The Impact of Maximum Waiting Time Targets in Norwegian Hospitals

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Aims:
In September 2004, individual maximum waiting times for inpatient treatments were introduced in Norway. This involved explicit guidelines on how patients should be prioritised within patient groups: Patients are allocated into groups satisfying rights to treatment, either with or without an individual limit on medically maximum acceptable waiting time. This implies that the patients with severe health conditions should get treatment faster than patients whose medical condition would not deteriorate with longer waiting time. In the period 2002-2008, the treatment activity increased most for five medical groups: diseases of the nervous system, diseases of the eye, diseases of the ear, diseases of the circulatory system and diseases of the musculoskeletal system. The aim of this study is to explore if and how the implemented policy affect the distributions of waiting times for these medical groups: Has the probability of admission increased for the most prioritised patients? Are there any patient characteristics or medical conditions that lead to higher hazard rates?

Methods:
Duration analysis.

Data:
The data are taken from the Norwegian Patient Register covering the whole population of patients referred for inpatient hospital treatments in the period 2003-2006. The dataset contains individual information on waiting times, age, gender, main diagnosis, number of co-morbidities, DRG-weights and procedure codes.

Results:
The main results from the duration analysis show that there are no major differences in the waiting time distributions after the introduction of the individual maximum waiting time in Norway for the five medical groups. Still, there is an indication that older patients and patients with many co-morbidities have higher hazard rates and that patients waiting for the surgery have higher survival rates.

Key words: Waiting time, prioritization, duration analysis, Norway

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1. Introduction

When the demand for health care services exceeds supply, the patients are rationed by waiting lists. Long waiting times in the health care sector is a well known phenomenon in countries where most of the health care is publically provided (Siciliani and Hurst, 2005). The main reason is that the health care services are financed through taxes, copayments are low and all inhabitants have the right to treatment. A number of studies show that reducing waiting times benefits patients in a number of ways (shorter periods in pain, reduced risk of complications during the treatment, increase chances for a better outcome, shorter time on sick leave, etc.), while there is no evidence that long WT can be beneficial for patients (except in cases where diagnosis is difficult or unclear) (Appleby & Harrison, 2009).

Different policies have therefore been introduced in order to tackle long waiting times. Most of the policies use supply-side strategies (more funding, waiting time targets, performance management), but some countries have also introduced demand side strategies, where medical criteria is used to prioritise which patients should wait shortest (Willcox et al., 2007).

The most common policy is blanket waiting time target setting (introduced in Australia, Denmark, England, Italy, Scotland, Spain, and Sweden). With blanket waiting time targets all patients have equal priority, regardless of their clinical condition and the treatment they are waiting to receive. This unconditional guarantee may be effective in reducing long waiting times (Siciliani and Hurst, 2005). But the reduction of waiting times does not necessarily benefit all the patients; the hospitals may choose to treat less needy patients to have a lower proportion of patients on the waiting lists, which would imply that the most severe patients are worse off. Other countries have introduced vertical waiting time prioritisation. With this type of prioritisation, explicit guidelines are given on how patients should be prioritised *within* patient groups. In New Zealand, patients receive points, and patients with more points have shorter waiting times (Edwards 1999). In Norway, the seriousness of the disease, the expected benefit of the treatment and cost-effectiveness considerations determine an individually set maximum waiting time. It is believed that vertical waiting time targets reduce the problem of less needed patients getting too high priority.

The right to access and equal treatment for all inhabitants, irrespective of age, gender, ethnicity, socio-economic status and place of resident, is an important principle within the Norwegian health care system (Ministry of Health and Social Affairs, 2000). Still, the recent studies show that there exist big variations in the prioritisation practices (Askildsen et al., 2009). The share of patients, who qualify for the right to necessary health care, vary from 48-

80 % in different health regions in Norway in 2009, and there is no reason to believe that the population is so different (IS-1744, IS-1786).

The demand for health care services will most likely not go down; aging population and new technologies make it possible to treat more diseases and people are living longer. On the other hand, improved technology makes it possible to perform some of the treatments more efficiently, which could contribute to shorter waits. The overview of the waiting times and activity in the Norwegian hospitals in the period 2002-2008 states that there is no direct relationship between waiting lists and activity in the hospitals (IS-1744).[1] In the period 2002-2008, the share of patients treated increased by 18 %. When adjusted for population growth, the treatment activity has still increased by about 13 %.

Activity seems to have increased for almost all patient groups, but patient groups that experienced the biggest increase are patients within diseases of the genitourinary system (N00-N99) and neoplasm (C00-D48). This is due to increased use of dialysis and chemotherapy as day cases treatments. The other five major groups where activity increased most in the period 2002-2008, are diseases of the nervous system, diseases of the eye, diseases of the ear, diseases of the circulatory system and diseases of the musculoskeletal system (IS-1744; 10/2009). Why there are more patients treated within these groups is difficult to say, but an interesting question is what characterises the patients in these groups. The aim of this study is therefore to explore if and how the implemented policy affect the distributions of waiting times, i.e. which patient groups- more or less severe patients- experience increased probability of admission. The duration analysis is applied on the waiting time data in order to compare the hazard- and survival rates, both for different medical groups and for different priority groups within the same medical group.

More specifically, the research questions are:

- To explore the distributions of waiting times and the probability of admissions for the patients within the five medical groups: are the hazard rates highest for the most prioritised patients?
- Can we observe any changes in hazard rates and the admission probabilities after the introduction of individual maximum waiting time?
- Do individual characteristics (gender, age, number of co-morbidities) have any impact on admission rates?

