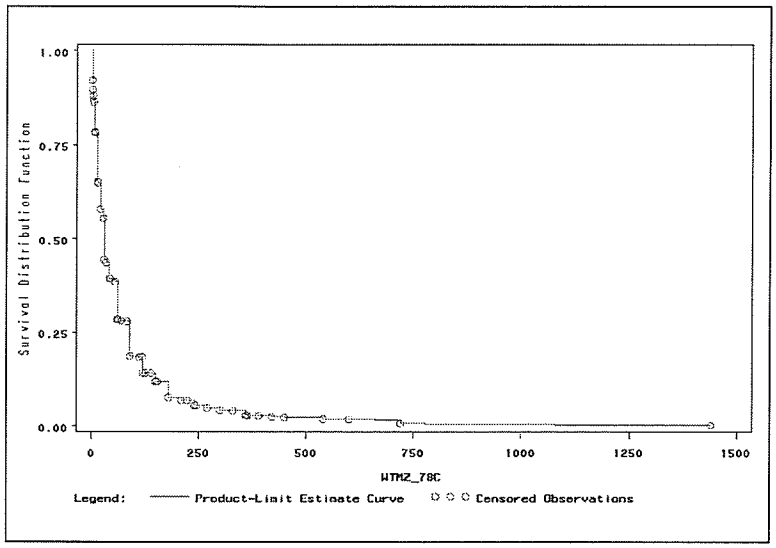

Figure 3.1 Survival density plot of the waiting time to access the service from a medical specialist.

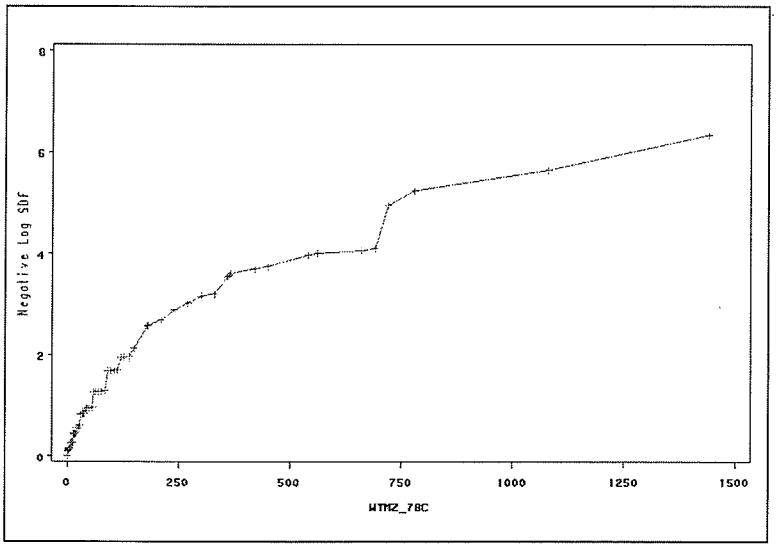

Figure 3.2 Cumulative hazard plot of the waiting time to access the service from a medical specialist.

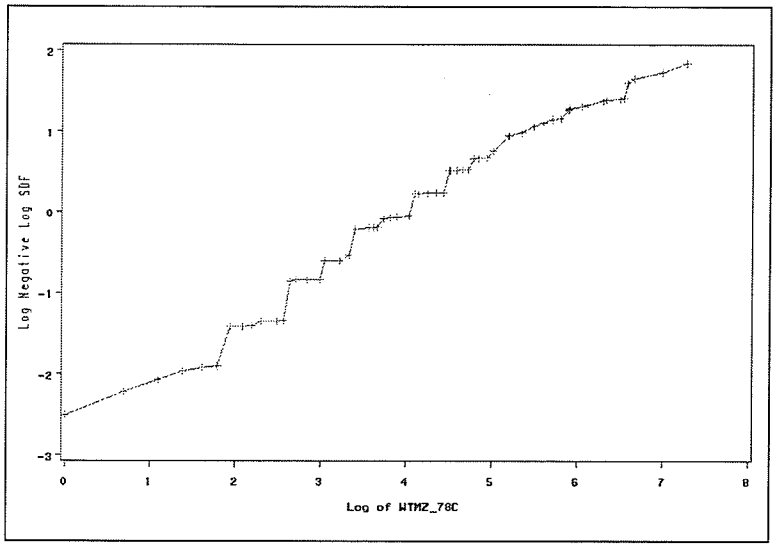

Figure 3.3 Log-cumulative hazard plot of the waiting time to access the service from a medical specialist.

3.2.2 Survival distribution for receiving a non-emergency surgery

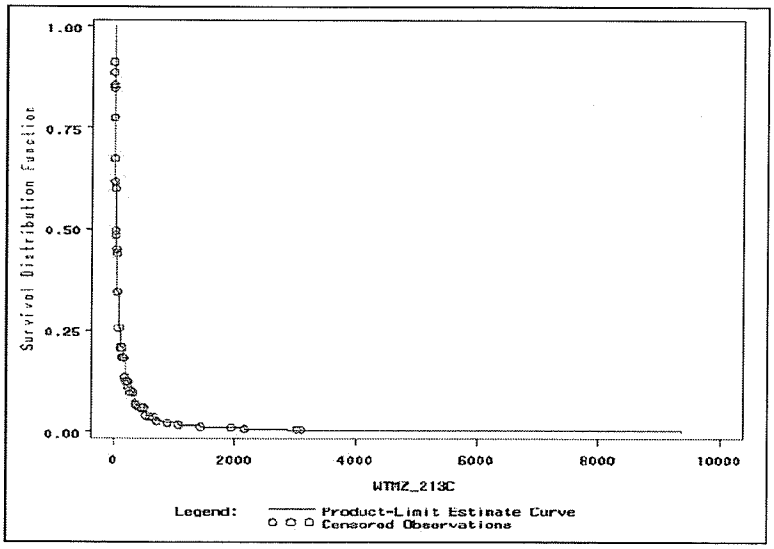

Figure 3.4 Survival density plot of the waiting time to receive a non-emergency surgery.

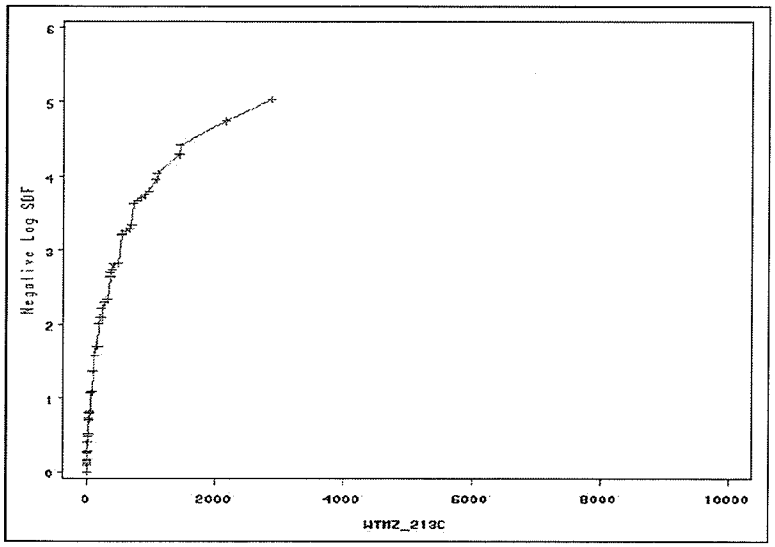

Figure 3.5 Cumulative hazard plot of the waiting time to receive a non-emergency surgery.

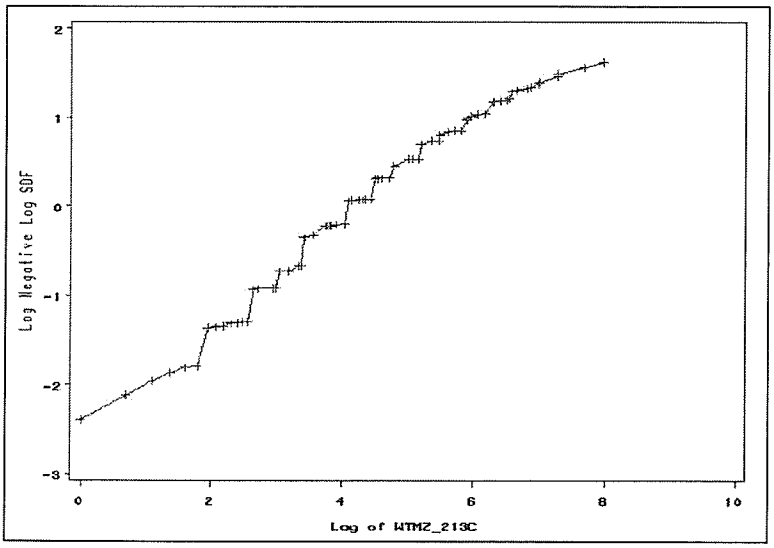

Figure 3.6 Log-cumulative hazard plot of the waiting time to receive a non-emergency surgery.

3.2.3 Survival distribution for receiving selected diagnostic tests

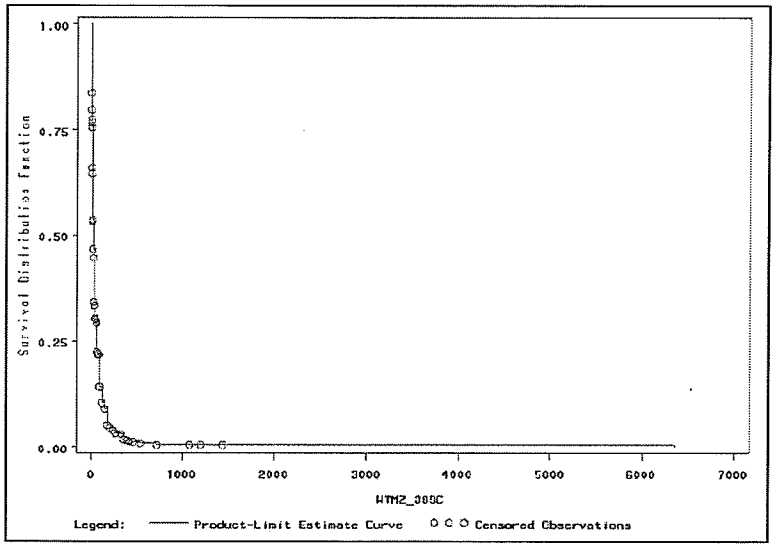

Figure 3.7 Survival density plot of the waiting time to receive selected diagnostic tests

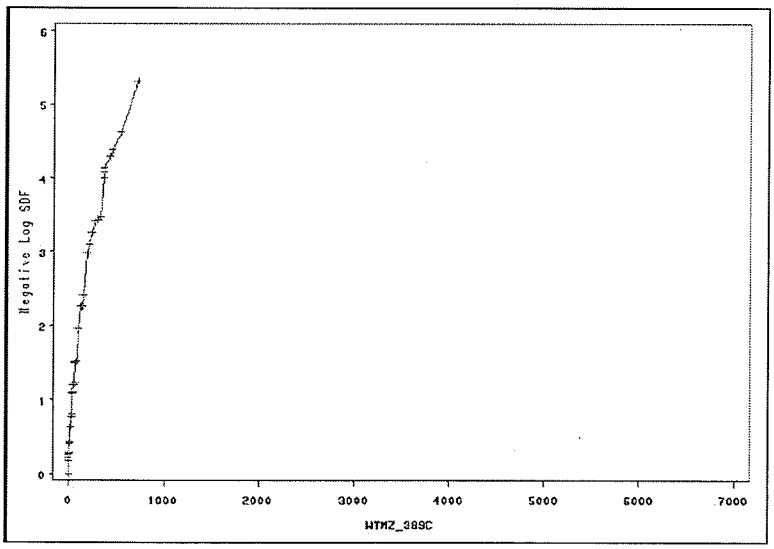

Figure 3.8 Cumulative hazard plot of the waiting time to receive selected diagnostic tests

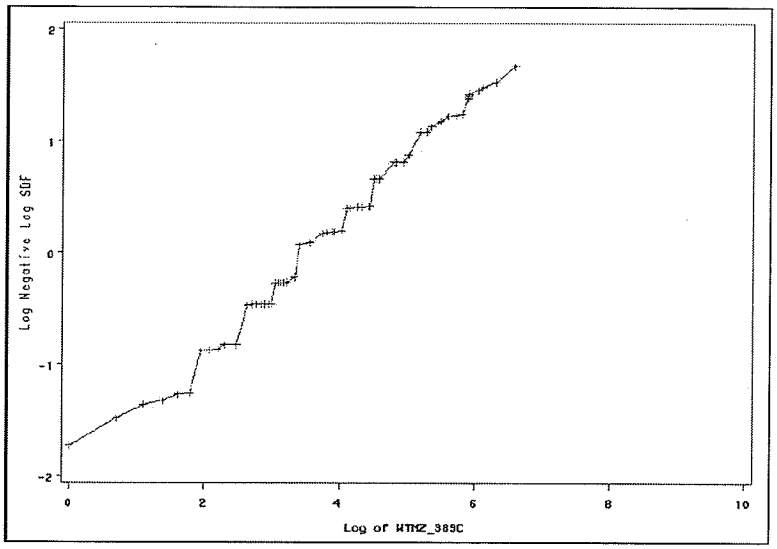

Figure 3.9 Log-cumulative hazard plot of the waiting time to receive selected diagnostic tests.

