Research Paper

Hospital Longevity, Results of a survival analysis of the Dutch Health Care

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Results of a survival analysis of the Dutch Health Care

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Summary

This paper describes the results of a survival analysis performed on the Dutch hospital sector. The survival of hospitals and groups of hospitals over a certain period of time are determined and their survival rates are calculated statistically. Furthermore, the relation between a hospital's longevity and a number of predictive variables is investigated. In this study, one of these variables, the fact whether a hospital merged with another hospital, will be considered in more detail. Our study was performed on data from all hospitals, operational in years 1978 to 2010, and presents results on the complete hospital population as well as the subgroup of general hospitals only.

Our analysis shows that smaller hospitals in particular have been driven out of the market. The difference in longevity between hospitals which had merged compared to those which had not was significant. Identical results were found if differences in the type of hospital were taken into account. It was found that merging had no significant effect on hospital longevity when corrected for size, type, and location.

Keywords: Hospital mergers, survival analysis

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1 Introduction

The ultimate objective of every organization is survival, no matter the form. Earlier studies of the hospital care market structure analyzed market withdrawal (Scott et al., 2000; Bays, 1986; Mobley et al., 1994; Vita et al., 1991; Janssen et al., 1993). Besides the "personal" survival drive of the hospital organization there is a public interest for continuity of this kind of services. This interest will be stronger if there is no alternative available. It became evident that not every hospital was assured of survival. We concern ourselves here with hospital survival in the Netherlands. A survival analysis will be applied to data pertaining to all Dutch hospitals covering the period 1978 to 2010.
In the first part of the paper, we briefly describe the method of survival analysis that was used for this study. We then describe the influence of several factors on the longevity of hospitals mergers; the location of hospitals (the proximity to the Randstad which is the conurbation in the western part of the Netherlands) and the type of hospital. We conclude with a discussion of the contribution of mergers to the hospital survival rate.

2 Method and Data

The presented survival analysis describes the proportion of hospitals still operating over a certain period of time based on the examination of a single or various groups of hospitals such that survival rates can be statistically tested. Simultaneously, the relation between a hospital's longevity and a number of predictive variables is determined. For this end, we estimate a Cox Proportional hazards model.

In this study, a merger indicator will be used to determine if merging has an important factor in hospital longevity once other predictive variables have been corrected for. We assume that variables that have an influence on the survival rate of hospitals are constant over the investigated time period.

The analysis includes all hospitals operational as of January 1, 1978. The covered period is from 1978 to 2010. We distinguish academic, general, and specialized hospitals. General hospitals are further divided into top, central, and basic hospitals. Hospitals located in the Randstad are also investigated as a separate group. The number of beds in a hospital is used as a measure of hospital size. As mentioned above, a "merged" indicator is used for hospitals which merged between 1978 and 2010. A merged hospital is defined as a juridical merger of two or more hospitals.

For each type of hospital in combination with the Randstad status, we give in Table 1 the number of hospitals that were active in 1978. Since then, a number of hospitals ceased to exist. These failures are also indicated in the table.

Table 1: Number of observations and (failures) for each hospital type, 1978-2010.

	General Hospitals				Other hospitals		All hospitals
	Basic	Central	Top	Subtotal	Specialized	Academic	
Randstad	26 (6)	41 (1)	15 (0)	82 (7)	31 (12)	6 (0)	119 (19)
No Randstad	40 (4)	47 (0)	14 (0)	101 (4)	21 (7)	2 (0)	124 (11)
Total	**66 (10)**	**88 (1)**	**29 (0)**	**183 (11)**	**52 (19)**	**8 (0)**	**243 (30)**

3 Description of hospital survival between 1978 and 2010

3.1 Main features of the Dutch health care system

Like most health care in the Netherlands, hospital care is supplied mainly by private, non-profit institutions (Van de Ven et al, 2009). As a rule, Dutch medical doctors are not hospital employees, but are granted privileges to work in hospitals. About three-quarters of physicians work in hospitals as private entrepreneurs, while the rest are wage earners. However, most of the medical doctors are wage earners at an university hospital.

Health care in the Netherlands is traditionally an insurance based system. During the period under consideration this health insurance system developed from a partial regulated system to a more harmonized public system. In order to promote more managed competition, the Health Insurance Act (HIA) has been introduced in 2006. The HIA forces health insurers to become more prudent buyers of care on behalf of their enrollees. For that reason they have the possibility to selectively contract specific hospitals (Boonen, 2009). This means that hospitals have a larger risk of not receiving funds if they do not sufficiently take the wishes of insurers or their agent into account. Development of the HIA took almost 20 years, and during this period all kinds of anticipating behavior were observed. The health insurers market concentrated significantly and transformed from a regional oriented market to national oriented market. At the end of the period under observation the biggest four insurers have a market share of almost 90%.

