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MASTER THESIS

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Cost Effectiveness Analysis of a Heart Failure Clinic

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PREFACE

This paper is written by Jeppe Ravn during the fourth semester of the Medical Market Access branch of the education Master of Science in Medicine with Industrial Specialization at the Department of Health Science and Technology, Aalborg University.

The academic level of the report is intended for students that have completed the master program Medical Market Access, others with the same qualifications, and persons with an interest in health economic evaluation methods and medical market access.

I wish to thank Anne Vingaard Olesen who helped me with practical issues regarding STATA and my supervisor, Lars Ehlers for advice and support throughout the semester.

RATIONALE OF THE PROJECT

The hospital in Hobro is considering establishing an outpatient clinic for patients with arrhythmia. Before going into more advanced planning, the administration of the hospital is interested in getting an appraisal of the heart failure clinic, an outpatient clinic established in 2011, which have similar settings as the potential arrhythmia clinic would have. By the definition of Drummond (1), societal resources are finite and inadequately satisfy all needs, and with this perspective this project will be the assessment of the current heart failure clinic. This will provide information to the decision-makers, allowing them to make an informed choice.

PROBLEM STATEMENT

Based on the rationale of the project, the overall problem statement this project will strive to accomplish is as follows:

Is it cost-effective to have a heart failure clinic at Hobro Hospital?

Scope

- This article will assess the costs of both the heart failure clinic and the previous follow-up at the general practitioner.
- Only patients with first-time heart failure is included. This is defined: patients have not been hospitalised with heart failure within five years of the inclusion period.
- The costs for establishing the HFC will be included, as will running costs.

- The costs associated by visiting the GP will be included based on the rate issued by Northern Denmark Region.
- In this paper, the term “re-hospitalisation” will encompass a hospital admission within 365 days
- The costs of transportation for the patient to- and from the hospital will not be included.

LITERATURE SEARCH

A search on PubMed is conducted with the following search terms: ”heart failure[MeSH Terms]” along with “disease management program”, “heart failure clinic”, ”nurse led clinics”, ”outpatient clinics”, and similar to cover the variation in the definition of disease management programs (DMPs). The majority of studies is identified from bibliographies of retrieved articles and published systematic reviews.

LIST OF ABBREVIATIONS

HF	Heart Failure		**ESC**	European Society of Cardiology
HFC	Heart Failure Clinic		**NYHA**	New York Heart Association
DMP	Disease Management Program		**MR**	Mortality rate
GP	General Practitioner		**ICER**	incremental cost-effectiveness ratio
Qol	Quality of life		**QALY**	Quality-adjusted life year

Abstract:

Objective: To evaluate cost effectiveness of the heart failure clinic (HFC) at Hobro Hospital.
Data gathering: Registry study to establish the consumption of health care services by patients with heart failure (HF) at Hobro Hospital before and after the establishment of a HFC
Methods: Cost-effectiveness analysis with death prevented as outcome measurement, presented as an incremental cost-effectiveness ratio (ICER)
Result: No statistical differences for deaths prevented was found between the groups, but the intervention is found to be DKK 18,384 more expensive per patient.
Conclusion: It is not cost-effective to have a HFC at Hobro Hospital

INTRODUCTION

Heart failure (HF) has become a universal problem affecting an estimated 26 million people worldwide in 2010 (2). In developed countries approximately 1-2% of the adult population suffer from HF, with the prevalence increasing to ≥ 10% for persons older than 70 years of age (3). With the high prevalence, the economic burden of HF is substantial and a recent article from 2014 estimates the total global HF costs in 2012 to be $108 billion, with ~60% of them being direct costs. The overall HF cost for Denmark has been estimated to be DKK 4 Billion (4)(5) with ~DKK 2.9 billion spent on direct costs. In addition to the health-care resources, HF places a huge burden on impact on morbidity and mortality (6). This burden is further intensified by the risks involved in long admission, such as community acquired infections and medication errors.

Throughout the years, several attempts have been made to decrease the mortality rate and rehospitalisation of HF patients. A general term for these attempts will be described as HF 'disease management programmes' (DMPs) henceforth. A systematic review by Göhler from 2006 on HF DMPs including 8341 patients in 36 studies found a reduction of 3% and 8% for mortality and rehospitalisation, respectively (8), and thus proving the effectiveness of DMPs. The optimal guidelines of a DMP have, however, not been concretised.

The structure and contents of the HF DMPs may vary in different countries and healthcare settings, but the overall objective is the same. Although the evidence base in chronic care management programs is underdeveloped to some extent (9), a review on specialized multi-professional care in the clinic or non-clinic from 2004 found a decrease in mortality by 25%, HF hospitalizations by 26%, and all-cause hospitalizations by 19% (10), strongly indicating that multi-professional care is effective. The European Society of Cardiology (ESC) constructed in 2011 a paper on delivering HF care based on the newest evidence at the time. This paper stated that the follow-up and monitoring of HF patients after the discharge is still largely a neglected area, but stated that the optimal follow-up is within a multi-professional HFC to which HF patients has easy access. Staff-types mentioned to be included in the multi-professional HFC are cardiologists and HF nurses, supported by dieticians, physiotherapists, and psychologists(11,12) .