From the plots of log-cumulative hazard versus the log of waiting time (Figure 3.3, Figure3.6 and Figure 3.9), it appears that a linear model fit is appropriate. Following the procedure discussed in section 3.3.1, this suggests that the Weibull distribution may provide good fits to the data of the waiting time to access the service from a medical specialist, to receive a non-emergency surgery and to receive selected diagnostic tests. In fact, statistical tests have been carried out and indeed the fit of the Weibull distribution is statistically significant in all three cases.

3.3 The Weibull model for survival data

The Weibull hazard function is

(3.5) $$h(t) = \lambda\gamma\, t^{\gamma-1} \qquad t \geq 0,\ \gamma > 0,\ \lambda > 0\ ,$$

where γ is known as the shape parameter, and λ is known as the scale parameter. The survival function is

(3.6) $$S(t) = \exp\left[-\lambda t^{\gamma}\right].$$

and the corresponding probability density function is

(3.7) $$f(t) = \lambda\gamma\, t^{\gamma-1} \exp\left[-\lambda t^{\gamma}\right].$$

The cumulative distribution function is

(3.8) $$F(t) = 1 - \exp\left[-\lambda t^{\gamma}\right]$$

The mean and median survival times of the Weibull distribution are

(3.9) $$\mu = E(t) = \frac{\Gamma\left[1+1/\gamma\right]}{\lambda^{1/\gamma}}$$

and

(3.10) $$median = \left[\frac{\log 2}{\lambda}\right]^{1/\gamma}.$$

and the variance of the distribution is

(3.11) $$\sigma^2 = \frac{1}{\left(\lambda^{1/\gamma}\right)^2}\left[\Gamma\left(1+\frac{2}{\gamma}\right)-\Gamma^2\left(1+\frac{1}{\gamma}\right)\right].$$

3.3.1 Preliminary study of the assessment of model fitting

Suppose the survival times have a Weibull distribution with a scale parameter λ and a shape parameter γ. Taking the negative logarithm of $S(t)$, and then taking log again, equation (3.6) gives us

(3.12) $$\log\{-\log S(t)\} = \log\lambda + \gamma \log t .$$

This indicates that the Weibull distribution is characterized by a straight line of $\log\{-\log S(t)\}$ versus $\log t$, and the intercept is $\log\lambda$ and the slope is γ. We substitute the Kaplan-Meier estimate of the survivor function $\hat{S}(t)$ for $S(t)$ in equation (3.12). If the assumption of a Weibull distribution is appropriate, $\hat{S}(t)$ should be close to $S(t)$, and the plot of $\log\{-\log\hat{S}(t)\}$ against $\log t$ would give an approximately straight line. Let $H(t)$ be the cumulative hazard function. Since

(3.13) $$-\log S(t) = H(t),$$

then the plot of $\log\{-\log\hat{S}(t)\}$ against $\log t$ would be close to a straight line if the Weibull distribution is appropriate.

To determine the Kaplan-Meier estimate of the survivor function from a sample of censored survival data, a series of time intervals is formed, such that distinct death times are taken to be the start of the intervals, except for time $t_0 = 0$.

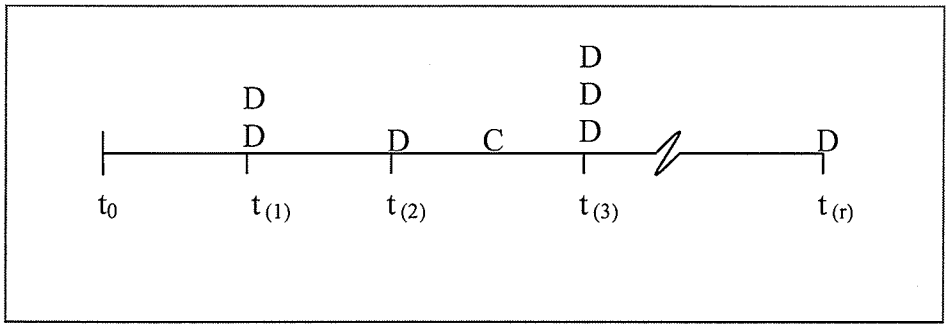

Figure 3.10 Construction of intervals used in the derivation of the Kaplan-Meier estimate.

Suppose that there are n individuals with observed survival times $t_{(1)}$, $t_{(2)}$, $t_{(3)}$, ..., $t_{(n)}$. Some observations are censored, and there may also be more than one individual with the same observed survival time. The situation is illustrated diagrammatically in Figure 3.10, in which D represents a death and C pepresents a censored survival time. Time origin is denoted by t_0, and so there is an initial period commencing at t_0 which ends just before $t_{(1)}$. There are r distinct death times amongst the individuals, where $r \leq n$. So the ordered distinct death times are $t_{(1)} < t_{(2)} < t_{(3)} < \ldots < t_{(r)}$. The number of individuals who are alive just before time $t_{(j)}$, including those who die at time $t_{(j)}$, is denoted as n_j, $j = 1, 2, 3, \ldots, r$, and the number of deaths at time $t_{(j)}$ is denoted as d_j denotes. Here the time interval $[t_{(j)} - \delta, t_{(j)}]$ includes one death time, where δ is an infinitesimally small number. The estimated probability of survival through the interval is estimated by $(n_j - d_j)/n_j$.

If a death time and a censored survival time occur simultaneously, the censored survival time is taken to occur immediately after the death time when computing the values of n_j.

Under the assumption that the deaths of the individuals in the sample occur independently of one another, the estimated survivor function at any time in the k'th constructed time interval $\left[t_{(k)}, t_{(k+1)}\right)$, k = 1, 2, 3, ... , r, is the probability of surviving through the interval $\left[t_{(k)}, t_{(k+1)}\right)$, and all preceding intervals. This is the Kaplan-Meier estimate of the survivor function

$$\hat{S}(t) = \prod_{j=1}^{k}\left(\frac{n_j - d_j}{n_j}\right). \tag{3.14}$$

3.3.2 Weibull regression model

Now, we consider the effects of some covariates $x = \left(x_{1i}, x_{2i}, \cdots, x_{pi}\right)$. From section 3.3.1, it is reasonable to assume that the waiting times to access service from a medical specialist, to receive a non-emergency surgery and to receive selected diagnostic tests can be modeled by the Weibull distribution. To incorporate covariates into the Weibull distribution, we use a model for the log-survival-time of individual i defined as

$$\log T_i = \alpha_0 + \sum_{k=1}^{p}\alpha_k x_{ki} + \sigma\varepsilon_i \tag{3.15}$$

where $\alpha = \left(\alpha_0, \alpha_1, \alpha_2, \cdots, \alpha_p\right)$ are the coefficients of the covariates, ε has density

function $g(\varepsilon)$ and survivorship function $G(\varepsilon)$ given by

(3.16) $$g(\varepsilon) = \exp[\varepsilon - \exp(\varepsilon)]$$

and

(3.17) $$G(\varepsilon) = \exp[-\exp(\varepsilon)]$$

Then, $S(t) = P(T_i \geq t) = P(\log T_i \geq \log t)$

$$= P(\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki} + \sigma\varepsilon_i \geq \log t) = P\left[\sigma\varepsilon_i \geq \log t - (\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki})\right]$$

$$= P\left[\varepsilon_i \geq \frac{\log t - (\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki})}{\sigma}\right]$$

$$= \exp\left[-\exp\left(\frac{\log t - (\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki})}{\sigma}\right)\right]$$

$$= \exp\left[-t^{\frac{1}{\sigma}} \exp\left(-\frac{\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki}}{\sigma}\right)\right]$$

This model is the Weibull regression model. The survival time T_i has the Weibull distribution with

(3.18) $$\lambda_i = \exp\left[\frac{-\left(\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki}\right)}{\sigma}\right] \quad \text{and} \quad \gamma = \frac{1}{\sigma}$$

and the corresponding hazard, density, and survival functions are

(3.19) $$h(t, \lambda_i, \gamma) = \lambda_i \gamma \, t^{\gamma-1}$$

(3.20) $$f(t, \lambda_i, \gamma) = \lambda_i \gamma \, t^{\gamma-1} \exp\left(-\lambda_i t^{\gamma}\right).$$

(3.21) $$S(t, \lambda_i, \gamma) = \exp\left(-\lambda_i t^{\gamma}\right)$$

There are p covariates considered in the analysis of waiting time to access service from a medical specialist. We assume that the logarithm of waiting time has an explicit relationship with the covariates. Let $x = \left(x_{1i}, x_{2i}, \cdots, x_{pi}\right)$ denote the p covariates considered. If the parameter λ_i in the Weibull distribution is related to the vector x as in equation (3.18), then equation (3.21) becomes

(3.22)

$$\log\{-\log S(t, \lambda_i, \gamma)\} = -\gamma\left(\alpha_0 + \sum_{k=1}^{p} \alpha_k x_{ki}\right) + \gamma \log t = -\left(\beta_0 + \sum_{k=1}^{p} \beta_k x_{ki}\right) + \gamma \log t$$

which presents a linear relationship between $\log\{-\log S(t, x)\}$, $\log t$ and the covariates.