[1] The reasons might be increased number of the referrals, changing practice for the patient registering and the fact that it's difficult to compare activity in emergency cases, day cases and inpatient treatments as some of the diseases that used to be inpatient treatment are now carried out as day case treatments.

The paper is organised as follows: The institutional settings in Norway are contained in section 2. Section 3 presents the empirical method. The dataset is presented in section 4. Section 5 presents the estimation results and section 6 contains the concluding remarks.

2. Institutional Settings

The Norwegian specialised health care sector is predominantly publicly owned, and as of 2002 organised as state owned enterprises within five (north, mid, west, south, east; four from June 2007 when south and east were merged) regional health authorities. The regional health authorities have the responsibility for providing specialist health care to all patients within the region.[2] Provision of this health care is organised through health enterprises owned and governed by the regional enterprises. The regional health authorities can also contract with private suppliers for providing treatment. However, this outsourcing is quite small compared to overall treatment activity, and confined to a few diagnoses.

Regional Health Authorities are financed by a mixture of block grants, based on capitation or risk adjustment formula, and a DRG activity based system (ABF, implemented in the Norwegian hospital sector from 1 July 1997). Another important feature is the patients' right to free choice of hospital, which came into effect at a national level in 2001. However, relatively few patients seem to have opted for the possibility of receiving treatment outside of natural hospital catchment areas, Vrangbæk *et al*. (2007).

An important principle within the Norwegian health care system is the right to access and to equal treatment for all inhabitants, irrespective of age, gender, ethnicity, socio-economic status and place of residence. This principle is regulated through the Act on Patients Rights and administrative regulation of prioritisation (Ministry of Health and Social Services, 1999; 2003). For elective patients, it establishes that upon referral, the assessment of a patient's conditions must consider: a) how serious is the condition, b) whether a suitable treatment exists that may improve the patient's condition, and c) the cost-effectiveness of this treatment. From September 2004 patients who are referred to the specialist health care sector have the right, within 30 days from referral, to an evaluation of whether their medical condition is such that it gives a right to treatment within an individually maximum waiting time.

[2] See Hagen and Kaarbøe (2006) and Magnussen *et al* (2007) for more detailed descriptions of the Norwegian hospital sector and the 2002-reform where hospital ownership was transferred from the county councils to the central government.

According to the new regulations all patients should be categorised into one of the following categories:

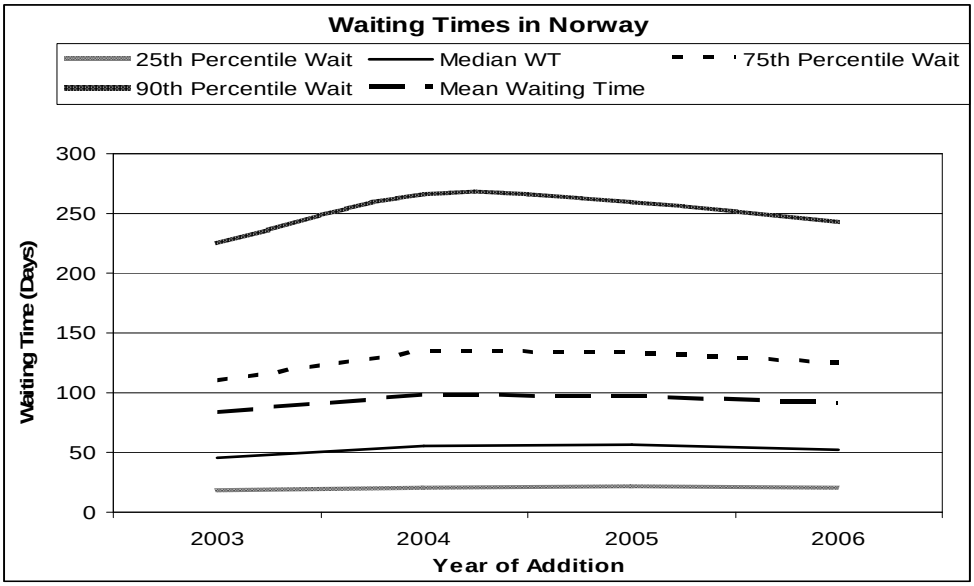
1. Emergency care (EC)
2. Elective treatment, with individual maximum waiting time (elective with)
3. Elective treatment, without individual waiting time (elective without)
4. Other health care services that may be demanded.

In addition to EC patients, for whom the hospitals must deliver health care services, it is patients in priority group two (elective with) that comprise the core health care supply of Norwegian public hospitals. However, patients in group three (elective without) also have the right to treatment. It is only demand from patients in group four that are excluded from the mandatory activities of the public health enterprises.

The allocation of prioritisation status to elective patients is formally managed the following way. Upon receipt of a referral, within 30 days the hospital has to consider whether the patient belongs to group 2 or 3, or whether (s)he should not receive treatment at all. This decision is based only on the description of the medical condition given by the primary care physician. Each patient is to be considered according to the priority regulations, criteria I-III above. If the patient is considered as belonging to group 2 (elective with), (s)he is given an individual maximum waiting time until start of treatment. If waiting time is exceeded, the patient has the right to file a complaint. The hospital is then given a short time frame for providing treatment (typically14 days). If treatment is still not given, the patient can choose treatment at another hospital, privately, publically or abroad, at the cost of the initial health enterprise. The Norwegian Labour and Welfare Service (NAV) has organized a special unit to help patients choose provider. This unit will also handle administrative tasks, and ensure that the new provider gets paid.