In Denmark, the guidelines for HF are largely build on The ESC guidelines for HF(11,13). Patients with HF should be referred to an outpatient HF clinic for up-titration of evidence-based therapy such as ACE inhibitors, beta-blockers, aldosterone receptor antagonists and evaluation for device therapy as well as disease education, self-management, and physical rehabilitation.

Before the establishment of the HFC at Hobro Hospital, there were very little standardisations on the follow-up of HF patients. The patient would arrive at the hospital from the GP or emergency services, receive a diagnosis, and be treated for the symptoms at the hospital. The follow-up was far less structured, as this could happen at either the GP, through an outpatient program at the outpatient clinic, or not at all. Besides the structural differences, the content of the follow-up was largely up to the individual GP and consisted primarily of the pharmaceutical up titration. After the HFC was established in April 2011, the structure changed, as HF patients would be offered to receive their follow-up treatment at the HFC.

In *'Appendix 1 – Overview over changes the establishment of the HFC trigger'* an elaborating description with flowcharts of the 'system' both before and after the establishment of the HFC is presented.

Put into practice, the establishment of the HFC encompasses an additional room for the clinic, but no additional personal. The clinic is open once a week for 8 hours and is serviced by the nurses normally affiliated in the medical section M1. It takes one nurse to service the HFC. No additional nurses are applied to M1. The room used for the HFC is used for other purposes the remaining days of the week.

An essential principal in health economics is that societal resources are finite and inadequately satisfy all needs (1,14), and as such, the aim of this study is to make a cost-effectiveness analysis to enable Hobro Hospital to optimize their resources. The cost-effectiveness analysis will be based on registry data drawn before and after the establishment of the HFC, and will follow the principles of Drummond (1).

METHODS

A cost-effectiveness analysis based on a pragmatic registry study on patients with HF diagnosis is performed and presented as an incremental cost-effectiveness ratio (ICER). The primary outcome measure is death prevented, and the secondary outcome measure mean number of days before re-admission. Mean differences in costs and effect between intervention and comparator are used in the calculations of ICER.

In '*Appendix 2 – Registry study'* an account of the registry 'study' is made, with methods, study population and results.

All calculations and analyses of data is performed in STATA version 12 (StataCorp, College Station, Texas, USA)

OUTCOME MEASUREMENT

Since evaluation of the consumption of healthcare services is an aim of this paper, all such services were endpoints. Healthcare services are however all included as costs, and as such, the effectiveness is measured by all-cause mortality as primary outcome, and days before re-admission as secondary outcome.

The all-cause mortality is preferred over HF-specific mortality as HF patients generally have many co-morbidities, leading to multiple and often indistinguishable causes of hospitalization

or death. In Table 1 the outcome measurements, found from the registry study (Appendix 2) is listed.

Table 1 – Outcome measurements for the ICER

	Before HFC	*With the HFC established*
Mortality rate	*0.361*	*0.398*
Days before re-admission	-	-

The mean effect for mortality is 0.037

The statistical tests for the secondary outcome measurement could not be finished in time to be included in the paper.

RESOURCE CONSUMPTION AND COST

Costs included in the ICER are derived from two parts; the cost directly connected to the HFC, and the costs associated with the consumption of health care services, such as visiting the GP, hospitalisations and out-patient clinic visits.

The costs of the HFC can be divided into two parts; the planning and establishment of the clinic, and the day-to-day running costs. As for the day-to-day running costs, the wages for the nurse is the only known cost, as the overhead costs of the room (electricity, wages for administration, secretaries and cleaning staff, upkeep of the equipment etc.) are unknown, as there is no budget for the clinic. Overhead costs are therefore estimated based on the budget for the medical section M1, from which the staff is affiliated. M1 encompasses ten wards, and the HFC is estimated to be one third of a ward (based on square meters). As no budgetary costs for the establishment was made either, the planning was estimated to have taken one week for the administrative workers and one week for the nurses to plan their schedule. The costs for equipment are not included. All costs are converted into 2013-2014 currency. All costs for the establishment and day-to-day running costs of the HFC can be seen in Table 2. Calculations can be seen in Appendix 5.

Table 2 – Cost of establishing and day-to-day running of the HFC.

	DKK	*Reference*
Planning, administration + nurses *Equipment*	*129.9* *Unknown, set to zero*	*(15)* *(15)*
Day-to-day running, wages *Day-to-day running, overhead*	*170.05* *30.0*	*(15)* *(16)*
Mean costs per patient:	329.95	

The costs of the healthcare services is found through the registry study (see Appendix 2), thus mirroring the exact costs registered. The cost of a hospital admission is based on the DRG-rate(17) but is also including "long lyers-cost". The cost of an outpatient clinic visit is based on DAGS-rates(17), and the cost a GP visit is based on the *'GP service catalogue'*. All costs are converted into 2014 currency using an inflation rate on 2.5%. From the registry study, the 'consumption' of healthcare services in Table 3 is found.