Furthermore, the manner in which hospitals were reimbursed has also changed. Until 1982, hospitals were financed by cost-based reimbursement systems, based on patient days. With no production limit and prices based on individual hospital average costs, this output financing system had strong incentives to supplier induced demand and weak incentives to improve efficiency (Janssen et al., 1994). Fees were set according to the National Health Tariffs Act (WTG) and had to be paid by all insurers. At the time, however, many insurance companies, notably those responsible for implementing the National Health Act (ZFW), had a legal monopoly in their region, as the law prohibited customers from shopping around. Consequently, insurance companies had no incentive to enter into budget negotiations with hospitals.

In 1982 hospital reimbursement changed into a prospective closed end budget system. The budget was based on three components: availability, capacity and production and was determined from an estimated cost curve. After having negotiated on the budget, the level of the budget was fixed. In this period, hospitals had a strong incentive to enlarge there geographic market in order to enlarge the availability component. Therefore, it seems logical that mergers became attractive to attain a better position in this budget system (Janssen et al, 2003).

In 2005, this reimbursement system was partly replaced by a more output-related system, based on a Diagnosis Related Groups payment system. In this system, insurers are able to negotiate prices per Diagnosis Treatment Combination (DBC) for a number of routine hospital services.

In fact, the market is still in a period of transition from the earlier mentioned budget system to a case payment system based on decentralised negotiations (Varkevisser, 2009). It is expected that this transition is completed in 2011. In that year, the budget system will almost be replaced by an case mix based (DBC's) reimbursement system.

3.2 Analysis

The number of hospitals at the beginning of the study period, i.e. 1978, was 243. At the end of the study period, in 2009, this number was reduced to 112. This decline was due to departures from the market and mergers. Our survival analysis only takes into account hospital departures from the market, given that these hospitals were active in 1978. We did not examine the decrease in the number of hospitals by virtue of merger.

Figure 1 displays the development of all hospitals from 1978. It indicates that, between 1978 and 2010, the number of hospitals decreased by about 12%. The number of hospital closures was particularly high during the first half of the investigated period. Between 1978 and 1993 (the first 15 years of the analysis), 22 hospitals ceased to exist. After 1993 the number of hospital closures dropped to 8.

Figure 1: Survival analysis of all hospitals from 1978 to 2010.

Table 2 provides an overview of hospitals closed between 1978 and 2010 ranked by size (number of reported beds). It can be seen that only hospitals with less than 300 beds were affected by this trend. This is a strong indication that hospital size plays an important role in hospital survival.

Table 2: Overview of Dutch hospitals closed between 1978 and 2010, by size.

Size (by beds)	N 1978	Closed	N 2009	Survival percentage
<100	28	15	13	46%
100-199	66	10	56	85%
200-299	43	5	38	88%
300-399	48	0	48	100%
400-499	18	0	18	100%
500-599	15	0	15	100%
600-699	7	0	7	100%
700-799	8	0	8	100%
800-899	3	0	3	100%
900-999	5	0	5	100%
≥1000	2	0	2	100%
Total	243	30	213	88%

The results of differentiation by hospital type are presented in Figure 2. It can be seen that academic hospital survival rate was 100% and the general hospital survival rate was 94%. The largest number of closures concerned specialized hospitals. Almost 37% of such hospitals were closed between 1978 and 2010.

Figure 2: Survival analysis by Dutch hospital type, 1978-2010.