The distributions of waiting times for all inpatient treatments for the period 2003-2006 are illustrated in Figure 1. The figure shows that the median waiting time is stable at approximately 50 days. The waiting time at the 90^{th} percentile has gradually increased between 2003 and 2004, but then decreased back to around 250 days in 2006.

Figure 1: Distributions of waiting times for the inpatient treatment in Norway, 2003-2006.



3. Applying duration analysis to waiting time data

The main interest in survival models is duration, the time spent in a state, for example waiting time for the treatment. The method is robust even if the residuals are not normally distributed and allows us to look at the distribution of the depended variable instead of the average values. In addition, the method allows for censoring, which otherwise would bias the estimates, and also to include the time varying variables in the analysis.[3]

The basic concepts in the survival analysis are survival function and hazard rate. *Survival function* is the conditional probability of surviving in the state (on the waiting list) until a given time (admittance to the hospital): $S(t) = 1- F(t) =P(T>t)$ where $0 \leq S(t) \leq 1$ and $F(t)$ is the cumulative distribution function (for the length of a spell for an individual in the sample): $F(t) = P(T \leq t)$. The probability of survival is equal 1 at entry in the state of interest. In this analysis we follow the individuals from the time the hospital receives the referral until the patients get the treatment; the survival state is therefore the waiting list. The *hazard rate*, on the other hand, shows the probability of leaving the state (leaving the waiting list and getting the treatment) at a given time, conditioned that a person has been in the state until that time:[4]

[3] Supply side variables, as number of beds, doctors and nurses in the hospitals will be included when data are available.
[4] It is the instantaneous rate of failure per unit of time.

$$\theta(t) = \lim_{dt \to 0} \frac{F(t+\Delta t) - F(t)}{dt} * \frac{1}{1-F(t)} = \frac{f(t)}{1-F(t)} = \frac{f(t)}{1-F(t)} = \frac{f(t)}{S(t)}$$

The models can be explained as consisting of two parts: the underlying hazard function (baseline hazard) that describes how the hazard changes over time, and the effect parameters, which describe how hazard relates to other factors, for example age, gender, etc. The likelihood function can then be estimated.[5]

There are three main approaches in the duration analysis. *Non-parametric method*, such as Kaplan Meier, estimates the probability of survival past a certain point in time, or compares the survival experiences for some qualitative variables (e.g. gender, age, etc.). The important heterogeneity effects, like how covariates effect the changes or the distribution of failure times are not taken into account here. Semi-parametric and parametric models yield therefore more efficient results. Nevertheless, the non-parametric method gives an important insight about the survival- and hazard rates as it does not make any assumptions about the distribution of failure times.

Parametric analyses rely on fully specifying the baseline hazard function. Misspecification of duration dependence may lead to biases in the regression parameters, and these models are also sensitive to the problems caused by unobserved heterogeneity. *Semi-parametric* models, on the other hand, are more flexible and more robust than parametric models; the baseline hazard is not specified, but treated as an unknown function of time. But the trade-off is less efficient estimates compared to parametric models.

4. Dataset

The data are taken from Norwegian Patient Register (NPR) covering the whole population of patients hospitalized in the period 2003 – 2007. The register contains detailed information on inpatients, i.e. patient characteristics such as age and gender, waiting time, name and location of the hospital providing the treatment, type of treatment (medical or surgical; acute care patients are not included), main and secondary diagnoses, length of stay and place of residence. However, the dataset contains only information on the patients that received the treatment. The patients that dropped from the list (e.g. decided to get the treatment at a private hospital, was admitted as an emergency patient while being on the waiting list or died) are not

[5] It can be argued that hazard rates in the sample do depend on each other, as one treated patient makes a space for another patient that is on the waiting list as the capacity in the hospitals are fixed. Still, there are many observations in different hospitals, diseases and maximum waiting times in the sample. Therefore, I argue that condition for spell independence is not violated.

in the dataset. The depended variable, waiting time, is measured from the time the referral is received to admission at the hospital.

In the analysis, the interest is in the patients added to the list in years 2003 and 2005.[6] Waiting times, longer than two years, are excluded from the analysis as these are most likely coding errors. The follow up period is 18 months, which implies that the observations are right censored at 550 days. Only observations for the five ICD10 chapters, namely diseases of the nervous system, diseases of the eye, diseases of the ear, diseases of the circulatory system and diseases of the musculoskeletal system, are included in the analysis.[7]

However, not all observations in the register could be used in the final analyses. Table 1 summarises the exclusions.

Table 1. Exclusions

	Total:	2003	2005
Patients added to the list:	110,653	54,047	56,606
Exclusions due to:			
Re-admissions[8]	3,925	1,854	2,071
Missing WT&WT<1	7,570	2,151	5,419
WT>730	1,459	1,085	374
Sample:	97,699	48,957	48,742

Following the exclusion criteria described above, we are left with a sample of 97,699 patients. The dataset is a flow sample, which means that observations start into the state of interest at a calendar time 0.

Table 2 shows the distributions of waiting times for the five medical groups. We can see that the mean waiting times increased most for nerves (by 41 days), for diseases of the musculoskeletal system (by 9 days) and diseases of the circulatory system (by 1 day). The mean waiting times for diseases of the eye and ear decreased by 1 day. We notice also that mean waiting times are shortest for the patients with the diseases of the circulatory system and longest for the patients with the diseases of the ear.

Table 2: Distribution of waiting times (days) for the five ICD10 chapters. By addition years.