Table 3 – Costs for consumption of healthcare services

All costs are in DKK	*2009-2010*	*2012-2013*	*P-value (H0)*
Cumulative days hospitalised (mean(SE))	*10.58 (0.98)*	*11.72 (1.28)*	*0.48*
Number of re-hospitalisations (mean(SE))	*1.36 (0.73)*	*1.54 (0.12)*	*0.40*
Costs for cumulative hospitalisations [DRG+"long-lying"] (Mean(SE))	*45,519 (2,601)*	*55,817 (5,902)*	*0.00*
Outpatient clinic, Count (mean (SE))	*0.66 (0.27)*	*0.73 (0.33)*	*0.74*
Outpatient clinic, Costs (mean (SE))	*1,139 (442)*	*715 (287)*	*0.58*
GP, count (mean (SE))	*22.6 (1.80)*	*28.43 (2.22)*	*0.02*
GP, cost (mean (SE))	*37,188 (3,137)*	*45,274 (3,660)*	*0.05*

All of the data in Table 3 are skewed to the right, and not normally distributed. Hence, Mann Whitney test is used for the statistical analyses. The p-value in the table is from the Mann whiney, thus connected to medians, and not to the mean.

The costs used to calculate the mean cost is added up in Table 4.

Table 4 – Costs of the two groups used in the ICER

All costs are in DKK	***Cost for consumption of healthcare***	***Cost of Planning + day-to-day running***
Before the HFC	*45519+1139+37188 =83846*	*0*
With the HFC established	*55817+715+45274 =101806*	*329.95*

RESULTS

The baseline ICER for comparing before and after the establishment of the HFC is listed in Table 5

Table 5 – One-way sensitivity analysis on the variables in the ICER. All with ±20%

	Mean effect	*Mean Cost*	*ICER*
Baseline	*0.037*	*18289,95*	*494323*
Costs			
Costs for cumulative hospitalisations+20%	*0.037*	*20349,55*	*549988*
Costs for cumulative hospitalisations-20%	*0.037*	*16230,35*	*438658*
Outpatient clinic, Costs+20%	*0.037*	*18205,15*	*492031*
Outpatient clinic, Costs-20%	*0.037*	*18374,75*	*496615*
GP, cost+20%	*0.037*	*19907,15*	*538031*
GP, cost-20%	*0.037*	*16672,75*	*450615*
Planning & running costs +20%	*0.037*	*18355,94*	*496106*
Planning & running costs -20%	*0.037*	*18223,96*	*492539*
Effects			
Mortality rate+20%	*0,0444*	*18289,95*	*411936*
Mortality rate-20%	*0,0296*	*18289,95*	*617904*

From the ICER we can read that it will cost DKK 494,323 for preventing an extra death.

If the non-significant variables are omitted, there is an increase in costs for the intervention on DKK 18,384

In Table 5, one-way sensitivity analyses are conducted, and show the impact the changes have on the ICER. All variables are performed with a ±20 %.

From the one-way sensitivity analyses, we can see that none of the variables shifts the ICER to another operational sign. The variable that changes the ICER the most is the mortality rate.

DISCUSSION

In order to understand the results, this discussion will encompass the methods and results of the registry study, as this 'study' was the sole provider of outcome measure and quantity of healthcare services consumed for the cost-effectiveness analysis.

Design of the registry study

A 'buffer-zone' is integrated in the design of the registry study (see Figure 3, Appendix 2) to prevent biases due to the changes in structure. This decision together with the recent establishment of the HFC (mid-2011) is causing a natural limitation of the length of the inclusion periods. In order to appraise the consumption of healthcare services for the HFC, an inclusion period of 365 days from index admission was chosen.

Study population

After the removal of patients with a history of HF, 118 patients was identified for the control group, and 83 patients was identified for the intervention group. The groups was compared, and no statistical differences was found for age, sex and number of days hospitalised for the index admission. The author suspected that there might have been a difference in the length of

admission, the argument being that HF patients could be discharged earlier in the intervention group as there is qualified follow-up options available on site. This was however not the case with the H_0 hypothesis not being rejected (P=0.87). There was significant changes in both the diagnostic codes and the way of referral. The change in diagnostic code is most likely explained by minor changes of habit by the relative few number of doctors affiliated with the M1 section. The way of referral changes from being almost 50-50 with 'no referral' and 'referred by GP' in the control group to 75% of the patients being referred from another section of the hospital and the 20% being 'referred by GP'. The reason behind this change in way of referral is unlikely to be connected to the HFC, and the author suspects that if similar data were extracted for another clinic / medical ward, there would be similar changes.

Results from the registry study; costs

There was found to be statistical differences between the quantity of GP visits (P=0.02), costs of GP visits (P=0.05), and cumulative costs of hospitalisations (P=0.00). There was found statistical differences in quantity of outpatient clinic visits (P=0.74), costs of outpatient clinics (P=0.58), cumulative number of days hospitalised (P=0.48), or number of re-hospitalisations (P=0.40). The most surprising variable that was not found to be statistical different between the two groups was the quantity of outpatient clinic visits as the intervention itself centers on visits to the HFC (which is an outpatient clinic). The only reason I can think of for this variable not to be different between the two groups is that there is a registration issue with the relatively new clinic, and patients affiliated with the HFC is not registered in the same database as other outpatient clinics. The low count of outpatient clinic visits (an average of 0.66 visits in the control group vs 0.73 in the intervention group) indicates can mean two things: one, HF-patients do not visit outpatient clinics, which is a bit unrealistic, or two, that there is a systematic error in either the database itself or the way we have acquired our data from this database. Whatever reason that might lie behind, there is a significant bias in the consumption of healthcare services.