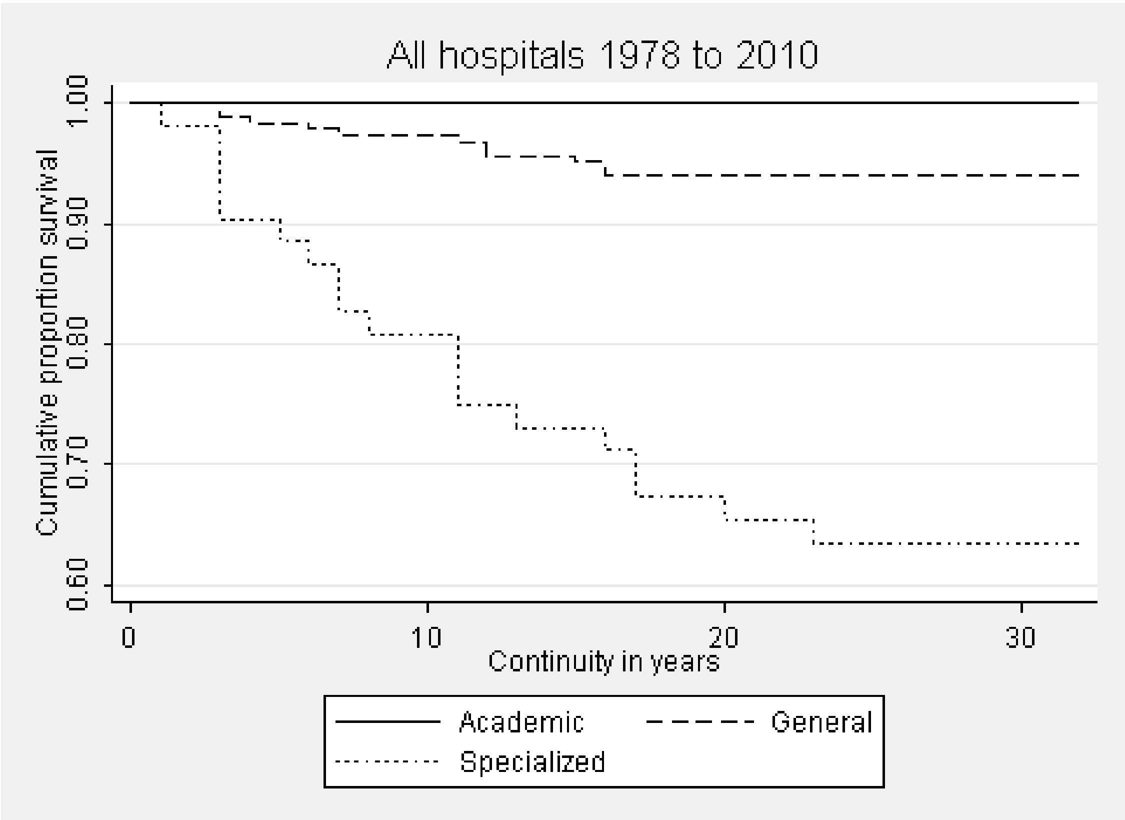


Table 3 presents the number of general and specialized hospitals that ceased to exist between 1978 and 2010, ordered with respect to their size. Also here, it can be seen that in particular small hospitals were forced to close. This applies to both general as well as specialized hospitals. The relative number of closed hospitals is notably larger among specialized than general hospitals. It is noteworthy that, in terms of percentage, there were more specialized hospitals that ceased to exist in the 200-299 category than in the 100-199 category. When differentiated by basic, central, and top, it appears that, within general hospitals, all closures were of basic hospitals, except for a single central hospital.

Table 3: Number of Dutch hospitals by size who ceased to exist, 1978-2010.

	General hospitals				Specialized hospitals			
Size (by bed)	N 1978	Failed	N 2009	Percentage	N 1978	Failed	N 2009	Percentage
<100	4	2	2	50%	24	13	11	46%
100-199	47	6	41	87%	19	4	15	79%
200-299	36	3	33	92%	7	2	5	71%
300-399	47	0	47	100%	1	0	1	100%
400-499	17	0	17	100%				
500-599	15	0	15	100%				
600-699	7	0	7	100%				
700-799	6	0	6	100%	1	0	1	100%
800-899	2	0	2	100%				
900-999	2	0	2	100%				
>1000								
Total	183	11	172	94%	52	19	33	63%