We construct the log-likelihood function to estimate the unknown coefficients $\alpha = \left(\alpha_0, \alpha_1, \alpha_2, \cdots, \alpha_p\right)$. The likelihood function of the waiting time T for the n completed or m censored observations is

(3.23) $$L(\alpha_0,\alpha_1,\cdots,\alpha_p,\gamma)=\prod_{i=1}^{n+m}\left[f(t_i)^{\delta_i}S(t_i)^{1-\delta_i}\right]^{w_i}$$

Where δ_i is an indicator variable taking value zero when the waiting time t_i is censored and value one when t_i is an uncensored waiting time. Placing the $f(t_i,\lambda_i,\gamma)$ and $S(t_i,\lambda_i,\gamma)$ in the log-likelihood function gives

(3.23) $$\log L(\alpha_0,\alpha_1,\cdots,\alpha_p,\gamma)=\sum w_i\log[f(t_i,\lambda_i,\gamma)]+\sum w_i\log[S(t_i,\lambda_i,\gamma)]$$

$$=\sum w_i\left\{\log\gamma+(\gamma-1)\log t_i-\gamma\left(a_0+\sum_{k=1}^{p}a_kx_{ki}\right)-t_i^{\gamma}\exp\left[-\gamma\left(a_0+\sum_{k=1}^{p}a_kx_{ki}\right)\right]\right\}$$

$$+\sum w_i\left\{-t_i^{\gamma}\exp\left[-\gamma\left(a_0+\sum_{k=1}^{p}a_kx_{ki}\right)\right]\right\}$$

In this log-likelihood function, the first term sums over the completed observations and the second term sums over the censored observations. By applying the Newton-Raphson iteration procedure, the maximum likelihood estimates $MLE(\hat{\alpha}_0,\hat{\alpha}_1,\cdots\hat{\alpha}_p)$ of $(\alpha_0,\alpha_1,\cdots\alpha_p)$ are the solution of

(3.24) $$\frac{\partial\log L(\alpha_0,\alpha_1,\cdots,\alpha_p,\gamma)}{\partial\alpha_i}=0 \qquad i=0,1,\cdots,p$$

where $\sigma=1/\lambda$.

The survivorship function in (3.21) can be estimated by using (3.18) and $MLE(\hat{\alpha}_0,\hat{\alpha}_1,\cdots\hat{\alpha}_p)$, and σ.

Chapter 4 Results of Data Analysis

4.1 Fitting survival distributions of waiting time to access service from a medical specialist

Let WTMZ_78C be the waiting time to access service from a medical specialist, Censor be a dummy variable with Censor=0 if WTMZ_78C is censored and 1 otherwise, and DHHE_AGE, DHHE_SEX, GEOE_PRV, WTMZ_02 and WTMZ_03 be the index variables described in section 2.1 and section2.2, and WTSE_S3M be the weighting variable. From section 3.2, it is reasonable to assume that the waiting time to access service from a medical specialist follows a Weibull distribution. Incorporating covariates, the following regression model is used:

$$\begin{aligned}(4.1)\quad \log(WTMZ\_78C)_i &= a_0 + \alpha_1(DHHE\_AGE\_1)_i + \cdots + \alpha_{14}(DHHE\_AGE\_14)_i \\ &+ \alpha_{15}(DHHE\_SEX\_1) + \alpha_{16}(DHHE\_PRV\_1)_i + \cdots + \alpha_{27}(DHHE\_PRV\_61)_i \\ &+ \alpha_{28}(WTMZ\_02\_1)_i + \cdots + \alpha_{35}(WTMZ\_02\_8)_i + \alpha_{36}(WTMZ\_03\_1)_i \\ &+ \cdots + \alpha_{38}(WTMZ\_03\_3) + \sigma\varepsilon_i\end{aligned}$$

where ε_i has an extreme value distribution as defined in (3.16), and $\alpha = (\alpha_0, \alpha_1, \cdots, \alpha_{38})$ are the coefficients of covariates. This model is the Weibull

regression model. The variable $WTMZ\_78C$ has the Weibull distribution with

$$(4.2) \qquad \lambda_i = \exp\left\{\frac{-\left[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i + \cdots \alpha_{38} (WTMZ\_03)_i\right]}{\sigma}\right\} \text{ and } \gamma = \frac{1}{\sigma}$$

We consider each observation's weight, which corresponds to the number of persons in the entire population that are represented by the respondent. The weighted log-likelihood function of the waiting time WTMZ_78C to access service from a medical specialist for the 4004 completed and 348 censored observations is

$$(4.3) \qquad \log L(a_0, a_1, \cdots, a_p, \gamma) = \sum (\text{WTSE\_S3M})_i \left\{ \log[f(t_i, \lambda_i, \gamma)] + \log[S(t_i^*, \lambda_i, \gamma)] \right\}$$

$$= \sum (WTSE\_S3M)_i \Big\langle \log\gamma + (\gamma - 1)\log(WTMZ\_78C)_i$$

$$-\gamma \left[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i + \cdots + a_{38} (WTMZ\_03\_3)_i\right]$$

$$-(WTMZ\_78C)_i^{\gamma} \exp\Big\{ -\gamma[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i$$

$$+ \cdots + a_{38} (WTMZ\_03\_3)_i] \Big\} \Big\rangle$$

$$+ \sum (WTSE\_S3M)_i \Big\langle -(WTMZ\_78C)_i^{\gamma} \exp\Big\{ -\gamma \left[\alpha_0 + \alpha_1 (DHHE\_AGE)_i$$

$$+ \cdots + \alpha_{38} (WTMZ\_03\_3)_i] \Big\} \Big\rangle$$

The covariate DHHE_AGE, DHHE_SEX, GEOE_PRV, WTMZ_02, WTMZ_03 are coded as indicator (dummy) variables, therefore, a set of indicator variables were created

in the DATA step (in SAS). After eliminating the insignificant covariates, the final results from SAS based on the Weibull regression model in (4.1) are shown in Table 4.1, where Intercept=α_0, and SCALE=σ

Analysis of Parameter Estimates						
Parameter	**DF**	**Estimate**	**Standard Error**	**95% Confidence Limits**	**Chi-Square**	**Pr > ChiSq**
Intercept	1	3.5329	0.0027	3.5276 3.5381	1738008	<.0001
GEOE_PRV_11	1	-0.0587	0.0102	-0.0788 -0.0387	32.94	<.0001
GEOE_PRV_48	1	-0.0253	0.0027	-0.0306 -0.0199	84.68	<.0001
GEOE_PRV_59	1	0.0111	0.0022	0.0068 0.0154	25.38	<.0001
WTMZ_02_1	1	-0.2381	0.0028	-0.2435 -0.2326	7341.56	<.0001
WTMZ_02_2	1	-0.6171	0.0033	-0.6234 -0.6107	35975.2	<.0001
WTMZ_02_4	1	0.2938	0.0040	0.2859 0.3018	5279.59	<.0001
WTMZ_03_1	1	0.5647	0.0028	0.5592 0.5702	40669.1	<.0001
WTMZ_03_2	1	0.3372	0.0035	0.3303 0.3441	9187.52	<.0001
WTMZ_03_3	1	0.0263	0.0035	0.0193 0.0332	54.96	<.0001
Scale	1	1.2588	0.0006	1.2576 1.2599		
Weibull Shape	1	0.7944	0.0004	0.7937 0.7951		

Table 4.1 Results for the waiting time to access the service from a medical specialist.

Here in this table, the chi-square refers to the value of the statistical for the likelihood ratio test for the local test of individual parameters. Moreover, only statistically significant covariates are reported in the table.

The final estimated regression model is obtained as:

(4.4)

$$\log(WTMZ\_78C)_i = 3.5329 - 0.0587(GEOE\_PRV\_11)_i - 0.0253(GEOE\_PRV\_48)_i$$
$$+ 0.0111(GEOE\_PRV\_59)_i - 0.2381(WTMZ\_02\_1)_i - 0.6171(WTMZ\_02\_2)_i$$
$$+ 0.2938(WTMZ\_02\_4)_i + 0.5647(WTMZ\_03\_1)_i + 0.3372(WTMZ\_03\_2)_i$$
$$+ 0.0263(WTMZ\_03\_3)_i + 1.2588\varepsilon_i$$

The (likelihood ratio, score and Wald) global tests all indicate that the fitted model is statistically significant at 5% level of significance. The null hypothesis states that all population parameters (except for the intercept) in the linear models are equal to zero.

4.2 Fitting survival distributions of waiting time to receive a non-emergency surgery

Let WTMZ_213C be the waiting time to receive the non-emergency surgery, Censor be a dummy variable with Censor=0 if WTMZ_213C is censored and 1 otherwise, and DHHE_AGE, DHHE_SEX, GEOE_PRV, WTMZ_16, WTMZ_17, WTMZ_18, WTMZ_19, WTMZ_20, WTMZ_22, WTMZ_26 and WTMZ_27 be index variables described in section 2.1 and section 2.3, and WTSE_S3M be the weighting variable. From section 3.2, it is reasonable to assume that the waiting time to receive a non-emergency surgery follows a Weibull distribution. Incorporating covariates, the following regression model is used:

$$
\begin{aligned}
(4.5)\quad \log(WTMZ\_213C)_i = {} & a_0 + \alpha_1(DHHE\_AGE\_1)_i + \cdots + \alpha_{14}(DHHE\_AGE\_14)_i \\
& + \alpha_{15}(DHHE\_SEX\_1) + \alpha_{16}(DHHE\_PRV\_1)_i + \cdots + \alpha_{27}(DHHE\_PRV\_61)_i \\
& + \alpha_{28}(WTMZ\_16\_1)_i + \cdots + \alpha_{33}(WTMZ\_16\_6)_i + \alpha_{34}(WTMZ\_18\_1)_i \\
& + \alpha_{35}(WTMZ\_19\_1)_i + \alpha_{36}(WTMZ\_20A\_1)_i + \cdots + \alpha_{49}(WTMZ\_20N\_1)_i \\
& + \alpha_{50}(WTMZ\_22\_1)_i + \alpha_{51}(WTMZ\_26\_1)_i \\
& + \alpha_{52}(WTMZ\_27A\_1)_i + \cdots + \alpha_{55}(WTMZ\_27D\_1) + \sigma\varepsilon_i
\end{aligned}
$$

where ε_i has an extreme value distribution as defined in (3.16), $\alpha = (\alpha_0, \alpha_1, \cdots, \alpha_{55})$ are the coefficients of covariates. This model is the Weibull regression model. The

variable $WTMZ\_213C$ has the Weibull distribution with

$$(4.6) \qquad \lambda_i = \exp\left\{\frac{-\left[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i + \cdots \alpha_{55} (WTMZ\_27D\_1)_i\right]}{\sigma}\right\} \text{ and } \gamma = \frac{1}{\sigma}$$

We consider each observation's weight, which corresponds to the number of persons in the entire population that are represented by the respondent. The weighted log-likelihood function of the waiting time $WTMZ\_213C$ to receive a non-emergency surgery for the 2532 completed and 227 censored observations is

$$(4.7) \qquad \log L(a_0, a_1, \cdots, a_p, \gamma) = \sum (\text{WTSE\_S3M})_i \left\{ \log[f(t_i, \lambda_i, \gamma)] + \log\left[S(t_i^*, \lambda_i, \gamma)\right] \right\}$$

$$= \sum (WTSE\_S3M)_i \Big\langle \log\gamma + (\gamma - 1)\log(WTMZ\_213C)_i$$

$$- \gamma \left[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i + \cdots + a_{55} (WTMZ\_27D\_1)_i\right]$$

$$- (WTMZ\_213C)_i^{\gamma} \exp\Big\{ -\gamma [\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i$$

$$+ \cdots + a_{55} (WTMZ\_27D\_1)_i] \Big\} \Big\rangle$$

$$+ \sum (WTSE\_S3M)_i \Big\langle - (WTMZ\_213C)_i^{\gamma} \exp\Big\{ -\gamma \left[\alpha_0 + \alpha_1 (DHHE\_AGE)_i\right.$$

$$\left. + \cdots + \alpha_{55} (WTMZ\_27D\_1)_i\right] \Big\} \Big\rangle$$

The covariate DHHE_AGE, DHHE_SEX, GEOE_PRV, WTMZ_16, WTMZ_17, WTMZ_18, WTMZ_19, WTMZ_20, WTMZ_22, WTMZ_26 and WTMZ_27 are coded

as indicator (dummy) variables, therefore, a set of indicator variables were created in the DATA step (in SAS). After eliminating the insignificant covariates estimation, the final results from SAS based on the Weibull regression model in (4.5) are shown in Table 4.2, where Intercept=α_0, and SCALE=σ

Analysis of Parameter Estimates							
Parameter	**DF**	**Estimate**	**Standard Error**	**95% Confidence Limits**		**Chi-Square**	**Pr > ChiSq**
Intercept	1	3.9463	0.0016	3.9431	3.9495	5828157	<.0001
GEOE_PRV_24	1	0.4005	0.0030	0.3945	0.4065	17333.3	<.0001
GEOE_PRV_47	1	0.4711	0.0062	0.4590	0.4832	5796.49	<.0001
WTMZ_16_2	1	-0.5399	0.0050	-0.5497	-0.5301	11665.9	<.0001
WTMZ_16_3	1	1.6360	0.0066	1.6230	1.6491	60578.4	<.0001
WTMZ_16_4	1	0.4272	0.0038	0.4198	0.4345	12949.3	<.0001
WTMZ_16_5	1	0.4887	0.0087	0.4715	0.5058	3119.64	<.0001
WTMZ_19_1	1	0.8792	0.0059	0.8676	0.8908	22029.5	<.0001
WTMZ_20B_1	1	-1.0268	0.0157	-1.0575	-0.9960	4290.79	<.0001
WTMZ_20E_1	1	0.1530	0.0070	0.1391	0.1668	471.24	<.0001
Scale	1	1.4499	0.0009	1.4482	1.4517		
Weibull Shape	1	0.6897	0.0004	0.6889	0.6905		

Table 4.2 Results for the waiting time to receive the non-emergency surgery.