As the HFC-intervention includes regular visits to the GP (to get blood samples), it is not surprising that there is a difference between both the number of visits to the GP and the cumulative costs of these visits to the GP. The fact that there is a significant difference in cost for cumulative hospitalisations stands in contrast to the non-significant cumulative number of days hospitalised and quantity of re-hospitalisations, but can be explained by the differences in diagnostics (from study population). This might be because the diagnosis of HF can be difficult, as many the symptoms of HF are non-discrimination, thus of limited diagnostic value. Many of the symptoms of HF originate from sodium and water retention, and thereby easily resolved diuretic therapy, something many elder patients receive due to various reasons. Consequently, patients receiving such diuretics are even more difficult to diagnose (3). Besides being difficult to diagnose, HF care is complex. Patients are required to make lifestyle changes and take multiple drugs. In addition, the average age of an HF patient at diagnosis is 76 years – i.e. it is predominantly a 'cardio-geriatric syndrome' and affected patients have frequent and multiple co-morbidities. Furthermore, the therapies themselves have numerous side effects. These rather comprehensive changes in lifestyle and general well-being can result in inconsistent adherence to therapy (12).

Results from the registry study; outcome

There was no statistical difference between the two groups in mortality rate (P=0.59). As this is the only measured outcome measurement, the

ICER calculated in the cost-effectiveness can not be used for any conclusions.

In context, the mortality rate of 40% and 36% of the control and intervention group respectively, the ESC-HF study found a 1-year mortality rate of 17.4 % (7).

Result of the cost-effectiveness analysis

As the outcome measure is not significant, it makes little sense to talk about the ICER as a result. From the registry study it is not possible to claim anything other than an increase in costs for the intervention group.

Future work

In order to better be able to appraise the HFC at Hobro Hospital, other outcome measurements should be included in a CEA. One of these could be the mentioned 'days before re-admission'. Had a full dataset been available sooner, I would have performed a Kaplan Meier survival analysis to include that variable. Another outcome measurements that would be interesting for the appraisal is QALY gain, but as patients were not asked to score their quality of life (Qol) this cannot be done. During the data extraction, the NIP factors were looked at, but was found to be extremely sparse with ~30 and 40% of the patients having recorded their NIP factors and was not included in the appraisal. Some interesting comparisons could have been done on quality of treatment with more complete NIP data. The result of the registry study and the cost-effectiveness analysis does not comply with the common conception at Hobro Hospital and at the HFC. Here the belief is that the both the Qol and the quality of care is better with the HFC. With the data available at the moment, it is not possible to validate the claim that the patients have an increase in Qol.

ADVISE TO HOBRO HOSPITAL REGARDING THEIR PLANS TO OPEN A NEW OUTPATIENT CLINIC

The rationale behind this project was to evaluate the HFC with the intention of establishing a similar outpatient clinic for patients with arrhythmia. From a health economic perspective, it is important to have concrete objectives of what the intention of the new intervention is. The HFC was established on the basis of the evidence published by the ESC, which, in the perspective of medicine personal and science is 'good practice'. It is, however, difficult to appraise a clinic with no budget and insufficient measured variables. Therefore, my advice is to be specific on what the objective of the new clinic is, and then measure the variables in question. Eg. Gather Qol data, if that is one of the variables that is likely to change.

CONCLUSION

It is not cost-effective to have the heart failure clinic at Hobro Hospital. There is no statistical differences in deaths prevented, but an increase in costs.

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APPENDIX 1 – OVERVIEW OVER CHANGES THE ESTABLISHMENT OF THE HFC TRIGGER

This appendix is featuring elaborating explanation of the system changes that encompasses with the establishment of the HFC. The text is largely focused around the two flowcharts (Figure 1 and Figure 2) that appears at the end of this appendix. The two flowcharts are deliberately next to each other to ease the comparison, and it is recommended that the figures should be visual inspected before and while reading the rather elaborating text in this appendix.

Before the HFC (Figure 2)

Before the establishment of the HFC, there were very little standardisations of the follow-up of HF patients. In **Fejl! Et bogmærke kan ikke henvise til sig selv.** a flowchart of the route of a HF patient is shown.

The '**Entry**' bracket indicates how the patient enters the system, and this occurs either through the GP or through emergency services. If the patient comes through the emergency services, they all will be transferred to the hospital, where they will receive a diagnosis. This will not necessary occur at the medical section M1, as the figure shows, but at a receiving-section at the hospital, from which the variety of patients will be send to the appropriate medical section. In the case of HF patients, this will be the M1 section. If the patient enters the system through a GP, two routes are possible. In most cases, the patient will be send to the hospital, but will most likely be send directly to the M1, as the GP have performed the initial diagnosis. (In some rare cases, the GP can send the patient directly to a cardiological outpatient clinic for some tests (echocardiogram etc)).

The '**Diagnosing and initial treatment**' bracket includes the M1 and the cardiological outpatient clinic. Once at the medical section M1, the patient will be diagnosed (if this did not occur at the GP) and will receive the initial treatment required. This will commonly be a treatment of the symptoms. If the patient is diagnosed at the GP and send directly to the outpatient clinic, little treatment is needed at the outpatient clinic, as this option only occurs if the GP concludes that the treatment needed is minor, and can be done without supervision by healthcare personal.

The '**Follow-up treatment**' bracket includes the GP and the outpatient clinic, but not the M1 section. Subsequent to the treatment received at the M1 (or in rare cases the GP), the patients will be summited to take an echocardiogram at the outpatient clinic. Depending on the result of the echocardiogram, the patient will be offered a follow-up programme at either the GP, the outpatient clinic, or not at all. The content of the follow-up offered is largely up to the individual GP and consists primarily on the pharmaceutical up titration.