[6] Will be changed to 2006 when the data for 2008 will be available.

[7] Diseases of the genitourinary system (N00-N99) and neoplasm (C00-D48) are not included since increase in activity for these medical groups is mostly due to increased use of dialysis and chemotherapy as day cases and is difficult to compare with the inpatient treatment.

[8] The interest is the waiting time for first hospital admission.

Period	Percentiles					Mean
	10th	25th	50th	75th	90th	
Diseases of the nervous system (ICD10- 6)						
2003	13	29	69	175	327	125.01
2005	20	45	101	247	427	166.85
Diseases of the eye (ICD10- 7)						
2003	15	35	75	129	238	106.27
2005	14	34	67	126	246	105.06
Diseases of the ear (ICD10- 8)						
2003	27	61	159	339	500	214.17
2005	32.5	68	163.5	321	470	213.67
Diseases of the circulatory system (ICD10- 9)						
2003	7	20	45	96	218	85.40
2005	7	19	42	101	224	86.77
Diseases of the musculoskeletal system (ICD10-13)						
2003	15	34	76	161	305	122.21
2005	19	40	88	177	310	131.19

Table 3 shows the number of observations for different priority groups. We can see that there is some variation in maximum acceptable waiting times for different medical groups. ICD10 chapter 6 does not have any observations in priority group 56 days, diseases of the eye includes only observations with MWT 84 days and "no-right", while diseases for the ear has only observations for MWT 84 days and "no right". The two major groups- diseases of the circulatory system and musculoskeletal system include observations for all MWT groups.

Table 3. Number of observation for different priority groups within ICD10 chapters.

ICD10	MWT 28	MWT 56	MWT 84	MWT 182	No right	Without MWT	Total
6	2,029	0	1,038	1,143	630	15,430	20,270
7	0	51	0	0	3,164	2,301	5,516
8	0	0	1,035	0	594	470	2,099
9	1,302	3,285	3,866	2,675	9,818	4,421	25,367
13	308	38	858	15,238	14,528	13,477	44,447
Total	3,639	3,374	6,797	19,056	28,734	36,099	97,699

5. Empirical Methods and results

The method applied in this paper is suggested by Askildsen *et al*. (2010) which derives maximum waiting times from Norwegian medical guidelines. The guidelines contain descriptions of medical conditions, where each condition is given either a recommended maximum waiting times (4-56 weeks) or no priority which makes it possible to rank medical

conditions by severity. By adding ICD10 codes to the medical conditions in the guidelines it is possible to merge individual patient information from Norwegian patient register to information on corresponding maximum acceptable waiting time from the medical guidelines. It is therefore possible to compare actual waiting times for patients with medical conditions of different severity in different time periods. If, for a particular group of patients, the probability of admission increases (decreases) relative to other patients, this might be interpreted as if this patient group is being higher (lower) prioritised.

One of the goals of this paper is to measure the impact of maximum waiting time targets on the distribution of waiting times. If the maximum waiting time targets do have any effect, the differences in hazard rates in the pre- and post reform periods would be observed in the data for different priority groups: an increasing probability that a patient gets treatment as waiting times increases up to the (around) the maximum waiting time target, and then decreasing probability after the maximum is reached. Higher hazard rates around the targets would be an indication that the hospitals are trying to provide the treatment within the maximum waiting times.

The explanatory variables that are included in the analysis are patient characteristics: Gender, age (average age in the sample, *age-56*), number of co-morbidities; Medical conditions: MWT targets (28, 56, 84, 112 days and "no-priority" group), dummies for the different medical groups, a dummy showing if the patient is waiting for surgical or medical treatment and DRG-weights indicating the severity of the main diagnosis. The quarters of the additions, dummies for the health regions and year dummies are also included in the analysis.

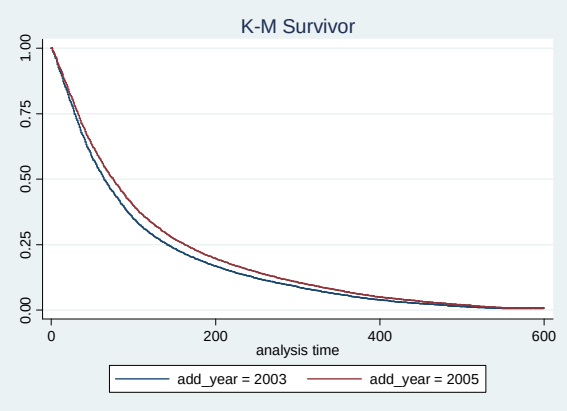
To analyse if the prioritisation has changed over time, the interaction variables for priority groups and pre- and post reform dummy variables are included in the next model. Matching is applied to pre-process the data set, so that the treatment and control groups have the same background characteristics. This involves pruning of observations that have no close match which makes the subsequent parametric analyses less sensitive for the model specification (Ho *et al*. 2007, Imbens and Wooldridge 2009). In order to equalise case-mix over time Exact Matching method is used to weight the pre-reform patients to the composition of patients in the post-reform period (Iacus *et al*. 2009). The matching is undertaken on combinations of the following variables: gender, age, number of co-morbidities, and main diagnosis.

As presented in section 3, several approaches may be used in duration analysis. In the following, the methods applied and results are presented.