Here in this table, the chi-square refers to the value of the statistical for the likelihood ratio test for the local test of individual parameters. Moreover, only statistically

significant covariates are reported in the table.

The final estimated regression model is obtained as:

(4.8)

$$\log(WTMZ\_213C)_i = 3.9463 + 0.4005(GEOE\_PRV\_24)_i + 0.4711(GEOE\_PRV\_47)_i$$
$$- 0.5399(WTMZ\_16\_2)_i + 1.6360(WTMZ\_16\_3)_i + 0.4272(WTMZ\_16\_4)_i$$
$$+ 0.4887(WTMZ\_16\_5)_i + 0.8792(WTMZ\_19\_1)_i - 1.0268(WTMZ\_20B\_1)_i$$
$$+ 0.1530(WTMZ\_20E\_1)_i + 1.4499\varepsilon_i$$

The (likelihood ratio, score and Wald) global tests all indicate that the fitted model is statistically significant at 5% level of significance. The null hypothesis states that all population parameters (except for the intercept) in the linear models are equal to zero.

4.3 Fitting survival distributions of waiting time to receive selected diagnostic tests

Let $WTMZ\_389C$ be the waiting time to receive selected diagnostic tests, Censor be dummy variable with Censor=0 if $WTMZ\_389C$ is censored and 1 otherwise, and DHHE_AGE, DHHE_SEX, GEOE_PRV, WTMZ_30, WTMZ_31, WTMZ_33, WTMZ_35, WTMZ_36, WTMZ_22, WTMZ_37, WTMZ_42 and WTMZ_43 be index variables described in section 2.1 and section 2.4, and WTSE_S3M be the weighting variable. From section 3.2, it is reasonable to assume that the waiting time to receive the selected diagnostic tests follows Weibull distribution. Incorporating covariates, the following regression model is used:

$$
\begin{aligned}
(4.9)\quad \log(WTMZ\_389C)_i = {} & a_0 + \alpha_1(DHHE\_AGE\_1)_i + \cdots + \alpha_{14}(DHHE\_AGE\_14)_i \\
& + \alpha_{15}(DHHE\_SEX\_1) + \alpha_{16}(DHHE\_PRV\_1)_i + \cdots + \alpha_{27}(DHHE\_PRV\_61)_i \\
& + \alpha_{28}(WTMZ\_30\_1)_i + \alpha_{29}(WTMZ\_30\_2)_i + \alpha_{30}(WTMZ\_31\_1)_i + \cdots \\
& + \alpha_{33}(WTMZ\_31\_4)_i + \alpha_{34}(WTMZ\_33\_1)_i + \cdots + \alpha_{36}(WTMZ\_33\_3)_i \\
& + \alpha_{37}(WTMZ\_35\_1)_i + \alpha_{38}(WTMZ\_36\_1)_i + \alpha_{39}(WTMZ\_37A\_1)_i + \cdots \\
& + \alpha_{52}(WTMZ\_37M\_1)_i + \alpha_{53}(WTMZ\_42\_1)_i + \alpha_{54}(WTMZ\_43\_1)_i + \cdots \\
& + \alpha_{57}(WTMZ\_43\_4)_i + \sigma\varepsilon_i
\end{aligned}
$$

where ε_i has an extreme value distribution as defined in (3.16), $\alpha = (\alpha_0, \alpha_1, \cdots, \alpha_{57})$

are the coefficients of covariates. This model is the Weibull regression model. The variable $WTMZ\_389C$ has the Weibull distribution with

$$(4.10)\quad \lambda_i = \exp\left\{\frac{-\left[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i + \cdots \alpha_{57} (WTMZ\_43\_4)_i\right]}{\sigma}\right\} \text{ and } \gamma = \frac{1}{\sigma}$$

We consider each observation's weight, which corresponds to the number of persons in the entire population that are represented by the respondent. The weighted log-likelihood function of the waiting time $WTMZ\_389C$ to receive the selected diagnostic tests for the 3178 completed and 210 censored observations is

$$(4.11)\quad \log L(a_0, a_1, \cdots, a_p, \gamma) = \sum (\text{WTSE\_S3M})_i \left\{ \log[f(t_i, \lambda_i, \gamma)] + \log[S(t_i^*, \lambda_i, \gamma)] \right\}$$

$$= \sum (WTSE\_S3M)_i \Big\langle \log\gamma + (\gamma - 1)\log(WTMZ\_389C)_i$$

$$-\gamma \left[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i + \cdots + a_{57} (WTMZ\_43\_4)_i\right]$$

$$-(WTMZ\_389C)_i^{\gamma} \exp\Big\{ -\gamma[\alpha_0 + \alpha_1 (DHHE\_AGE\_1)_i$$

$$+ \cdots + a_{57} (WTMZ\_43\_4)_i] \Big\} \Big\rangle$$

$$+ \sum (WTSE\_S3M)_i \Big\langle -(WTMZ\_389C)_i^{\gamma} \exp\Big\{ -\gamma \left[\alpha_0 + \alpha_1 (DHHE\_AGE)_i$$

$$+ \cdots + \alpha_{57} (WTMZ\_43\_4)_i] \Big\} \Big\rangle$$

The covariate DHHE_AGE, DHHE_SEX, GEOE_PRV, WTMZ_30, WTMZ_31, WTMZ_33, WTMZ_35, WTMZ_36, WTMZ_22, WTMZ_37, WTMZ_42 and WTMZ_43 are coded as indicator (dummy) variables, therefore, a set of indicator variables were created in the DATA step (in SAS). After eliminating the insignificant covariates estimation, the final results from SAS based on the Weibull regression model in (4.9) are shown in Table 4.3, where Intercept $=\alpha_0$, and SCALE $=\sigma$

Analysis of Parameter Estimates						
Parameter	**DF**	**Estimate**	**Standard Error**	**95% Confidence Limits**	**Chi-Square**	**Pr > ChiSq**
Intercept	1	8.1340	0.0122	8.1100 8.1580	440925	<.0001
DHHE_SEX_1	1	-0.2068	0.0017	-0.2102 -0.2034	14132.8	<.0001
GEOE_PRV_11	1	-0.3221	0.0132	-0.3479 -0.2963	597.24	<.0001
GEOE_PRV_12	1	-0.5843	0.0062	-0.5965 -0.5721	8845.72	<.0001
GEOE_PRV_13	1	-0.5446	0.0065	-0.5573 -0.5320	7091.79	<.0001
GEOE_PRV_24	1	-0.3808	0.0045	-0.3895 -0.3720	7240.92	<.0001
GEOE_PRV_35	1	-0.4411	0.0043	-0.4495 -0.4327	10597.2	<.0001
GEOE_PRV_46	1	-0.3568	0.0061	-0.3688 -0.3448	3386.87	<.0001
GEOE_PRV_48	1	-0.3727	0.0048	-0.3821 -0.3632	5927.68	<.0001
GEOE_PRV_59	1	-0.3862	0.0047	-0.3954 -0.3771	6797.29	<.0001
GEOE_PRV_60	1	-0.9709	0.0276	-1.0249 -0.9168	1237.64	<.0001
GEOE_PRV_61	1	-0.5093	0.0277	-0.5636 -0.4550	337.94	<.0001
WTMZ_30_1	1	0.3838	0.0018	0.3803 0.3873	45724.7	<.0001

WTMZ_31_1	1	-0.0608	0.0027	-0.0660	-0.0556	520.70	<.0001
WTMZ_33_1	1	-4.4106	0.0116	-4.4334	-4.3879	144430	<.0001
WTMZ_33_2	1	-4.8340	0.0122	-4.8579	-4.8101	157523	<.0001
WTMZ_33_3	1	-4.8254	0.0121	-4.8490	-4.8017	160097	<.0001
WTMZ_35_1	1	-1.6021	0.0028	-1.6077	-1.5965	318494	<.0001
WTMZ_36_1	1	1.2926	0.0026	1.2876	1.2977	250567	<.0001
WTMZ_37A_1	1	0.6735	0.0132	0.6476	0.6993	2606.42	<.0001
WTMZ_37J_1	1	0.6728	0.0157	0.6419	0.7037	1825.69	<.0001
WTMZ_42_1	1	1.0780	0.0042	1.0697	1.0863	64683.1	<.0001
Scale	1	1.2226	0.0006	1.2214	1.2239		
Weibull Shape	1	0.8179	0.0004	0.8171	0.8188		

Table 4.3 Results for the waiting time to receive the selected diagnostic tests.

Here in this table, the chi-square refers to the value of the statistical for the likelihood ratio test for the local test of individual parameters. Moreover, only statistically significant covariates are reported in the table.

The final estimated regression model is obtained as:

(4.12)

$$\log(WTMZ\_389C)_i = 8.134 - 0.2068(DHHE\_SEX\_1)_i - 0.3221(GEOE\_PRV\_11)_i$$

$$- 0.5843(GEOE\_PROV\_12)_i - 0.5446(GEOE\_PROV\_13)_i$$

$$- 0.3808(GEOE\_PROV\_24)_i - 0.4411(GEOE\_PROV\_35)_i$$

$$-0.3568(GEOE\_PROV\_46)_i - 0.3727(GEOE\_PROV\_48)_i$$

$$-0.3862(GEOE\_PROV\_59)_i - 0.9709(GEOE\_PROV\_60)_i$$

$$-0.5093(GEOE\_PROV\_61)_i + 0.3838(WTMZ\_30\_1)_i - 0.0608(WTMZ\_31\_1)_i$$

$$-4.4106(WTMZ\_33\_1)_i - 4.8340(WTMZ\_33\_2)_i - 4.8254(WTMZ\_33\_3)_i$$

$$-1.6021(WTMZ\_35\_1)_i + 1.2926(WTMZ\_36\_1)_i + 0.6735(WTMZ\_37A\_1)_i$$

$$+0.6728(WTMZ\_37J\_1)_i + 1.0780(WTMZ\_42\_1)_i + 1.2226\varepsilon_i$$

The (likelihood ratio, score and Wald) global tests all indicate that the fitted model is statistically significant at 5% level of significance. The null hypothesis states that all population parameters (except for the intercept) in the linear models are equal to zero.

Chapter 5 Summary and Conclusion

We now summarize the results obtained in this practicum. Using the variable descriptions in Chapter 2, equations 4.4, 4.8 and 4.12 can be interpreted as follows.