The "arrow" from the M1 directly to the GP is for the patients not summited to an echocardiogram, and is discharged and is, in principle, out of the system. The content of the follow-up was largely up to the individual GP and consisted primarily on the pharmaceutical up titration.

It is important to notice that the follow-up at the GP or at the outpatient clinic is not standardised, and can vary greatly from the recommendations from the literature.

After the HFC is incorporated (Figure 3)

After the HFC was established in April 2011 the structure changed and HF patients would be offered to receive their follow-up treatment at the HFC. In **Fejl! Henvisningskilde ikke fundet.**, the flowchart shows the route of a HF patient after HFC is established.

The **'Entry'** bracket indicates how the patient enter the system, and consists of the GP and emergency services. The arrows from the GP and the emergency services encompasses exactly the same meaning as in Figure 1.

The '**Diagnosing and initial treatment**' bracket includes the M1 and the cardiological outpatient clinic. Similar to before the establishment of the HFC, diagnosis and treatment for the symptoms occurs at the M1, and the patient is subsequently summited to an echocardiogram at the cardiological outpatient clinic. It is noteworthy that there is no follow-up treatment that occurs at the cardiological outpatient clinic.

The '**Follow-up treatment**' bracket includes only the HFC and not the GP. Note that there is no circular arrow at any other place than the HFC. The establishment of the HFC entail that all the patients that complies with the inclusion criteria for the HFC (18), will be incorporated into the HFC, and will regularly re-visit this clinic until the up-titration is complete as well as the disease education, self-management, and physical rehabilitation. Depending on the individual patient's ongoing medication chart and the patient's ability to adapt to the new medication, the up-titration length can vary to a great extent. At any given time, the patient may feel the need seek personal GP. Prior and subsequently to the enrolment in the HFC, the patient is send to the cardiological outpatient clinic for an echocardiogram. Once completed in the HFC, the patient subsequent follow-up is handed over to the GP (which in principle means that the patient is out of the system)

Figure 1 -Flowchart over the course of a HF patient before HFC was established. The half-circle arrows indicate the revisits in the follow-up treatment

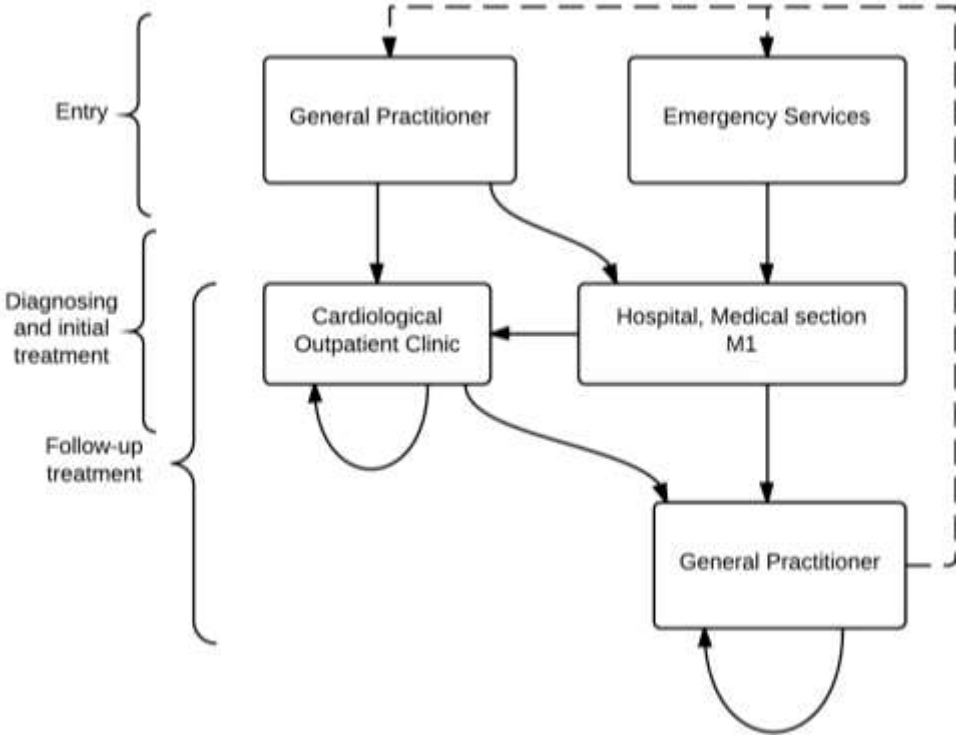
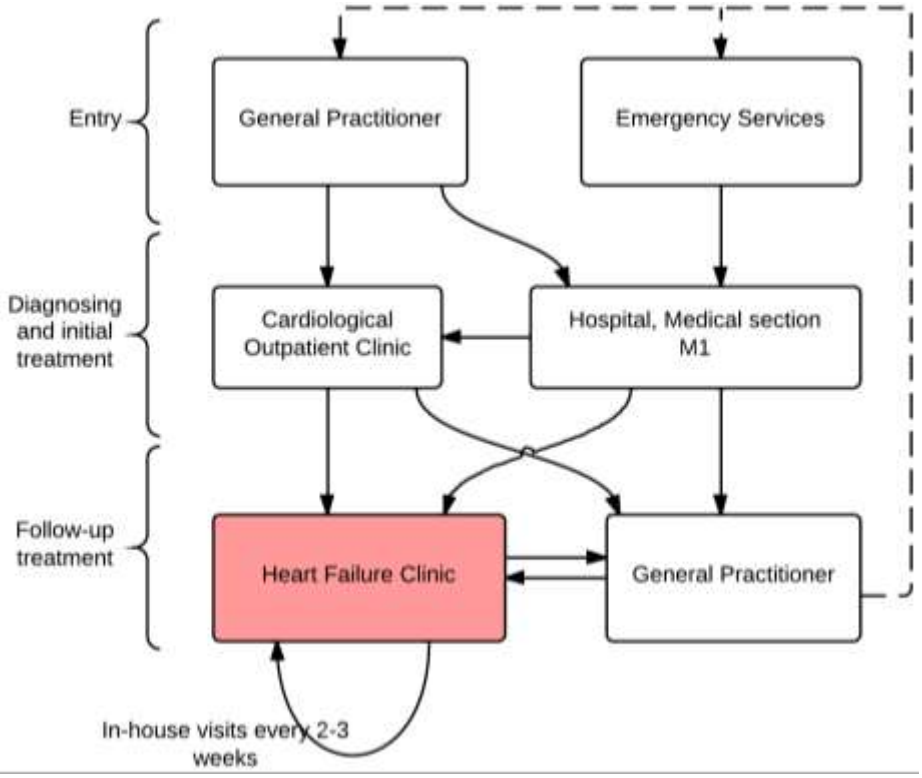