5.1. Non-parametric analysis

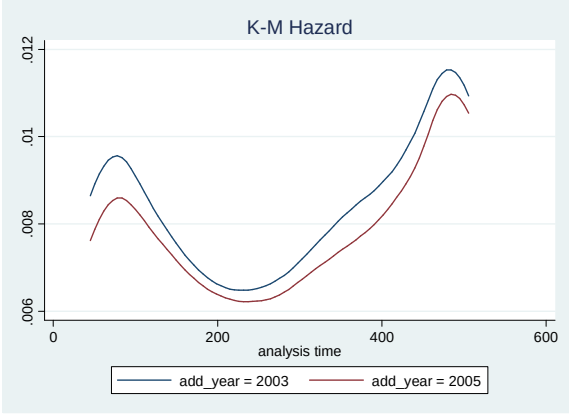
The analysis starts with a simple, non-parametric graphical analysis of the survivor and hazard functions. The vertical axis in Kaplan-Meier survivor function shows the proportion of waiting times started and that are still on the waiting list after a stated number of days. Calendar time is ignored in this figure.

Figure 2. Kaplan-Meier survival functions for the additions in 2003 and 2005.



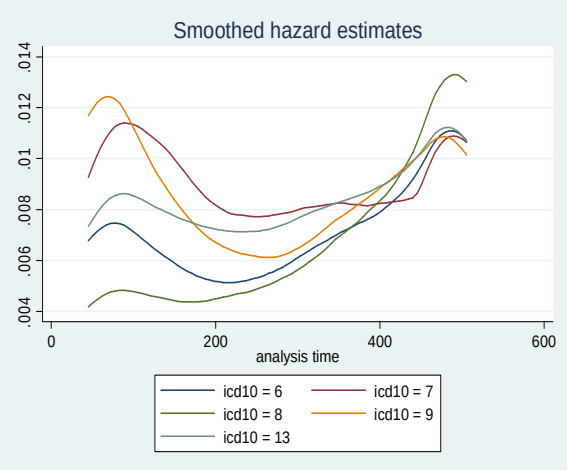
The function starts at one and declines to zero, indicating that all waiting times eventually end. We see that in 2005, the patients had a slightly better survival experience (i.e. are longer on the waiting list) than in 2003.

Figure 3. Hazard rates for the additions in 2003 and 2005.



The corresponding hazard rates for the two addition years are in line with the survivor rates: we can see that the patients, added to the list in 2003, had higher hazard rates.

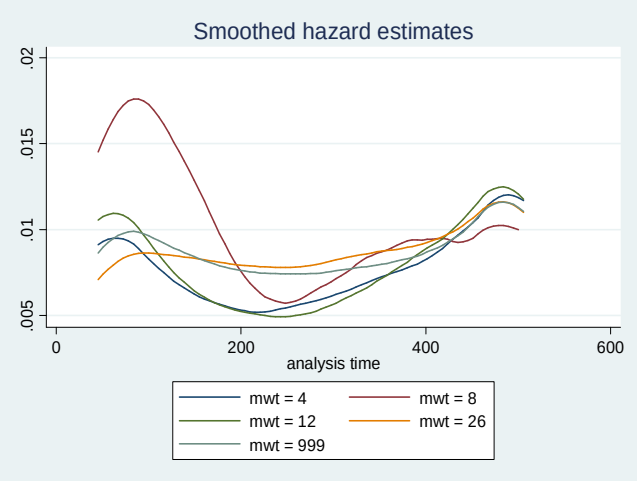
Figure 4. Hazard rates for the five ICD10 chapters.



We observe a big variation in the hazard rates for the five ICD10 chapters. The highest hazard rate is for the ICD10 chapter 9 (Diseases of the circulatory system) and lowest for ICD10 chapter 8 (Diseases of the ear). This is in line with the maximum waiting times as the minimum maximum waiting time for the ear patients are 84 days.[9]

[9] See Table 3.

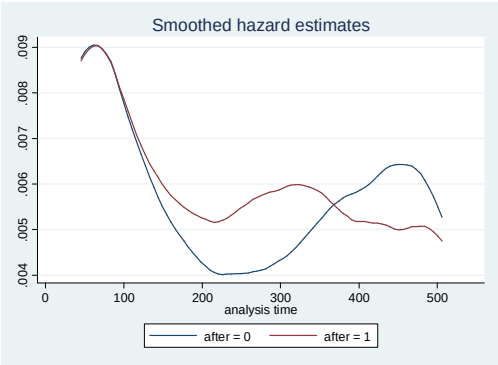
Figure 5. Hazard rates for the different priority groups.



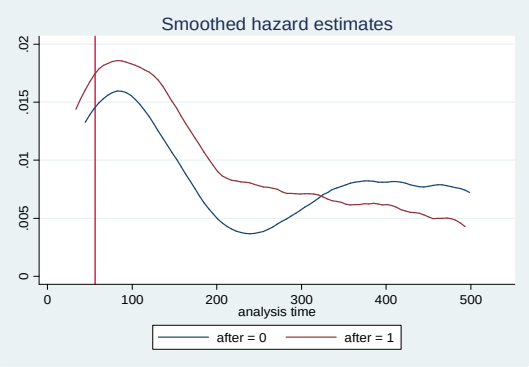
There is also much variation in the hazard rates for different priority groups. The hazard rate seems to be highest for the second most prioritised patient group. The diseases of the circulatory system form a relatively big part of this group.

Figure 6. Hazard rates for the groups with:

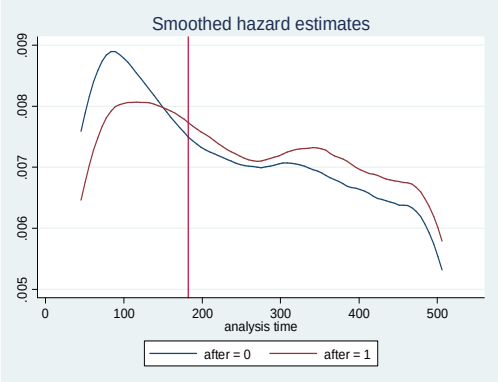
MWT 28 days.