In our initial modeling, relevant covariates which are potentially important for analyzing waiting times were included in the parametric regression analysis. These covariates were decided upon with consultation from Dr. Wendy Fallis. After applying the variable selection procedures, only the statistically significant covariates are kept in the final model. Weights for the individuals were given in the data set.

The regression model for accessing health service from a medical specialist, based on 4004 completed and 348 censored observations, is estimated as

$$\begin{aligned}(5.1)\quad \ln(\text{Waiting Time to Specialist})_i &= 3.5329 - 0.0587(\text{PEI})_i - 0.0253(\text{AB})_i \\ &+ 0.0111(\text{BC})_i - 0.2381(\text{Heart Condition or Stroke})_i - 0.6171(\text{Cancer})_i \\ &+ 0.2938(\text{Arthritis ou Rheumatism})_i + 0.5647(\text{Referred by Doctor})_i \\ &+ 0.3372(\text{Referred by Specialist})_i + 0.0263(\text{Referred by Health Care Provider})_i \\ &+ 1.2588\varepsilon_i\end{aligned}$$

The regression model for receiving a non-emergency surgery, based on 2532 completed and 227 censored observations, is estimated as

(5.2) $\ln(\text{Waiting Time to Non-emergency Surgery})_i = 3.9463 + 0.4005(\text{QC})_i$
$+ 0.4711(\text{SK})_i - 0.5399(\text{Cancer})_i + 1.636(\text{Hip/Knee Replacement Surgery})_i$
$+ 0.4272(\text{Cataract/Other Eye Surgery})_i + 0.4887(\text{Hysterectomy})_i$
$+ 0.8792(\text{Experienced Difficulties})_i - 1.0268(\text{Difficulty getting Diagnosis})_i +$
$0.153(\text{Waited too long for Diagnostic Test})_i + 1.4499\varepsilon_i$

The regression model for receiving selected diagnostic tests, based on 3178 completed and 210 censored observations, is estimated as

(5.3) $\ln(\text{Waiting Time to Diagnostic Test})_i = 8.134 - 0.2068(\text{Gender})_i$
$- 0.3221(\text{PEI})_i - 0.5843(\text{NS})_i - 0.5446(\text{NB})_i - 0.3808(\text{QC})_i - 0.4411(\text{ON})_i$
$- 0.3568(\text{MB})_i - 0.3727(\text{AB})_i - 0.3862(\text{BC})_i - 0.9709(\text{Y T})_i - 0.5093(\text{NT})_i$
$+ 0.3838(\text{MRI})_i - 0.0608(\text{Heart disease or Stroke})_i - 4.4106(\text{Test in Hospital})_i$
$- 4.834(\text{Test in Public Clinic})_i - 4.8254(\text{Test in Private Clinic})_i$
$- 1.6021(\text{In- Patient})_i + 1.2926(\text{Experienced Difficulties})_i$
$+ 0.6735(\text{Difficulty getting Referred})_i + 0.6728(\text{Deterioration of Health})_i$
$+1.078(\text{Test Cancelled /Postponed})_i + 1.2226\varepsilon_i$

Therefore, the following general observations can be made.

- The waiting time to access health service from a medical specialist depends on the residence area (i.e., province), type of health problems, and the type of referrals.
- The waiting time to receive non-emergency surgeries depends on the residence area (i.e., province), type of health problems, and other issues such as difficulty in diagnosis and excessively long waiting period for diagnostic test.

- The waiting time to receive selected diagnostic tests depends on gender, the residence area (i.e., province), type of tests, type of health problems, location of tests, in- or out-patient, and other issues such as referral and deterioration of health.

Chapter 6 Discussion and Future Research

Canadian government developed in 2004 a 10-year plan to address the issue of waiting times (http://www.hc-sc.gc.ca/hcs-sss/qual/acces/wait-attente/index-eng.php). This plan provides an outline for potential strategies to reduce waiting times for health services, in particularly for cancer, heart disease, diagnostic imaging, joint replacement and sight restoration services. To implement the plan and to significantly reduce the waiting times, the Canadian Federal Government has invested $4.5 billion over the years of 2004 – 2010 in the Wait Times Reduction Fund.

It is hoped that the findings in this practicum could provide some insight and help for decision makers in Canada to better understand the patterns of waiting times and to assist in the development of relevant strategies. It would be useful in the future to compare the pattern of waiting times after the implementation of the 10-year plan with the data set available for this practicum. Such a comparison would suggest whether or not the 10-year plan is effective in reducing waiting time for health services in Canada.

Parametric survival models provide a great deal of statistical power and accuracy. It is undoubtedly important within survival analysis and is a simple method typically used in real applications. The use of parametric model requires that data conform to particular parametric distributions. The Kaplan-Meier estimate of the survival function suggests

that our survival data are roughly distributed as a Weibull distribution, therefore the Weibull regression model is used to complete the research project.

Yet we can still argue that there are alternative methods such as the semi-parametric approach which could increase the flexibility of dealing with data that might not conform to parametric distributions. The Cox Proportional Hazards model might be considered for further research. If the proportional hazards assumption holds, then standard methods allow us to estimate the parameters and the hazard function.

Accelerated Failure Time Model (AFT) provides an alternative to the commonly-used proportional hazards models. An AFT model assumes that the effect of a covariate is to multiply the predicted event time by some constant. Therefore, AFT models can be framed as linear models for the logarithm of the survival time.

The proportional odds (PO) model with the property of convergent hazard functions is of considerable value in modeling survival data with non-proportional hazards. This model requires that the ratio of odds of survival be constant over time. Consequently, the ratio of the hazards converges to unity as time increases to infinity. This is in contrast to the proportional hazards (PH) model, with the property that the ratio of the hazards is constant over time but the odds ratio tends to 0 or infinity.

As other future research projects, we could find a new dataset and verify the goodness-of-fit of our prediction model. Moreover, different methods mentioned above could be compared as well.

Chapter 7 Appendix

7.1 SAS Code

7.1.1 Program of accessing service from a medical specialist

```
%let path =p:\Tan_HSAS\subdata\Feb5_2008;
libname c "&path";

data c.dataSP;
set Tmp1.hss3;
keep GEOE_PRV DHHE_AGE DHHE_SEX WTMZ_01 WTMZ_02 WTMZ_03
WTMZ_04 WTMZ_07A WTMZ_07B WTMZ_08A WTMZ_08B WTSE_S3M;
run;

data c.dataSP1;
set c.dataSP;
if WTMZ_07B="1" then WTMZ_07C=WTMZ_07A;
if WTMZ_07B="2" then WTMZ_07C=WTMZ_07A*"7";
if WTMZ_07B="3" then WTMZ_07C=WTMZ_07A*"30";
if WTMZ_08B="1" then WTMZ_08C=WTMZ_08A;
if WTMZ_08B="2" then WTMZ_08C=WTMZ_08A*"7";
if WTMZ_08B="3" then WTMZ_08C=WTMZ_08A*"30";
```

```
run;

data c.dataSP2;
set c.dataSP1;
if WTMZ_01="1";
run;

data c.dataSP3;
set c.dataSP2;
if WTMZ_07C="." then WTMZ_78C=WTMZ_08C;
else WTMZ_78C=WTMZ_07C;
run;

data c.dataSP4;
set c.dataSP3;
if WTMZ_08C="." then Censor=1;
else Censor=0;
run;

data c.dataSP5;
set c.datasp4;
if GEOE_PRV="10" then GEOE_PRV_10=1;
else GEOE_PRV_10=0;
if GEOE_PRV="11" then GEOE_PRV_11=1;
else GEOE_PRV_11=0;
if GEOE_PRV="12" then GEOE_PRV_12=1;
```

```
else GEOE_PRV_12=0;
if GEOE_PRV="13" then GEOE_PRV_13=1;
else GEOE_PRV_13=0;
if GEOE_PRV="24" then GEOE_PRV_24=1;
else GEOE_PRV_24=0;
if GEOE_PRV="35" then GEOE_PRV_35=1;
else GEOE_PRV_35=0;
if GEOE_PRV="46" then GEOE_PRV_46=1;
else GEOE_PRV_46=0;
if GEOE_PRV="47" then GEOE_PRV_47=1;
else GEOE_PRV_47=0;
if GEOE_PRV="48" then GEOE_PRV_48=1;
else GEOE_PRV_48=0;
if GEOE_PRV="59" then GEOE_PRV_59=1;
else GEOE_PRV_59=0;
if GEOE_PRV="60" then GEOE_PRV_60=1;
else GEOE_PRV_60=0;
if GEOE_PRV="61" then GEOE_PRV_61=1;
else GEOE_PRV_61=0;
*if GEOE_PRV="62" then GEOE_PRV_62=1;
*else GEOE_PRV_62=0;

if DHHE_SEX="1" then DHHE_SEX_1=1;
else DHHE_SEX_1=0;
*if DHHE_SEX="2" then DHHE_SEX_2=1;
*else DHHE_SEX_2=0;
```

```
if WTMZ_02="1" then WTMZ_02_1=1;
else WTMZ_02_1=0;
if WTMZ_02="2" then WTMZ_02_2=1;
else WTMZ_02_2=0;
if WTMZ_02="3" then WTMZ_02_3=1;
else WTMZ_02_3=0;
if WTMZ_02="4" then WTMZ_02_4=1;
else WTMZ_02_4=0;
if WTMZ_02="5" then WTMZ_02_5=1;
else WTMZ_02_5=0;
if WTMZ_02="6" then WTMZ_02_6=1;
else WTMZ_02_6=0;
if WTMZ_02="7" then WTMZ_02_7=1;
else WTMZ_02_7=0;
if WTMZ_02="8" then WTMZ_02_8=1;
else WTMZ_02_8=0;
*if WTMZ_02="9" then WTMZ_02_9=1;
*else WTMZ_02_9=0;

if WTMZ_03="1" then WTMZ_03_1=1;
else WTMZ_03_1=0;
if WTMZ_03="2" then WTMZ_03_2=1;
else WTMZ_03_2=0;
if WTMZ_03="3" then WTMZ_03_3=1;
```

```
else WTMZ_03_3=0;

if WTMZ_04="1" then WTMZ_04_1=1;
else WTMZ_04_1=0;
run;

proc contents data=tmp1.Datasp5;
run;

data c.dataSP6;
set c.datasp5;
if GEOE_PRV_10="1" or GEOE_PRV_12="1" or GEOE_PRV_13="1" or
GEOE_PRV_24="1" or GEOE_PRV_35="1" or GEOE_PRV_46="1" or
GEOE_PRV_47="1" or GEOE_PRV_60="1" or GEOE_PRV_61="1" then
GEOE_PRV_C=1;
else GEOE_PRV_C=0;
if WTMZ_02_3="1" or WTMZ_02_5="1" or WTMZ_02_6="1" or WTMZ_02_7="1" or
WTMZ_02_8="1" then WTMZ_02_C=1;
else WTMZ_02_C=0;
run;

title 'waiting time to see specialist';
options ls=75 ps=60 nocenter;
proc lifetest plot=(s,ls,lls) data=c.Datasp5 ;
time WTMZ_78C*censor(0);
symbol color=red line=1;
```

```
run;

proc lifereg covout data=c.Datasp6;
model WTMZ_78C*Censor(0)=DHHE_AGE
                         GEOE_PRV_C GEOE_PRV_11   GEOE_PRV_48
GEOE_PRV_59
                         WTMZ_02_C WTMZ_02_1 WTMZ_02_2 WTMZ_02_4
                         WTMZ_03_1 WTMZ_03_2 WTMZ_03_3 / d =weibull;
weight WTSE_S3M;
run;

proc lifereg covout data=c.Datasp6;
model WTMZ_78C*Censor(0)=DHHE_AGE
                         GEOE_PRV_C GEOE_PRV_11   GEOE_PRV_48
GEOE_PRV_59
                         WTMZ_02_C WTMZ_02_1 WTMZ_02_2 WTMZ_02_4
                         WTMZ_03_1 WTMZ_03_2 WTMZ_03_3 / d =weibull;
run;

proc lifereg covout data=c.Datasp6;
model WTMZ_78C*Censor(0)=GEOE_PRV_11   GEOE_PRV_48 GEOE_PRV_59
                             WTMZ_02_1 WTMZ_02_2 WTMZ_02_4
                             WTMZ_03_1 WTMZ_03_2 WTMZ_03_3 / d =weibull;
run;

proc lifereg covout data=c.Datasp6;
```

```
model WTMZ_78C*Censor(0)=GEOE_PRV_11   GEOE_PRV_48 GEOE_PRV_59
                                WTMZ_02_1 WTMZ_02_2 WTMZ_02_4
                                WTMZ_03_1 WTMZ_03_2 WTMZ_03_3 / d =weibull;
weight WTSE_S3M;
run;


proc phreg data=c.Datasp6;
     model WTMZ_78C*Censor(0)=GEOE_PRV_11 GEOE_PRV_48 GEOE_PRV_59
                    WTMZ_02_1 WTMZ_02_2 WTMZ_02_4 WTMZ_03_1
                    WTMZ_03_2 WTMZ_03_3 ;
      baseline out=a survival=s logsurv=ls;
run;

data b;
set a;
y=log(-ls);
x=log(WTMZ_78C);
run;

proc reg data = b;
model y = x;
run;
```