Figure 2 – Flowchart over the course of a HF patient with the HFC established. The half-circle arrows indicate the revisits in the follow-up treatment.

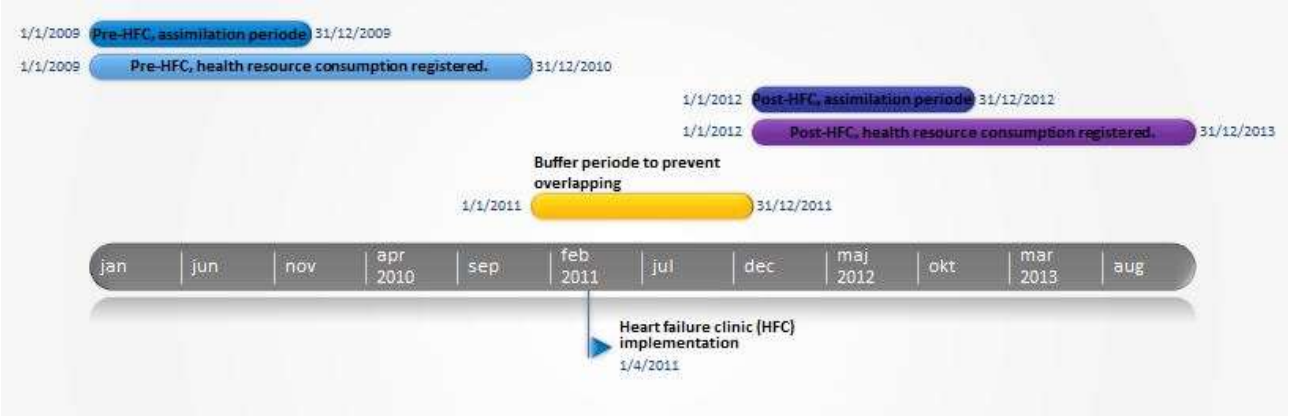


APPENDIX 2 – REGISTRY STUDY

DESIGN

A retrospective cohort study of two periods of 365 days before and after the implementation of a HFC, respectively. In the timeline in Figure 3 the two periods, the period the data can be collected within, and the date of the implementation of the HFC can be seen. To prevent overlapping of data between the two periods, the entire year of 2011 will work as a buffer.

Figure 3 – Timeline, showing the two periods of data inclusion.



STUDY POPULATION

The study population consisted of patients hospitalised for HF[1] in the periods 01/01/2009-31/12/2009 and 01/01/2012-31/12/12. From the time of admittance, data was collected for 365 days, giving the range of

[1] The following diagnosis is within the criteria as "hospitalised for HF", and must be established as an action-diagnosis:

- I11.0 (Incompensatio cordis hypertensiva)
- I13.0 (Morbus cordis hypertensivus et morbus hypertensivus renalis med hjertesvigt)
- I13.2 (Morbus cordis hypertensi et morbus hypertensivus renalis med hjertesvigt og nyresvigt)
- I42.0 (Cardiomyopathia congestiva)
- I42.6 (Cardiomyopathia alcoholica)
- I42.7 (Cardiomyopathia forårsaget af medikamina eller andre ydre påvirkninger)
- I42.9 (Cardiomyopathia uden specifikation)
- I50.0 (Incompensatio cordis congestiva)
- I50.1 (Incompensatio cordis sinistri)
- I50.9 (Hjerteinkompensation uden specifikation)

data to span over two years for both periods, as a patient hospitalised the 30th of December within the inclusion period would accumulate data for the subsequent 365 days. Patients with a history of previous HF were excluded as only patients with a first-time HF diagnosis is of interest. In 2009, there was 150 registered HF diagnoses, and after the removal of the non-first timers, there was 124 HF diagnosis shared among 118 different patients. In 2012 there was 87 HF diagnosis on 83 unique patients.