4 Results of survival analysis

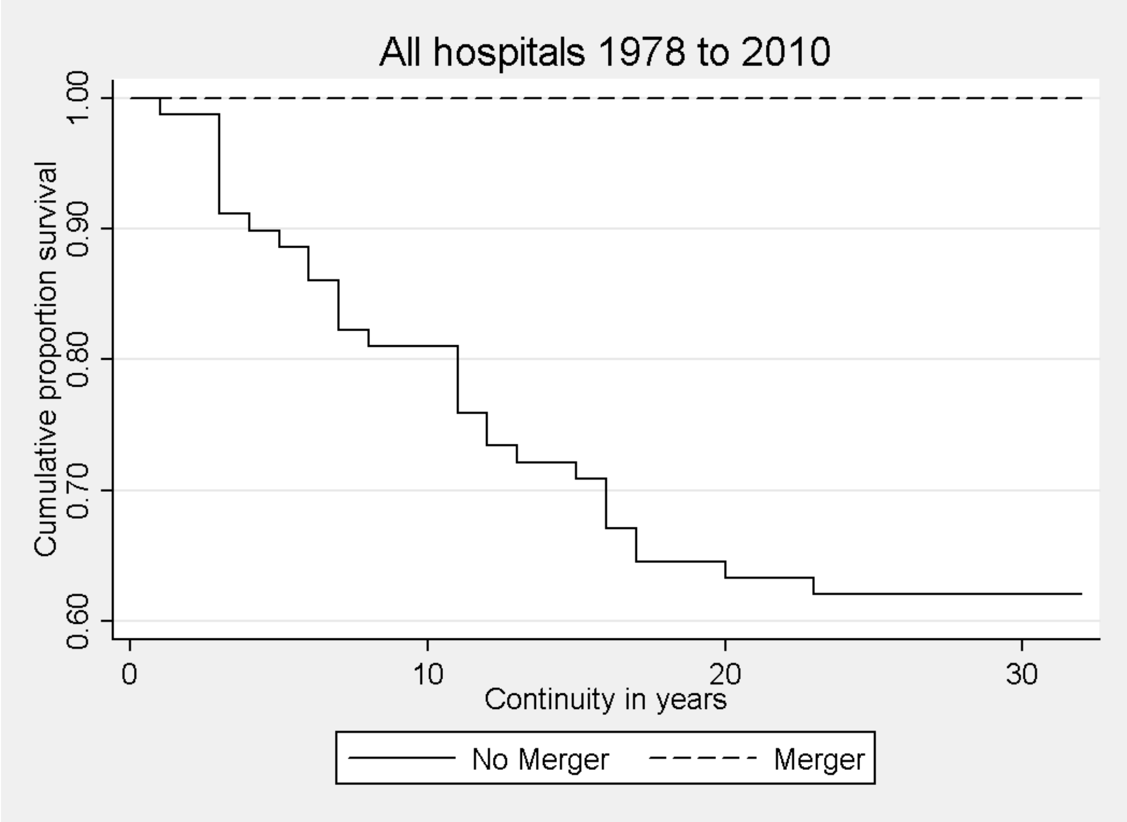
*We have investigated differences between the number of hospital closures based on whether they merged during the study period. This is done via the Kaplan-Meijer method, which was applied to all hospitals as well as general hospitals only.

All hospitals

Figure 2 (above) indicates the number of hospitals who ceased to exist by type. It appears that specialized hospitals in particular, and to a lesser degree general hospitals, suffered most. Variance by type was tested and appears significant when $\alpha \leq 0{,}01$ (χ^2 = 39,46; df=2). Note that, during the last decade, only specialized hospitals ceased to exist.

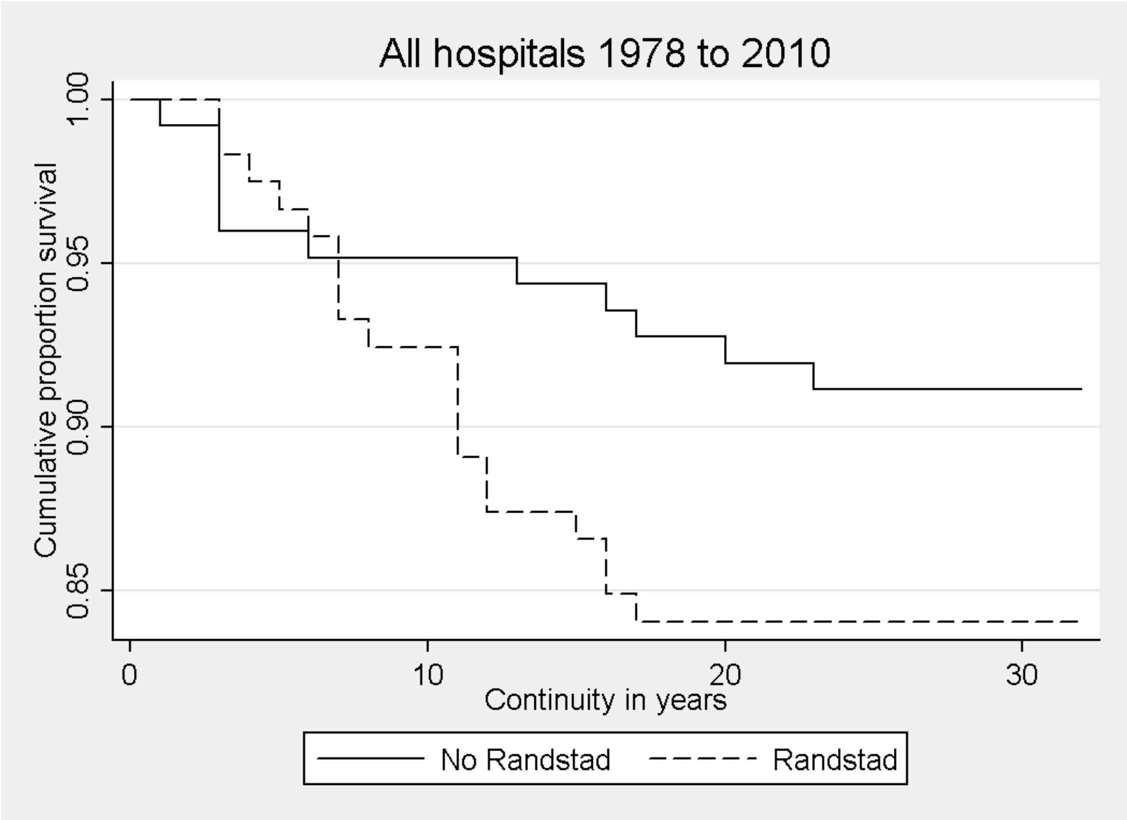
Figure 3 displays the difference in survival for all hospitals based on whether they merged. Every hospital that merged between 1978 and 2010 survived while only roughly 63% of those that did not merge survived the same time period of time. The variance is significant when $\alpha \leq 0{,}01$ (χ^2 = 76,51; df=1).