7.1.2 Program of receiving a non-emergency surgery

```
%let path =p:\Tan_HSAS\subdata\Jan10_2008;
libname c "&path";


data c.dataNES;
set Tmp1.hss3;
keep GEOE_PRV DHHE_AGE DHHE_SEX ACCZ_20
```

```
      WTMZ_16 WTMZ_17 WTMZ_18
      WTMZ_19 WTMZ_20A WTMZ_20B WTMZ_20C WTMZ_20D WTMZ_20E
    WTMZ_20F WTMZ_20G WTMZ_20H WTMZ_20I WTMZ_20J WTMZ_20K
    WTMZ_20L WTMZ_20M WTMZ_20N
      WTMZ_21A WTMZ_21B
      WTMZ_22
      WTMZ_23A WTMZ_23B
     WTMZ_26 WTMZ_27A WTMZ_27B WTMZ_27C WTMZ_27D
      WTSE_S3M;
run;

data c.datanes1;
set c.datanes;
if ACCZ_20="1";
run;
data c.datanes2;
set c.datanes1;
if WTMZ_21B="1" then WTMZ_21C=WTMZ_21A;
if WTMZ_21B="2" then WTMZ_21C=WTMZ_21A*"7";
if WTMZ_21B="3" then WTMZ_21C=WTMZ_21A*"30";
if WTMZ_23B="1" then WTMZ_23C=WTMZ_23A;
if WTMZ_23B="2" then WTMZ_23C=WTMZ_23A*"7";
if WTMZ_23B="3" then WTMZ_23C=WTMZ_23A*"30";
run;

data c.datanes3;
```

```
set c.datanes2;
if WTMZ_21C="." then WTMZ_213C=WTMZ_23C;
else WTMZ_213C=WTMZ_21C;
run;

data C.datanes4;
set c.datanes3;
if WTMZ_23C="." then Censor=1;
else Censor=0;
run;

proc lifetest plot=(s,ls,lls) data=c.Datanes4 ;
time WTMZ_213C*censor(0);
symbol color=red line=1;
Title 'Non emergency surgery';
run;

proc freq data=c.Datanes4;
tables
WTMZ_21c;
weight WTSE_S3M;
Title 'WT Non emergency surgery (Complted)Weighted';
run;

proc freq data=c.Datanes4;
tables
```

```
WTMZ_21c;
Title 'WT Non emergency surgery (Complted)';
run;

proc freq data=c.Datanes4;
tables
WTMZ_23C;
weight WTSE_S3M;
Title 'WT Non emergency surgery (censor) Weighted';
run;

proc freq data=c.Datanes4;
tables
WTMZ_23C;
Title 'WT Non emergency surgery (censor)';
run;

data c.Datanes5;
set c.Datanes4;
if GEOE_PRV="10" then GEOE_PRV_10=1;
else GEOE_PRV_10=0;
if GEOE_PRV="11" then GEOE_PRV_11=1;
else GEOE_PRV_11=0;
if GEOE_PRV="12" then GEOE_PRV_12=1;
else GEOE_PRV_12=0;
if GEOE_PRV="13" then GEOE_PRV_13=1;
```

```
else GEOE_PRV_13=0;
if GEOE_PRV="24" then GEOE_PRV_24=1;
else GEOE_PRV_24=0;
if GEOE_PRV="35" then GEOE_PRV_35=1;
else GEOE_PRV_35=0;
if GEOE_PRV="46" then GEOE_PRV_46=1;
else GEOE_PRV_46=0;
if GEOE_PRV="47" then GEOE_PRV_47=1;
else GEOE_PRV_47=0;
if GEOE_PRV="48" then GEOE_PRV_48=1;
else GEOE_PRV_48=0;
if GEOE_PRV="59" then GEOE_PRV_59=1;
else GEOE_PRV_59=0;
if GEOE_PRV="60" then GEOE_PRV_60=1;
else GEOE_PRV_60=0;
if GEOE_PRV="61" then GEOE_PRV_61=1;
else GEOE_PRV_61=0;

if DHHE_SEX="1" then DHHE_SEX_1=1;
else DHHE_SEX_1=0;

if WTMZ_16="1" then WTMZ_16_1=1;
else WTMZ_16_1=0;
if WTMZ_16="2" then WTMZ_16_2=1;
else WTMZ_16_2=0;
if WTMZ_16="3" then WTMZ_16_3=1;
```

```
else WTMZ_16_3=0;
if WTMZ_16="4" then WTMZ_16_4=1;
else WTMZ_16_4=0;
if WTMZ_16="5" then WTMZ_16_5=1;
else WTMZ_16_5=0;
if WTMZ_16="6" then WTMZ_16_6=1;
else WTMZ_16_6=0;

if WTMZ_17="1" then WTMZ_17_1=1;
else WTMZ_17_1=0;

if WTMZ_18="1" then WTMZ_18_1=1;
else WTMZ_18_1=0;

if WTMZ_19="1" then WTMZ_19_1=1;
else WTMZ_19_1=0;

if WTMZ_20A="1" then WTMZ_20A_1=1;
else WTMZ_20A_1=0;
if WTMZ_20B="1" then WTMZ_20B_1=1;
else WTMZ_20B_1=0;
if WTMZ_20C="1" then WTMZ_20C_1=1;
else WTMZ_20C_1=0;
if WTMZ_20D="1" then WTMZ_20D_1=1;
else WTMZ_20D_1=0;
if WTMZ_20E="1" then WTMZ_20E_1=1;
```

```
else WTMZ_20E_1=0;
if WTMZ_20F="1" then WTMZ_20F_1=1;
else WTMZ_20F_1=0;
if WTMZ_20G="1" then WTMZ_20G_1=1;
else WTMZ_20G_1=0;
if WTMZ_20H="1" then WTMZ_20H_1=1;
else WTMZ_20H_1=0;
if WTMZ_20I="1" then WTMZ_20I_1=1;
else WTMZ_20I_1=0;
if WTMZ_20J="1" then WTMZ_20J_1=1;
else WTMZ_20J_1=0;
if WTMZ_20K="1" then WTMZ_20K_1=1;
else WTMZ_20K_1=0;
if WTMZ_20L="1" then WTMZ_20L_1=1;
else WTMZ_20L_1=0;
if WTMZ_20M="1" then WTMZ_20M_1=1;
else WTMZ_20M_1=0;
if WTMZ_20N="1" then WTMZ_20N_1=1;
else WTMZ_20N_1=0;

if WTMZ_22="1" then WTMZ_22_1=1;
else WTMZ_22_1=0;

if WTMZ_26="1" then WTMZ_26_1=1;
else WTMZ_26_1=0;
```

```
if WTMZ_27A="1" then WTMZ_27A_1=1;
else WTMZ_27A_1=0;
if WTMZ_27B="1" then WTMZ_27B_1=1;
else WTMZ_27B_1=0;
if WTMZ_27C="1" then WTMZ_27C_1=1;
else WTMZ_27C_1=0;
if WTMZ_27D="1" then WTMZ_27D_1=1;
else WTMZ_27D_1=0;
run;

proc contents data=c.Datanes5;
run;

proc lifereg covout data=c.Datanes5;
model WTMZ_213C*Censor(0)=
        DHHE_AGE DHHE_SEX_1
        GEOE_PRV_10 GEOE_PRV_11 GEOE_PRV_12 GEOE_PRV_13
GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46 GEOE_PRV_47 GEOE_PRV_48
GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61
        WTMZ_16_1 WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
WTMZ_16_6
        WTMZ_18_1
        WTMZ_19_1
       WTMZ_20A_1 WTMZ_20B_1 WTMZ_20C_1 WTMZ_20D_1 WTMZ_20E_1
WTMZ_20F_1 WTMZ_20G_1 WTMZ_20H_1 WTMZ_20I_1 WTMZ_20J_1
WTMZ_20K_1 WTMZ_20L_1 WTMZ_20M_1 WTMZ_20N_1
```

```
        WTMZ_22_1
        WTMZ_26_1    WTMZ_27A_1 WTMZ_27B_1 WTMZ_27C_1 WTMZ_27D_1 /
d =weibull;
weight WTSE_S3M;
run;

proc lifereg covout data=c.Datanes5;
model WTMZ_213C*Censor(0)=
        DHHE_AGE DHHE_SEX_1
        GEOE_PRV_10 GEOE_PRV_11 GEOE_PRV_12 GEOE_PRV_13
GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46 GEOE_PRV_47 GEOE_PRV_48
GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61
        WTMZ_16_1 WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
WTMZ_16_6
        WTMZ_18_1
        WTMZ_19_1
       WTMZ_20A_1 WTMZ_20B_1 WTMZ_20C_1 WTMZ_20D_1 WTMZ_20E_1
WTMZ_20F_1 WTMZ_20G_1 WTMZ_20H_1 WTMZ_20I_1 WTMZ_20J_1
WTMZ_20K_1 WTMZ_20L_1 WTMZ_20M_1 WTMZ_20N_1
        WTMZ_22_1
       WTMZ_26_1    WTMZ_27A_1 WTMZ_27B_1 WTMZ_27C_1 WTMZ_27D_1 /
d =weibull;
run;

data c.Datanes6;
set c.Datanes5;
```

```
if GEOE_PRV_10="1" or GEOE_PRV_11="1" or GEOE_PRV_12="1" or
GEOE_PRV_13="1" or GEOE_PRV_35="1" or GEOE_PRV_46="1" or
GEOE_PRV_48="1" or GEOE_PRV_59="1" or GEOE_PRV_61="1" then
GEOE_PRV_C=1;
else GEOE_PRV_C=0;

if WTMZ_16_1="1" or WTMZ_16_6="1" then WTMZ_16_C=1;
else WTMZ_16_C=0;

if WTMZ_20A_1="1" or WTMZ_20C_1="1" or WTMZ_20D_1="1" or
WTMZ_20G_1="1" or WTMZ_20H_1="1" or WTMZ_20I_1="1" or WTMZ_20J_1="1"
or WTMZ_20K_1="1" or WTMZ_20L_1="1" or WTMZ_20M_1="1" or
WTMZ_20N_1="1" then WTMZ_20_C=1;
else WTMZ_20_C=0;

run;

proc lifereg covout data=c.Datanes6;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_C GEOE_PRV_24 GEOE_PRV_47 GEOE_PRV_60
        WTMZ_16_C WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20_C WTMZ_20B_1 WTMZ_20E_1 WTMZ_20F_1 / d =weibull;
weight WTSE_S3M;
run;
```

```
proc lifereg covout data=c.Datanes6;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_C GEOE_PRV_24 GEOE_PRV_47 GEOE_PRV_60
        WTMZ_16_C WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20_C WTMZ_20B_1 WTMZ_20E_1 WTMZ_20F_1 / d =weibull;
run;

data c.Datanes7;
set c.Datanes6;
if GEOE_PRV_60="1" or GEOE_PRV_10="1" or GEOE_PRV_11="1" or
GEOE_PRV_12="1" or GEOE_PRV_13="1" or GEOE_PRV_35="1" or
GEOE_PRV_46="1" or GEOE_PRV_48="1" or GEOE_PRV_59="1" or
GEOE_PRV_61="1" then GEOE_PRV_C=1;
else GEOE_PRV_C=0;
proc lifereg covout data=c.Datanes7;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_C GEOE_PRV_24 GEOE_PRV_47
        WTMZ_16_C WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20_C WTMZ_20B_1 WTMZ_20E_1 WTMZ_20F_1 / d =weibull;
run;

proc lifereg covout data=c.Datanes7;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_C GEOE_PRV_24 GEOE_PRV_47
```

```
        WTMZ_16_C WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20_C WTMZ_20B_1 WTMZ_20E_1 WTMZ_20F_1 / d =weibull;
weight WTSE_S3M;
run;

proc lifereg covout data=c.Datanes7;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_24 GEOE_PRV_47
        WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20B_1 WTMZ_20E_1 WTMZ_20F_1 / d =weibull;
run;

data c.Datanes8;
set c.Datanes7;
if WTMZ_20F_1="1" or WTMZ_20A_1="1" or WTMZ_20C_1="1" or
WTMZ_20D_1="1" or WTMZ_20G_1="1" or WTMZ_20H_1="1" or
WTMZ_20I_1="1" or WTMZ_20J_1="1" or WTMZ_20K_1="1" or WTMZ_20L_1="1"
or WTMZ_20M_1="1" or WTMZ_20N_1="1" then WTMZ_20_C=1;
else WTMZ_20_C=0;
run;

proc lifereg covout data=c.Datanes8;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_C GEOE_PRV_24 GEOE_PRV_47
```

```
        WTMZ_16_C WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20_C WTMZ_20B_1 WTMZ_20E_1 / d =weibull;
run;

proc lifereg covout data=c.Datanes8;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_24 GEOE_PRV_47
        WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20B_1 WTMZ_20E_1 / d =weibull;
run;

proc lifereg covout data=c.Datanes8;
model WTMZ_213C*Censor(0)=
        GEOE_PRV_24 GEOE_PRV_47
        WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5
        WTMZ_19_1
       WTMZ_20B_1 WTMZ_20E_1 / d =weibull;
weight WTSE_S3M;
run;

proc phreg data=c.Datanes8;
      model WTMZ_213C*Censor(0) = GEOE_PRV_24 GEOE_PRV_47
        WTMZ_16_2 WTMZ_16_3 WTMZ_16_4 WTMZ_16_5 WTMZ_19_1
        WTMZ_20B_1 WTMZ_20E_1 ;
```

```
    baseline out=a survival=s logsurv=ls;
run;

data b;
set a;
y=log(-ls);
x=log(WTMZ_213C);
run;

proc reg data = b;
model y = x;
run;
```