Patient description for the two periods can be seen in TABEL XX. The data was processed in STATA12, and the codes is attached in *'Appendix 3 – STATA12 codes for the study population'*

	2009		2012		H_0 test (P-value)
Age (mean (SE))	*78.82*		*76.39 [1.39]*		*0.31*
Males (%)	*62 (52.5%)*		*52 (62.7%)*		*0.16*
Diagnosis. (%)	*DI110*	*1 (0.85%)*	*DI110*	*10 (12.05%)*	*0.00*
	DI130	*1 (0.85%)*	*DI130*	*1 (1.20%)*	
	DI420	*3 (2.54%)*	*DI420*	*8 (9.64%)*	
	DI429	*2 (1.69%)*	*DI429*	*2 (2.41%)*	
	DI500	*29 (24.58%)*	*DI500*	*6 (7.23%)*	
	DI501	*9 (7.63%)*	*DI501*	*13 (15.66%)*	
	DI501B	*1 (0.85%)*	*DI501B*	*0 (0.00%)*	
	DI501C	*1 (0.85%)*	*DI501C*	*3 (3.61%)*	
	DI509	*71 (60.17%)*	*DI509*	*40 (48.19%)*	
	Total	*118 (100%)*	*Total*	*83 (100%)*	
Days of hospitalisation on the initial admission (median)	*6*		*6*		*0.87*
Days of hospitalisation on the initial admission (mean(SE))	*7.39 (0.51)*		*7.71 (0.71)*		*0.71*
Way of referral (%)	*No referral*	*50 (42.37%)*	*No referral*	*1 (1.20%)*	*0.00*
	Referral from GP	*53 (44.92%)*	*Referral from GP*	*17 (20.48%)*	
	Other (e.g. social worker)	*1 (0.85%)*	*Other (e.g. social worker)*	*1 (1.20%)*	
	*Ref. from hospital with wait**	*12 (10.17%)*	*Ref. from hospital with wait**	*64 (77.11%)*	
	*Ref. from hospital without wait**	*2 (1.69%)*	*Ref. from hospital without wait**	*0 (0.00%)*	
	Total	*118 (100%)*	*Total*	*83 (100%)*	

* In the Northern Denmark Region, the definition on "no wait" is if you are referred to another medical section / out-patient clinic, and you get in right away. (19)

All of the data in study population was non-normal distributed, and the Mann Whitney test was used. For the 'Diagnosis' and 'Way of referral', a chi square test was performed.

As for the study population there are no statistical difference regarding age, sex and length of initial admission between the two groups. There is statistical difference between the groups in the regard of how they were referred, and what diagnostic code they got.

	2009-2010	2012-2013	P-value
Costs:			
Cumulative days hospitalised (median)	*7*	*8*	*0.48*
Cumulative days hospitalised (mean(SE))	*10.58 (0.98)*	*11.72 (1.28)*	*0.47*
Number of re-hospitalisations (median)	*1*	*1*	*0.40*
Number of re-hospitalisations (mean(SE))	*1.36 (0.73)*	*1.54 (0.12)*	*0.19*
Costs for cumulative hospitalisations [DRG+"long-lying"] (Median)	*33,688*	*32,074*	*0.00*
Costs for cumulative hospitalisations [DRG+"long-lying"] (Mean(SE))	*45,519 (2,601)*	*55,817 (5,902)*	*0.08*
Amb. Count (median)	*0*	*0*	*0.74*
Amb. Count (mean (SE))	*0.66 (0.27)*	*0.73 (0.33)*	*0.86*
Amb. Costs (median)	*0*	*0*	*0.58*
Amb. Costs (mean (SE))	*1,139 (442)*	*715 (287)*	*0.47*
GP count (median)	*17.5*	*25*	*0.02*
GP count (mean (SE))	*22.6 (1.80)*	*28.43 (2.22)*	*0.04*
GP costs (median)	*DKK 26,654*	*DKK 37,895*	*0.05*
GP cost (mean (SE))	*DKK 37,188 (3,137)*	*DKK 45,274 (3,660)*	*0.10*
Effects:			
All-cause mortality within a year, deaths (%)	*47 (39.83%)*	*30 (36.14%)*	*0.59*
Days before re-hospitalisation			

The following statistical tests were used:
(all was performed in STATA12, and the codes are attached in appendix 4 and 5)

GP count: As the histogram showed a non-normal distribution (right-skewed), a mann-whitney test was performed to test the null-hypothesis. The Mann-whitney (or ranksum) test uses medians. As the mean is what is desirable in the ICER, they are also listed in the table.

GP costs: As the histogram showed a non-normal distribution (right-skewed), a mann-whitney test was performed to test the null-hypothesis. The Mann-whitney (or ranksum) test uses medians. As the mean is what is desirable in the ICER, they are also listed in the table.

Outpatient clinic count: As the histogram showed a non-normal distribution (right-skewed), a mann-whitney test was performed to test the null-hypothesis. The Mann-whitney (or ranksum) test uses medians. As the mean is what is desirable in the ICER, they are also listed in the table.

Outpatient clinic count: As the histogram showed a non-normal distribution (right-skewed), a mann-whitney test was performed to test the null-hypothesis. The Mann-whitney (or ranksum) test uses medians. As the mean is what is desirable in the ICER, they are also listed in the table.