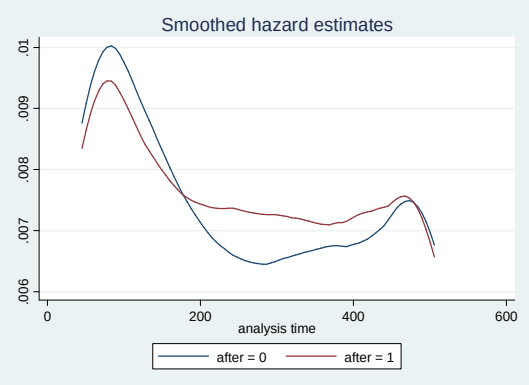
56 days.



182 days:



No right:



Hazard rates seem to be higher for the most prioritised groups (28 and 56 days) after the introduction of maximum medical acceptable waiting time. For the least prioritised patients, the hazard rates are lower after the reform until around 150 days (for MWT 182 days) and till around 180 days for the patients that do not qualify for the treatment within an individual maximum waiting time.

5.2. Parametric Analysis

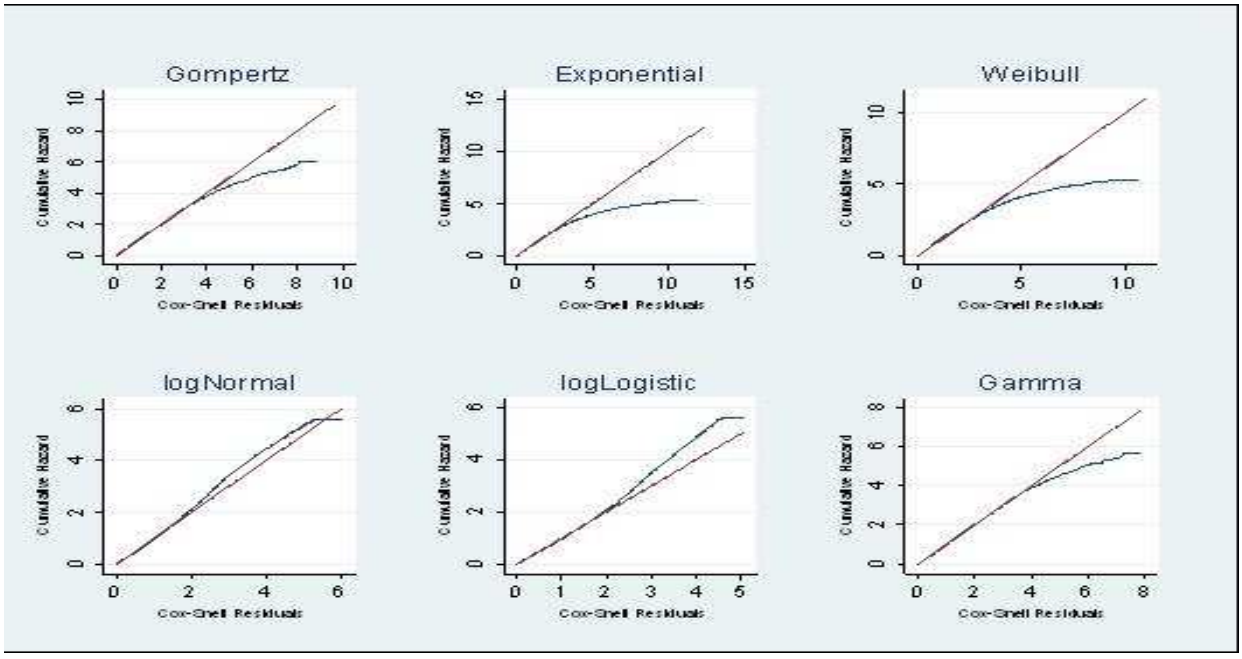
As mentioned in Section 3, the parametric analysis imposes a certain form on the baseline hazard. If the model applied poorly fits the data, this can lead to biased estimates. Cox-Snell residual test and the information criteria are therefore used when choosing the parametric distribution that fits the data best (Jones et. al, 2007). The mean duration times and medians are predicted after estimating the models, in order to find the best fit for the data.

Table 4. Information Criteria for Parametric models.

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
Gompertz	97699	-160505	-156705	35	313480.6	313812.7
Exponential	97699	-162419	-157818	34	315704.6	316027.3
Weibull	97699	-161621	-157518	35	315106.4	315438.6
Lognormal	97699	-161703	-157185	35	314440.1	314772.2
LogLogistic	97699	-161265	-156357	35	*312783.5*	*313115.7*
Gamma	97699	-159893	-155534	36	*311138.9*	*311480.5*

According to the Information Criteria, Gamma distribution seems to fit the data best, followed by Log-logistic distribution. This is in line with the Cox-Snell Residual test (Figure 7). This can be interpreted as an indication that the hazard rates are not monotonically increasing/ decreasing; models showing the best fit for the data estimate non-monotonic hazard rates.[10]

Figure 7. Cox-Snell Resdidual test.



[10] Predicted mean and median values differ from real mean and median waiting times in all the models.