7.1.3 Program of receiving selected diagnostic tests

```
%let path =p:\Tan_HSAS\subdata\Jan10_2008;
libname c "&path";

data c.dataDtest;
set Tmp1.hss3;
keep GEOE_PRV DHHE_AGE DHHE_SEX ACCZ_30 WTMZ_30 WTMZ_31
   WTMZ_32 WTMZ_33 WTMZ_35 WTMZ_36 WTMZ_37A WTMZ_37B
   WTMZ_37C WTMZ_37D WTMZ_37E WTMZ_37F WTMZ_37G WTMZ_37H
   WTMZ_37I WTMZ_37J WTMZ_37K WTMZ_37L WTMZ_37M WTMZ_38A
   WTMZ_38B WTMZ_39A WTMZ_39B WTMZ_42 WTMZ_43 WTSE_S3M;
run;
```

```
data c.dataDtest1;
set c.dataDtest;
if ACCZ_30="1";
run;

data c.dataDtest2;
set c.dataDtest1;
if WTMZ_38B="1" then WTMZ_38C=WTMZ_38A;
if WTMZ_38B="2" then WTMZ_38C=WTMZ_38A*"7";
if WTMZ_38B="3" then WTMZ_38C=WTMZ_38A*"30";

if WTMZ_39B="1" then WTMZ_39C=WTMZ_39A;
if WTMZ_39B="2" then WTMZ_39C=WTMZ_39A*"7";
if WTMZ_39B="3" then WTMZ_39C=WTMZ_39A*"30";
run;

data c.dataDtest3;
set c.datadtest2;
if WTMZ_38C="." then WTMZ_389C=WTMZ_39C;
else WTMZ_389C=WTMZ_38C;
run;

data C.dataDtest4;
set c.dataDtest3;
if WTMZ_39C="." then Censor=1;
else Censor=0;
```

```
run;

proc lifetest plot=(s,ls,lls) data=c.DataDtest4 ;
time WTMZ_389C*censor(0);
symbol color=red line=1;
Title 'Diagnostic Tests';
run;

data c.dataDtest5;
set c.dataDtest4;
if GEOE_PRV="10" then GEOE_PRV_10=1;
else GEOE_PRV_10=0;
if GEOE_PRV="11" then GEOE_PRV_11=1;
else GEOE_PRV_11=0;
if GEOE_PRV="12" then GEOE_PRV_12=1;
else GEOE_PRV_12=0;
if GEOE_PRV="13" then GEOE_PRV_13=1;
else GEOE_PRV_13=0;
if GEOE_PRV="24" then GEOE_PRV_24=1;
else GEOE_PRV_24=0;
if GEOE_PRV="35" then GEOE_PRV_35=1;
else GEOE_PRV_35=0;
if GEOE_PRV="46" then GEOE_PRV_46=1;
else GEOE_PRV_46=0;
if GEOE_PRV="47" then GEOE_PRV_47=1;
else GEOE_PRV_47=0;
```

```
if GEOE_PRV="48" then GEOE_PRV_48=1;
else GEOE_PRV_48=0;
if GEOE_PRV="59" then GEOE_PRV_59=1;
else GEOE_PRV_59=0;
if GEOE_PRV="60" then GEOE_PRV_60=1;
else GEOE_PRV_60=0;
if GEOE_PRV="61" then GEOE_PRV_61=1;
else GEOE_PRV_61=0;

if DHHE_SEX="1" then DHHE_SEX_1=1;
else DHHE_SEX_1=0;

if WTMZ_30="1" then WTMZ_30_1=1;
else WTMZ_30_1=0;
if WTMZ_30="2" then WTMZ_30_2=1;
else WTMZ_30_2=0;

if WTMZ_31="1" then WTMZ_31_1=1;
else WTMZ_31_1=0;
if WTMZ_31="2" then WTMZ_31_2=1;
else WTMZ_31_2=0;
if WTMZ_31="3" then WTMZ_31_3=1;
else WTMZ_31_3=0;
if WTMZ_31="4" then WTMZ_31_4=1;
else WTMZ_31_4=0;
```

```
if WTMZ_32="1" then WTMZ_32_1=1;
else WTMZ_32_1=0;

if WTMZ_33="1" then WTMZ_33_1=1;
else WTMZ_33_1=0;
if WTMZ_33="2" then WTMZ_33_2=1;
else WTMZ_33_2=0;
if WTMZ_33="3" then WTMZ_33_3=1;
else WTMZ_33_3=0;

if WTMZ_35="1" then WTMZ_35_1=1;
else WTMZ_35_1=0;

if WTMZ_36="1" then WTMZ_36_1=1;
else WTMZ_36_1=0;

if WTMZ_37A="1" then WTMZ_37A_1=1;
else WTMZ_37A_1=0;
if WTMZ_37B="1" then WTMZ_37B_1=1;
else WTMZ_37B_1=0;
if WTMZ_37C="1" then WTMZ_37C_1=1;
else WTMZ_37C_1=0;
if WTMZ_37D="1" then WTMZ_37D_1=1;
else WTMZ_37D_1=0;
if WTMZ_37E="1" then WTMZ_37E_1=1;
else WTMZ_37E_1=0;
```

```
if WTMZ_37F="1" then WTMZ_37F_1=1;
else WTMZ_37F_1=0;
if WTMZ_37G="1" then WTMZ_37G_1=1;
else WTMZ_37G_1=0;
if WTMZ_37H="1" then WTMZ_37H_1=1;
else WTMZ_37H_1=0;
if WTMZ_37I="1" then WTMZ_37I_1=1;
else WTMZ_37I_1=0;
if WTMZ_37J="1" then WTMZ_37J_1=1;
else WTMZ_37J_1=0;
if WTMZ_37K="2" then WTMZ_37K_1=1;
else WTMZ_37K_1=0;
if WTMZ_37L="2" then WTMZ_37L_1=1;
else WTMZ_37L_1=0;
if WTMZ_37M="1" then WTMZ_37M_1=1;
else WTMZ_37M_1=0;

if WTMZ_42="1" then WTMZ_42_1=1;
else WTMZ_42_1=0;

if WTMZ_43="1" then WTMZ_43_1=1;
else WTMZ_43_1=0;
if WTMZ_43="2" then WTMZ_43_2=1;
else WTMZ_43_2=0;
if WTMZ_43="3" then WTMZ_43_3=1;
else WTMZ_43_3=0;
```

```
if WTMZ_43="4" then WTMZ_43_4=1;
else WTMZ_43_4=0;
run;

proc contents data=c.DataDtest5;
run;

proc lifereg covout data=c.DataDtest5;
model WTMZ_389C*Censor(0)=DHHE_AGE DHHE_SEX_1 GEOE_PRV_10
    GEOE_PRV_11 GEOE_PRV_12 GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35
    GEOE_PRV_46 GEOE_PRV_47 GEOE_PRV_48 GEOE_PRV_59 GEOE_PRV_60
    GEOE_PRV_61 WTMZ_30_1 WTMZ_30_2 WTMZ_31_1 WTMZ_31_2
    WTMZ_31_3 WTMZ_31_4 WTMZ_33_1 WTMZ_33_2 WTMZ_33_3
    WTMZ_35_1 WTMZ_36_1 WTMZ_37A_1 WTMZ_37B_1 WTMZ_37C_1
    WTMZ_37D_1 WTMZ_37E_1 WTMZ_37F_1 WTMZ_37G_1 WTMZ_37H_1
    WTMZ_37I_1 WTMZ_37J_1 WTMZ_37K_1 WTMZ_37L_1 WTMZ_37M_1
    WTMZ_42_1 WTMZ_43_1 WTMZ_43_2   WTMZ_43_3 WTMZ_43_4 / d
    =weibull;
weight WTSE_S3M;
run;

proc lifereg covout data=c.DataDtest5;
model WTMZ_389C*Censor(0)=DHHE_AGE DHHE_SEX_1 GEOE_PRV_10
    GEOE_PRV_11 GEOE_PRV_12 GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35
    GEOE_PRV_46 GEOE_PRV_47 GEOE_PRV_48 GEOE_PRV_59 GEOE_PRV_60
    GEOE_PRV_61 WTMZ_30_1 WTMZ_30_2 WTMZ_31_1 WTMZ_31_2
```

```
    WTMZ_31_3 WTMZ_31_4 WTMZ_33_1 WTMZ_33_2 WTMZ_33_3
    WTMZ_35_1 WTMZ_36_1 WTMZ_37A_1 WTMZ_37B_1 WTMZ_37C_1
    WTMZ_37D_1 WTMZ_37E_1 WTMZ_37F_1 WTMZ_37G_1 WTMZ_37H_1
    WTMZ_37I_1 WTMZ_37J_1 WTMZ_37K_1 WTMZ_37L_1 WTMZ_37M_1
    WTMZ_42_1 WTMZ_43_1 WTMZ_43_2   WTMZ_43_3 WTMZ_43_4 / d
    =weibull;
run;

data c.dataDtest6;
set c.dataDtest5;
if GEOE_PRV_10="1" or GEOE_PRV_47="1" then GEOE_PRV_C=1;
else GEOE_PRV_C=0;

if WTMZ_31_2="1" or WTMZ_31_3="1" or WTMZ_31_4="1" then WTMZ_31_C=1;
else WTMZ_31_C=0;

if WTMZ_37B_1="1" or WTMZ_37C_1="1" or WTMZ_37D_1="1" or
WTMZ_37E_1="1" or WTMZ_37F_1="1" or WTMZ_37G_1="1" or
WTMZ_37H_1="1" or WTMZ_37I_1="1" or WTMZ_37K_1="1" or
WTMZ_37L_1="1" or WTMZ_37M_1="1" then WTMZ_37_C=1;
else WTMZ_37_C=0;
run;

proc lifereg covout data=c.DataDtest6;
model WTMZ_389C*Censor(0)=DHHE_SEX_1 GEOE_PRV_C GEOE_PRV_11
    GEOE_PRV_12 GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46
```

```
    GEOE_PRV_48 GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61 WTMZ_30_1
    WTMZ_30_2 WTMZ_31_C WTMZ_31_1 WTMZ_33_1 WTMZ_33_2
    WTMZ_33_3 WTMZ_35_1 WTMZ_36_1 WTMZ_37_C WTMZ_37A_1
    WTMZ_37J_1 WTMZ_42_1 / d =weibull;
weight WTSE_S3M;
run;

proc lifereg covout data=c.DataDtest6;
model WTMZ_389C*Censor(0)=DHHE_SEX_1 GEOE_PRV_C GEOE_PRV_11
    GEOE_PRV_12 GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46
    GEOE_PRV_48 GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61 WTMZ_30_1
    WTMZ_30_2 WTMZ_31_C WTMZ_31_1 WTMZ_33_1 WTMZ_33_2
    WTMZ_33_3 WTMZ_35_1 WTMZ_36_1 WTMZ_37_C WTMZ_37A_1
    WTMZ_37J_1 WTMZ_42_1 / d =weibull;
run;

proc lifereg covout data=c.DataDtest6;
model WTMZ_389C*Censor(0)=DHHE_SEX_1 GEOE_PRV_11 GEOE_PRV_12
    GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46 GEOE_PRV_48
    GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61 WTMZ_30_1 WTMZ_31_1
    WTMZ_33_1 WTMZ_33_2 WTMZ_33_3 WTMZ_35_1 WTMZ_36_1
    WTMZ_37A_1 WTMZ_37J_1 WTMZ_42_1 / d =weibull;
run;

proc lifereg covout data=c.DataDtest6;
```

```
model WTMZ_389C*Censor(0)=DHHE_SEX_1 GEOE_PRV_11 GEOE_PRV_12
    GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46 GEOE_PRV_48
    GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61 WTMZ_30_1 WTMZ_31_1
    WTMZ_33_1 WTMZ_33_2 WTMZ_33_3 WTMZ_35_1 WTMZ_36_1
    WTMZ_37A_1 WTMZ_37J_1 WTMZ_42_1 / d =weibull;
weight WTSE_S3M;
run;

proc phreg data=c.DataDtest6;
model WTMZ_389C*Censor(0)=DHHE_SEX_1 GEOE_PRV_11 GEOE_PRV_12
      GEOE_PRV_13 GEOE_PRV_24 GEOE_PRV_35 GEOE_PRV_46 GEOE_PRV_48
      GEOE_PRV_59 GEOE_PRV_60 GEOE_PRV_61 WTMZ_30_1 WTMZ_31_1
      WTMZ_33_1 WTMZ_33_2 WTMZ_33_3 WTMZ_35_1 WTMZ_36_1
      WTMZ_37A_1 WTMZ_37J_1 WTMZ_42_1 ;
baseline out=a survival=s logsurv=ls;
run;

data b;
set a;
y=log(-ls);
x=log(WTMZ_389C);
run;

proc reg data = b;
model y = x;
run;
```