Figure 3: Comparison of Dutch hospital survival based on whether they merged, 1978-2010.



The difference in hospitals who ceased to exist in and outside of the Randstad is presented in Figure 4. It appears that initially hospitals outside of the Randstad ceased to exist. Thereafter, however, the number of hospitals who ceased to exist within the Randstad quickly exceeded the number of those outside of it. More than 91% of the hospitals in the non-Randstad regions had survived in the investigated period, against 84% in the Randstad regions. However, variance in the survival rate of these categories was not significant when $\alpha \leq 0{,}01$ ($\chi^2 = 2{,}78$; df=1).

Figure 4: Comparison of Dutch hospital survival within and outside of the Randstad, 1978-2010.



General hospitals

Figure 5 presents the number of general hospitals that ceased to exist with a categorization based on whether they merged between 1978 and 2010. It seems that all general hospitals that were merged survived. The survival percentage for those which did not merge over the same period was almost 72%. The variance in survival between these two groups of general hospitals was significant when $\alpha \leq 0{,}01$ (χ^2 = 46,49; df=1).

Figure 5: Comparison of Dutch general hospital survival based on whether the hospital merged between 1978 and 2010.

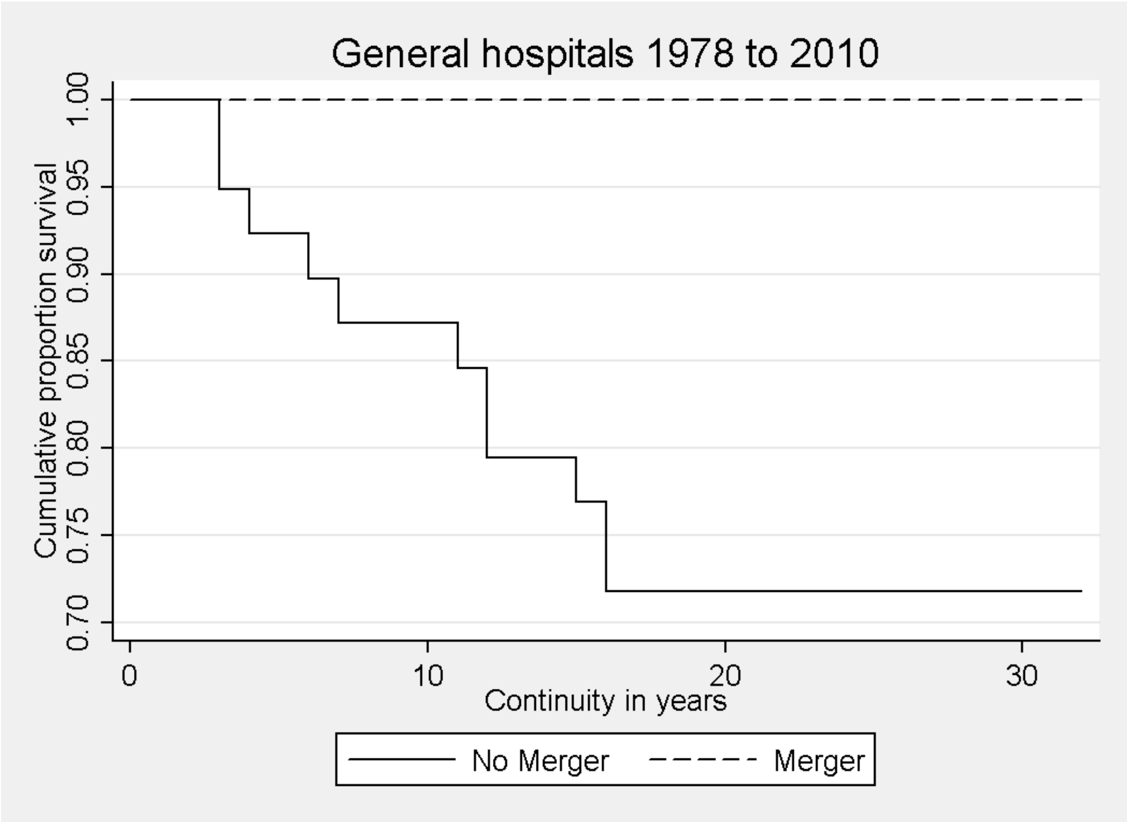
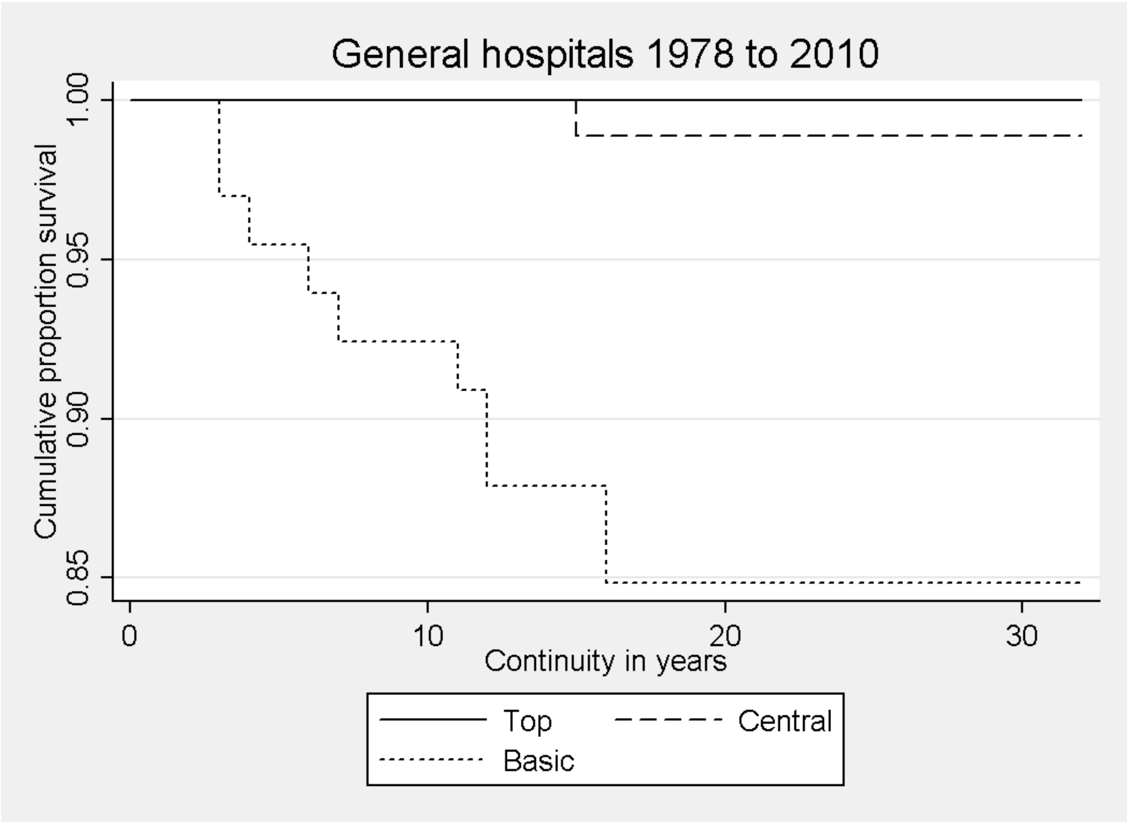