The regression results are presented in Table 5. Model 1 shows the coefficients using Gamma distributions in AFT metric. The next model shows the hazard ratios for Weibull model when assuming proportional baseline hazard (2) and Weibull when controlling for unobserved heterogeneity[11] (3).[12]

Table 5. Regression results

	(1)	(2)	(3)	(4)	(5)
Variable	AFT Gamma	PH Weibull (PH)	PH Weibull (UH)	COX Stratified on MWT	PWC
Female	Ref.	Ref.	Ref.	Ref.	Ref.
Male	0.00364	0.994	0.998	0.995	0.996
	(0.0178)	(0.0171)	(0.0219)	(0.0156)	(0.0161)
Age	-0.00391***	1.004***	1.005***	1.003***	1.004***
	(0.0010)	(0.0008)	(0.0013)	(0.0008)	(0.0008)
Co-morbidities	-0.0290**	1.018	1.040***	1.019*	1.019*
	(0.0116)	(0.0111)	(0.0151)	(0.0105)	(0.0106)
DRG-weight	-0.0103	1.010	1.011	1.009	1.010
	(0.0141)	(0.0130)	(0.0177)	(0.0121)	(0.0123)
Medical	Ref.	Ref.	Ref.	Ref.	Ref.
Surgery	0.232***	0.854***	0.738***	0.850***	0.851***
	(0.0590)	(0.0371)	(0.0560)	(0.0367)	(0.0361)
MWT 28 days	Ref.	Ref.	Ref.		Ref.
MWT 56 days	-0.0231	1.184	0.975		1.137
	(0.1695)	(0.1651)	(0.2162)		(0.1574)
MWT 84 days	-0.0191	1.052	1.018		1.042
	(0.0566)	(0.0509)	(0.0789)		(0.0480)
MWT 182 days	0.272*	0.840	0.692*		0.831*
	(0.1424)	(0.0924)	(0.1338)		(0.0888)
No right	0.132	0.959	0.823		0.940
	(0.1413)	(0.0969)	(0.1610)		(0.0954)
Diseases of the nervous system (G00-G99)	Ref.	Ref.	Ref.	Ref.	Ref.
Diseases of the eye (H00-H59)	-0.379***	1.391***	1.607***	1.347***	1.369***
	(0.1058)	(0.1487)	(0.1991)	(0.1332)	(0.1351)
Diseases of the ear (H60-H95)	0.363***	0.705***	0.642***	0.745***	0.729***
	(0.0859)	(0.0543)	(0.0717)	(0.0527)	(0.0527)

[11] Under unobserved heterogeneity, PH model will overestimate the degree of negative duration dependence in the (true) baseline hazard, and under-estimate the degree of positive duration dependence. Still, when controlling for unobserved heterogeneity, the results are sensitive to parametric form assumptions concerning baseline hazard. In the table, the Weibull model with gamma distribution is reported.

[12] The parametric results, using Log-Logistic and Gompertz distribution are similar to the ones obtained by Gamma and Weibull distributions and therefore not reported in the table.

Diseases of the circulatory system (I00-I99)	-0.572*** (0.1009)	1.542*** (0.1467)	2.099*** (0.2618)	1.509*** (0.1337)	1.539*** (0.1371)
Diseases of the musculoskeletal system (M00-M99)	-0.231*** (0.0894)	1.201** (0.0982)	1.350*** (0.1498)	1.185** (0.0887)	1.197** (0.0918)
Patient regions	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Quarters	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Constant	4.326*** (0.2050)				
Log Likelihood:	-155,671.49	-157,646.13	-155,539.1	-868,304.92	-155,485.01
N	97,699	97,699	97,699	97,699	567,730

Note: Standard errors in parentheses, clustered by hospitals. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Negative coefficients or hazard ratios lower than 1 indicate lower hazard rates in PH models. The negative values of the AFT coefficients can be interpreted as saying that those patients have shorter (log) survival rates. Higher hazard rates mean that the patients are leaving the waiting list faster, while higher survival rates mean that the patients stay longer on the list.

The reference person is a 56 years old woman without any co-morbidity, with a high prioritised disease of nerves and living in the health region east. From the table we can see that gender has no significant difference for the survival rates. One year increase in age is associated with under one day decrease in waiting time (exp(-0.00391)=0.996) and less than one day decrease in waiting time if number of co-morbidities increase by 1. Estimates also imply that at each survival time, the hazard rates for surgical patients are about 74 % of the hazard rates for the medical patients. Higher DRG-weight leads to shorter survival time (negative coefficients in the model 1) and higher hazard rate (hazard rates bigger that 1 in the models 3-5). However, the coefficients for DRG-weights are not statistically significant. There are no significant differences for the priority groups. When it comes to different medical groups we observe that the survival rates are shortest for the patients within the "Circulatory diseases" group.

5.3. Semi-parametric Analysis

The parametric models make assumptions about the shape of the hazard function. In Cox Proportional Hazard model no assumptions about the shape of the hazard over time are made. The only thing that is assumed is that whatever the shape, it is the same for everyone:

the effects of covariates can only induce proportional shifts in the transition rate, but cannot shift its shape.

Both graphical analysis and the test based on the Schoenfeld residuals show that PH assumption is violated. Still, the Cox- model results are reported for the sake of comparability. Three models were estimated: the full model (Cox1), a model stratified on maximum waiting time groups (Cox2) and a model stratified on medical groups (Cox3). The information criteria favoured model Cox2 and the results are reported in Table 5, model 4. The results are very similar to the estimates in the PH Weibull model. Older patients have higher hazard rates and there are no significant differences for the different priority groups.