7.2 Value taken of selected variables

7.2.1 Values taken of common variables for all three objectives

(1) DHHE_AGE

Content	Code
15 to 17 years	2
18 to 19 years	3
20 to 24 years	4
25 to 29 years	5
30 to 34 years	6
35 to 39 years	7
40 to 44 years	8
45 to 49 years	9
50 to 54 years	10
55 to 59 years	11
60 to 64 years	12
65 to 69 years	13
70 to 74 years	14
75 to 79 years	15
80 years or older	16

(2) DHHE_SEX

Content	Code
Male	1
Female	2

(3) GEOE_PRV

Content	Code
Newfoundland and Labrador	10
Prince Deward Island	11
Nova Scotia	12
New Brunswick	13
Quebec	24
Ontario	35
Manitoba	46
Saskatchewan	47
Alberta	48
British Columbia	59
Yukon	60
Northwest	61
Nunavut Territories	62

7.2.2 Values taken of accessing service from a medical specialist

(1) WTMZ_01

Content	Code
Yes	1
No	2
Not applicable	6
Don't know	7
Refusal	8
Not stated	9

(2) WTMZ_02

Content	Code
Heart condition or stroke	1
Cancer	2
Asthma or other breathing conditions	3
Arthritis ou rheumatism	4
Cataract or other eye conditions	5
Mental health disorder	6
Skin conditions	7
Gynaecological problems	8
Other	9

Not applicable	96
Don't know	97
Refusal	98
Not stated	99

(3) WTMZ_03

Content	Code
A family doctor	1
Another specialist	2
Another health care provider	3
Did not require a referral	4
Not applicable	6
Don't know	7
Refusal	8
Not stated	9

(4) WTMZ_04

Content	Code
Yes	1
No	2
Not applicable	6

Refusal	8
Not stated	9

(5) WTMZ_07A

Content	Code
Waiting time	1-365
Not applicable	996
Don't know	997
Refusal	998
Not stated	999

(6) WTMZ_07B

Content	Code
Days	1
Weeks	2
Months	3
Not applicable	6
Not stated	9

(7) WTME_08A

Content	Code
Waiting time	1-300
Not applicable	996
Don't know	997
Refusal	998
Not stated	999

(8) WTMZ_08B

Content	Code
Days	1
Weeks	2
Months	3
Not applicable	6
Not stated	9

7.2.3 Values taken of receiving a non-emergency surgery

(1) ACCZ_20

Content	Code
Yes	1
No	2

Don't know	7
Refusal	8
Not stated	9

(2) WTMZ_16

Content	Code
Cardiac surgery	1
Cancer related surgery	2
Hip or knee replacement surgery	3
Cataract/other eye surgery	4
Hysterectomy	5
Removal of Gall Bladder	6
Other	7
Not applicable	96
Don't know	97
Refusal	98
Not stated	99

(3) WTMZ_18

Content	Code
Yes	1

No	2
Not applicable	6
Don't know	7
Not stated	9

(4) WTMZ_19

Content	Code
Yes	1
No	2
Not applicable	6
Don't know	7
Not stated	9

(5) WTMZ_20A

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(6) WTMZ_20B

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(7) WTMZ_20C

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(8) WTMZ_20D

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(9) WTMZ_20E

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(10) WTMZ_20F

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(11) WTMZ_20G

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(12) WTMZ_20H

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(13) WTMZ_20I

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(14) WTMZ_20J

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(15) WTMZ_20K

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(16) WTMZ_20L

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(17) WTMZ_20M

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(18) WTMZ_20N

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(19) WTMZ_21A

Content	Code
Waiting time	1-365
Not applicable	996
Don't know	997
Refusal	998
Not stated	999

(20) WTMZ_21B

Content	Code
Days	1
Weeks	2
Months	3

Not applicable	6
Not stated	9

(21) WTMZ_22

Content	Code
Yes	1
No	2
Not applicable	6
Don't know	7
Not stated	9

(22) WTME_23A

Content	Code
Waiting time	1-365
Not applicable	996
Don't know	997
Refusal	998
Not stated	999

(23) WTMZ_23B

Content	Code
Days	1
Weeks	2
Months	3
Not applicable	6
Not stated	9

(24) WTMZ_26

Content	Code
Yes	1
No	2
Not Applicable	6
Don't know	7
Not Stated	9

(25) WTMZ_27A

Content	Code
Yes	1
No	2
Not Applicable	6

Don't know	7
Not Stated	9

(26) WTMZ_27B

Content	Code
Yes	1
No	2
Not Applicable	6
Don't know	7
Not Stated	9

(27) WTMZ_27C

Content	Code
Yes	1
No	2
Not Applicable	6
Don't know	7
Not Stated	9

(28) WTMZ_27D

Content	Code
Yes	1
No	2
Not Applicable	6
Don't know	7
Not Stated	9

7.2.4 Values taken of selected diagnostic tests

(1) ACCZ_30

Content	Code
Yes	1
No	2
Don't know	7
Refusal	8
Not stated	9

(2) WTMZ_30

Content	Code
MRI	1

CT Scan	2
Angiography	3
Not applicable	6
Don't know	7
Refusal	8
Not stated	9

(3) WTMZ_31

Content	Code
Heart disease or stroke	1
Cancer	2
Joints or fractures	3
Neurological or brain disorders	4
Others	5
Not applicable	6
Don't know	7
Refusal	8
Not stated	9

(4) WTMZ_32

Content	Code

Yes	1
No	2
Not applicable	6
Refusal	8
Not stated	9

(5) WTMZ_33

Content	Code
Hospital	1
Public clinic	2
Private clinic	3
Other	4
Not applicable	6
Don't know	7
Not stated	9

(6) WTMZ_35

Content	Code
Yes	1
No	2
Not applicable	6

Don't know	7
Not stated	9

(7) WTMZ_36

Content	Code
Yes	1
No	2
Not applicable	6
Refusal	8
Not stated	9

(8) WTMZ_37A

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(9) WTMZ_37B

Content	Code

Yes	1
No	2
Not applicable	6
Not stated	9

(10) WTMZ_37C

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(11) WTMZ_37D

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(12) WTMZ_37E

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(13) WTMZ_37F

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(14) WTMZ_37G

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(15) WTMZ_37H

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(16) WTMZ_37I

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(17) WTMZ_37J

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(18) WTMZ_37K

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(19) WTMZ_37L

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(20) WTMZ_37M

Content	Code
Yes	1
No	2
Not applicable	6
Not stated	9

(21) WTMZ_38A

Content	Code
Waiting time	1-365
Not applicable	996
Don't know	997
Refusal	998
Not stated	999

(22) WTMZ_38B

Content	Code
Days	1
Weeks	2
Months	3
Not applicable	6
Not stated	9

(23) WTME_39A

Content	Code
Waiting time	1-180
Not applicable	996
Don't know	997

Refusal	998
Not stated	999

(24) WTMZ_39B

Content	Code
Days	1
Weeks	2
Months	3
Not applicable	6
Not stated	9

(25) WTMZ_42

Content	Code
Yes	1
No	2
Not Applicable	6
Don't know	7
Not Stated	9

(26) WTMZ_43

Content	Code
By self	1
By specialist	2
By hospital	3
By clinic	4
Other	5
Not Applicable	6
Don't know	7
Not Stated	9

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