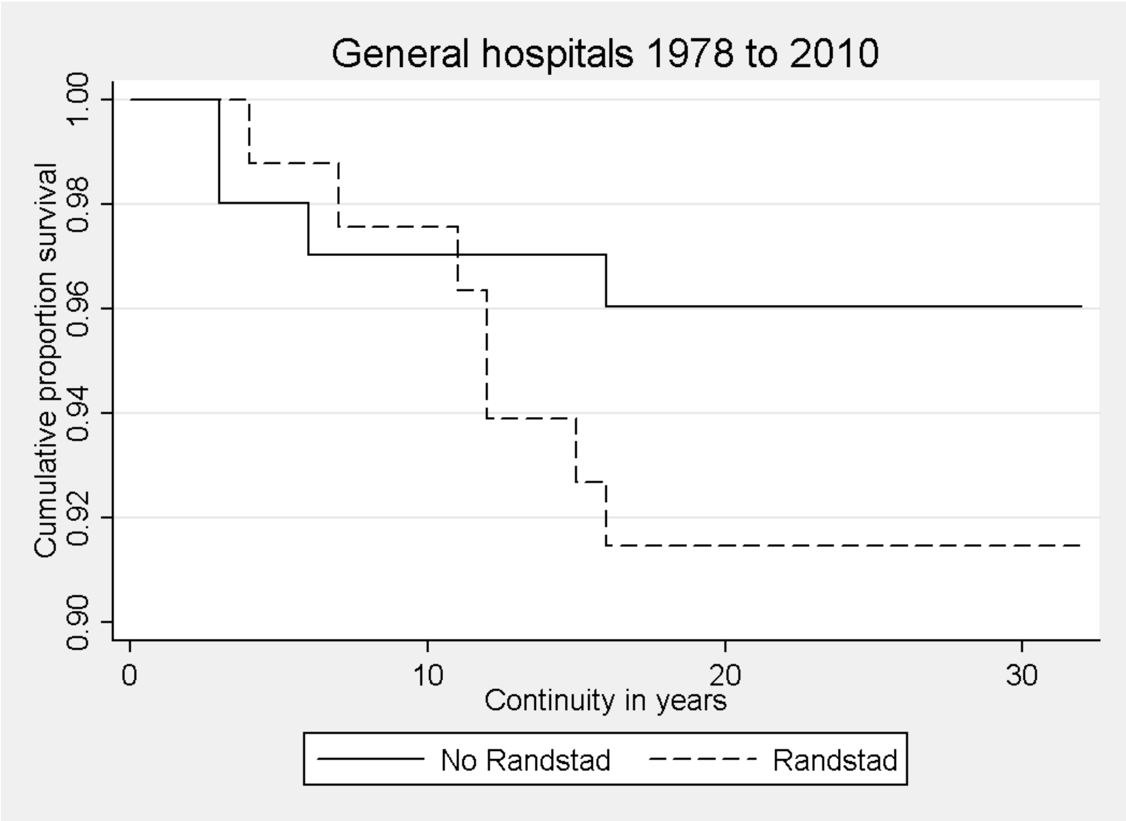
Figure 6 presents the number of hospital closures for general hospitals differentiated by top, central, and basic. It seems that virtually all were basic hospitals. Only a single central hospital closed between 1978 and 2010. Almost 85% of basic and 98,8% of central hospitals survived the entire study period. Survival variance is significant when $\alpha \leq 0{,}01$ ($\chi^2 = 15{,}62$; df=2).

Figure 6: Survival analysis by type of Dutch general hospital, 1978-2010.



Survival rate differences between general hospitals within and outside of the Randstad are presented in Figure 7. It appears that the trend observed for all hospitals is also evident for general hospitals. Hospitals outside of the Randstad had a relatively higher survival rate (96%) than those within it (91%). However, survival variance between these groups was not significant: $\alpha \leq 0{,}01$ ($\chi^2 = 1{,}61$; df=1).

Figure 7: Survival comparison of Dutch general hospitals within and outside of the Randstad, 1978-2010.



5 Forecasting survival

We have considered whether hospitals increased their chances of survival by merging between 1978 and 2010, controlling for a number of predictive variables. Also here, the analysis was performed to all hospitals and general hospitals alone. The Cox regression tests whether merging contributed to the survival of either group. In addition to having merged, other predictive variables including size, type, and location were included in this model.
For the first analysis (all hospitals), we have included a dummy for academic hospitals and a dummy for specialized hospitals. The reference group is general hospitals. For the second analysis (subsetting on general hospitals), we have included a dummy for central hospitals and a dummy for top hospitals. Basic hospitals are the reference group.

All hospitals
Table 4 presents the results of the Cox regression and shows a mixed picture. On one hand, the likelihood ratio test changed significantly with the addition of merger (model 2) as a survival predictive category (χ^2=113,0; df=5; p=0,00). On the other hand, based on the Wald test, merging caused no significant change when other predictive variables were corrected for (Wald test 0,00; p=1,00). Tabachnick (2001) reports for a similar test situation that the Wald test is more reliable and thus preferable.
Based on this, model 1 demonstrates that the set of the other variables is significant predictor of survival when $\alpha \leq 0{,}01$ (χ^2 =56,57; df=4; p=0,00) If $\alpha \leq 0{,}01$ is presumed, then only hospital size is significant (Wald test 16,03; p=0,00). Thus, hospital size in particular is a determinant of survival. The direction of the predictor 'size' is negative; the larger the hospital, the greater the longevity. The odds ratio for size is 0,99. Each additional bed increases chances of survival by 1%. The type of hospital and the proximity to the Randstad had no significant effect on longevity.
It is possible that there is a correlation between the merger and hospital size. Such correlation would mean there is multicollinearity in the model. To test this, we have performed a t-test to test if there is a difference in the average size for the merged hospitals and the not-merged hospitals. We did not find a significant difference (t= -1,56; df= 241; p=0,12).