Another approach within semi-parametric models is Piecewise Constant Exponential model, which is a generalisation of the standard exponential model. The basic idea here is to split the time axis into time periods, assuming that transition rates are constant in each of these intervals but can change between them [Blossfeld et.al, 2007]. The more episodes there are in the duration data, the better/ the more precise are the estimated baseline hazard. The numbers of observations in the model differ, depending on how many episodes there are in the model. The AIC criteria favour the model with most episodes split, and this model is reported in the table 5, model 5.[13]

Also here we see that the coefficients are very similar to the results obtained by proportional hazard Cox model: Surgical patients have lower hazard rates than medical ones (85 % of the hazard rate for medical patients), and higher hazard rates are observed for older patients and patients with more co-morbidities.

5.4. Analysing the reform effect

The same estimation techniques are applied for the matched sample model, where the interaction terms are also included in the regressions. The use of exact matching means that observations, for which there are no exact matches in the pre-reform period, are omitted from the analysis. This means that the sample size in the subsequent analysis is changed (83,435 observations).[14]

The results for the priority groups and the interaction variables are reported in table 6. The significant results from the earlier model (Table 5) haven't changed much and are not

[13] Episode splits were chosen according to the number of patients leaving the state.

[14] The more restrictions are imposed on the matching criteria, the more observations are lost. Different matching criteria have been applied without substantial changes in the results. Not reported in this draft.

reported in the table. However, there are no significant changes in the hazard rates for the priority groups.

Table 6. Results for priorty groups.

	(1)	(2)	(3)	(4)	(5)
Variable	AFT Gamma	PH Weibull (PH)	PH Weibull (UH)	COX Stratified on ICD10 chapters	PWC
Before the reform:					
MWT 28 days	Ref.	Ref.	Ref.	Ref.	Ref.
MWT 56 days	0.0732	1.102	0.866	1.017	1.056
	(0.1881)	(0.2041)	(0.2020)	(0.1569)	(0.1845)
MWT 84 days	-0.0465	1.097	1.040	1.068	1.080
	(0.0710)	(0.0785)	(0.0908)	(0.0679)	(0.0716)
MWT 182 days	0.235	0.865	0.716	0.868	0.853
	(0.1719)	(0.1249)	(0.1623)	(0.1162)	(0.1169)
No right	0.113	0.990	0.828	0.959	0.963
	(0.1483)	(0.1169)	(0.1642)	(0.1055)	(0.1093)
Without MWT	0.0967	0.950	0.853	0.942	0.938
	(0.1411)	(0.1035)	(0.1656)	(0.0981)	(0.0997)
After the reform:					
Trend	0.0276	0.987	0.950	0.989	0.978
	(0.0810)	(0.0707)	(0.0925)	(0.0648)	(0.0666)
MWT 56 days	-0.183	1.193	1.243	1.143	1.192
	(0.1610)	(0.2040)	(0.2531)	(0.1665)	(0.1976)
MWT 84 days	0.0148	0.989	0.990	0.988	0.994
	(0.0536)	(0.0633)	(0.0644)	(0.0517)	(0.0588)
MWT 182 days	0.0546	0.957	0.936	0.953	0.961
	(0.0830)	(0.0697)	(0.0948)	(0.0637)	(0.0665)
No right	-0.0294	1.012	1.055	1.018	1.023
	(0.0542)	(0.0563)	(0.0666)	(0.0483)	(0.0521)
Log Likelihood	-130786.08	-132446.4	-130640.32	-130640.32	-130668.7
N	83435	83435	83435	83435	488442

Note: Standard errors in parentheses, clustered by hospitals. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6. Preliminary Concluding Remarks

The paper explores the distributions and the probabilities of leaving the waiting list for five medical groups in the Norwegian hospitals. Patients added to the list in year 2003 and 2005 were followed up for 18 months. Non-parametric, parametric and semi-parametric results of the duration models for waiting times are presented.

On the aggregate level, the Kaplain-Meier survival functions and hazard rates show a slightly better survival rate (i.e. longer on the waiting list) for the patients, added to the list in

2005, after the individual maximum waiting time was introduced. However, a closer look at different priority groups show some changes in the hazard rates: the hazard rates for the most prioritised groups (MWT 4 and 8 weeks) are higher. Both the magnitude of the coefficients and statistical significance are similar in parametric and semiparametric models.

One of the objectives of this paper was to explore if the probability of admission is higher for the most prioritised patient group compared to the other priority groups. Kaplan Meier hazard rates show some changes in the hazard rates for the most prioritised patients. However, no significant differences in the admission rates for the most prioritised patients within the five medical groups are observed in the parametric models. The probability of admission does not seem to be affected by the introduction of maximum waiting time limit; the interaction terms in the second model specification are not statistically significant. The individual characteristics that seems to have most impact on the probability of being admitted is age (older people wait shorter) and number of co-morbidities (higher hazard rates if many co-morbidities), while gender doesn't seem to have any effect on waiting time. Patients, waiting for the surgery, have lower hazard rates than medical patients. If age and number of co-morbidities can be interpreted as an indication for how serious the condition is for a patient, we could say that patients are prioritised in terms of severity.

Why are there no obvious changes in the distributions of waiting times in the Norwegian hospitals? If the patients do not know their rights and just wait for the treatment, the hospitals are not forced enough to achieve the targets as in for example United Kingdom. On the other hand, if the waiting times are too long because of the capacity constrains, the waiting time targets alone can not help in reducing the waiting times for the most prioritised patients. These are the questions for further research.

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