Table 4: Cox regression analysis of the influence of various factors on the longevity of all Dutch hospitals, 1978-2010

Model 1	**B (coefficient)**	**Wald**	**Odds ratio (Hazard)**
Size	-0,012	16,031*	0,989*
Randstad	0,497	1,656	1,644
dumAcadHosp	-27,760	2,92E -12	8,83E-13
dumSpecHosp	0,468	1,035	1,597
χ^2 compared to smaller model (G^2)		56,57*	
N		243	

* Significant α<0,01

Model 2	**B (coefficient)**	**Wald**	**Odds ratio (Hazard)**
Size	- 0,011	17,344*	0,989*
Randstad	0,178	0,215	1,194
dumAcadHosp	-30,050	1,20E-13	8,87E-14
dumSpecHosp	- 0,796	3,270	0,451
Merging	-38,710	1,62E -12	1,54E-17
χ^2 compared to smaller model (G^2)		113,00*	
N		243	

* Significant α<0,01

General hospitals
As in our analysis of all hospitals, the Cox regression produces a mixed picture regarding general hospitals as well. As table 5 indicates, the likelihood ratio changes significantly with the addition of merging (model 4) as a predictive variable (χ^2=61,22; df=5; p=0,00). On the other hand, the Wald test shows that merger is not significant (Wald test 0,00; p=1,00).

The predictive value of those variables in model 3 is significant (χ^2=24,13;df=4; p=0,00). When $\alpha \leq 0{,}01$, no predictive variable is significant. The direction of the predictive variables' sign (positive or negative) was the same as in model 1. In addition to that stated above, this means that top hospitals have a relatively longer longevity than basic hospitals.

Table 5: Cox regression analysis of the influence of various factors on the longevity of Dutch general hospitals, 1978-2010

Model 3	**B (coefficient)**	**Wald**	**Odds ratio (Hazard)**
Size	- 0,017	4,618	0,983
Randstad	1,017	2,612	2,764
dumTopHosp	-30,020	2,31E -13	9,19E-14
dumCentralHosp	- 0,162	0,010	1,176
χ^2 compared to smaller model (G^2)		24,13*	
N		183	

* Significant α<0,01

Model 4	**B (coefficient)**	**Wald**	**Odds ratio (Hazard)**
Size	- 0,011	1,947	0,989
Randstad	0,323	0,224	1,381
dumTopHosp	-36,560	1,04E -14	1,33E-16
dumCentralHosp	- 0,879	0,268	0,415
Merging	-43,840	9,81E -15	9,11E-20
χ^2 compared to smaller model (G^2)		61,22*	
N		183	

* Significant α<0,01

A key assumption of a Cox model is proportional hazards, i.e. the effect of the covariates are constant over time. To test this assumption, we are determine if there is a zero slope in a generalized linear regression of the Schoenfeld residuals on the rank order of time. In each of the above models, we performed such test for the covariates. and accepted the null-hypothesis of proportional hazard ($\alpha \leq 0{,}01$).

6 Discussion and conclusion

This survival analysis demonstrates that small hospitals in particular suffer from closure. Specialized and basic hospitals, both of which are relatively small, suffered the most. Differences in longevity between hospitals which had or had not merged was significant. Differences between hospital types were also significant; this was true for all hospitals as well as for all general hospitals. Location – specifically whether a hospital was located in the Randstad – was not a significant survival factor. Merging had no significant effect on hospital longevity when corrected for size, type, and location. Based on the Wald test, hospital size was a significant longevity predictor for all hospitals. This matches findings by Scott et al. (2000) which are based on American data. This does not, however, support the conclusion that smaller hospitals are at a disadvantage, because other facts can also play a role (Aletras, 1997). This is certainly not the case for general hospitals. No single factor affecting hospital longevity was a significant predictor, but, taken together, they had an appreciable effect.

Differences between all hospitals and general hospitals are only explained by the fact that the former category includes specialized and academic institutions. Small in number, specialized hospitals in particular were not able to survive. Furthermore, academic hospitals are large and survived the duration of the study period. Because these two hospital categories were not included in general hospitals (models 3 and 4), size is not a significant predictor. It would appear that the significant predictive value of hospital location is attributable to academic and particularly specialized hospitals. Our analysis is based on the assumption that those variables which influenced survival at the beginning of the test period were still doing so at its end. We also assumed that all other conditions remained static (Tabachnick, 2001). In this study, particularly the last assumption is only tenable to a limited degree. That means that the results of this survival analysis on the relation between longevity and a set of predictive variables must be interpreted with requisite caution.

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NZa

The Dutch Healthcare Authority (NZa) is the regulator of health care markets in the Netherlands. The NZa promotes, monitors and safeguards the working of health care markets. The protection of consumer interests is an important mission for the NZa. The NZa aims at short term and long term efficiency, market transparency, freedom of choice for consumers, access and the quality of care. Ultimately, the NZa aims to secure the best value for money for consumers.

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