Cumulative number of days hospitalised: As the histogram showed a non-normal distribution (right-skewed), a mann-whitney test was performed to test the null-hypothesis. The Mann-whitney (or ranksum) test uses medians. As the mean is what is desirable in the ICER, they are also listed in the table

Number of re-hospitalisations: As the histogram showed a non-normal distribution (right-skewed), a mann-whitney test was performed to test the null-hypothesis. The Mann-whitney (or ranksum) test uses medians. As the mean is what is desirable in the ICER, they are also listed in the table

APPENDIX 3 – STATA12 CODES FOR THE STUDY POPULATION

```
*Denne del af do-filen vil finde de beskrivende faktorer ved indlæggelse - altså patient beskrivelse af de 2 grupper*
use "C:\Users\Jeppe\Dropbox\Specialet\Data\merged.data.2009.nip.dta", clear
keep adiag1 alder1 henm_1 aar1 indm_1 sengedage_1 sex_1 newid
drop aar1
gen aar=2009
save beskrivelse.dta, replace
clear
use "C:\Users\Jeppe\Dropbox\Specialet\Data\merged.data.2012.dta", clear
rename adiag_1 adiag1
rename alder_1 alder1
rename id newid
drop aar_1
gen aar=2012
keep adiag1 alder1 henm_1 aar indm_1 sengedage_1 sex_1 newid
append using beskrivelse.dta
*herfra er de interessante data nu samlet i en .dta fil, og de forskellige tests kan blive kørt*
*jeg starter med at teste alder - er det normal fordelt?*
hist alder1
sktest alder1
*det virker meget skævt på histogramet, og skewness-kurtosis testen siger det samme ( jeg bruger sktest pga lille obsevationsmængde)
* hvis normalfordelt, så havde den været således: ttest alder1, by (aar1)
bysort aar: summ alder1, det
ranksum alder1, by(aar)
*kigger på sex - det er kategorisk data*
tab sex_1 aar, chi2 col
ranksum sex_1, by(aar)
*kigger på adiag1 - det er ligeledes kategorisk, men der er noget bøvl med at de ikke står på samme måde*
tab adiag1 aar, chi2 col
*denne "tab" giver mig de procenter jeg gerne vil have, men den laver forskel mellem "DI110" og "DI110" fordi det står anderledes i filen (fordi der er blevet manuelt ændret på det)
gen newadiag=real(substr(adiag1,2,4))
drop newadiag
*Det var denne her komando vi brugte sidste gang jeg skulle lave noget lign. Anne?
*nå, jeg gør det manuelt*
sort adiag1
edit
replace adiag1 = "DI110" in 16
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replace adiag1 = "DI110" in 18
replace adiag1 = "DI110" in 19
replace adiag1 = "DI110" in 20
replace adiag1 = "DI110" in 21
replace adiag1 = "DI110" in 22
replace adiag1 = "DI110" in 23
replace adiag1 = "DI110" in 24
replace adiag1 = "DI420" in 27
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replace adiag1 = "DI500" in 42
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214.  replace adiag1 = "DI509" in 211
215.  replace adiag1 = "DI130" in 13
216.  replace adiag1 = "DI429" in 28
217.  replace adiag1 = "DI500" in 62
218.  replace adiag1 = "DI500" in 63
219.  replace adiag1 = "DI501C" in 89
220.  replace adiag1 = "DI501C" in 90
221.  replace adiag1 = "DI509" in 199
222.  replace adiag1 = "DI509" in 200
223.  replace adiag1 = "DI509" in 201
224.  drop if newid==.
225.  tab adiag1 aar, chi2 col
226.  *jeg kigger på henmåde*
227.  tab henm_1 aar, chi2 col
```

APPENDIX 4 – STATA12 CODES FOR GP AND OUTPATIENT CLINIC

This is the GP part:

```
use "C:\Users\Jeppe\Dropbox\Specialet\Data\praklæge2009.DTA", clear
keep aar1 id kontakt_dato brutto_honorar_ialt indexdto slutdto
drop if kontakt_dato< indexdto
drop if kontakt_dato> slutdto
gen lægebesøg=1
collapse (sum) lægebesøg , by(id)
*alle de id numre med 0 besøg ved lægen er røget væk. de kommer her ind igen manuelt*
set obs 106
replace id = 2 in 106
set obs 107
replace id = 13 in 107
set obs 108
replace id = 18 in 108
set obs 109
replace id = 32 in 109
set obs 110
replace id = 36 in 110
set obs 111
replace id = 37 in 111
set obs 112
replace id = 53 in 112
set obs 113
replace id = 61 in 113
set obs 114
replace id = 76 in 114
set obs 115
replace id = 77 in 115
set obs 116
replace id = 94 in 116
set obs 117
replace id = 88 in 117
set obs 118
replace id = 116 in 118
replace lægebesøg = 0 in 106
replace lægebesøg = 0 in 107
replace lægebesøg = 0 in 110
replace lægebesøg = 0 in 111
replace lægebesøg = 0 in 112
replace lægebesøg = 0 in 109
replace lægebesøg = 0 in 108
replace lægebesøg = 0 in 113
replace lægebesøg = 0 in 114
replace lægebesøg = 0 in 115
replace lægebesøg = 0 in 116
replace lægebesøg = 0 in 117
replace lægebesøg = 0 in 118
gen aar=2009
save antalbesøgvedlæge.dta, replace
use "C:\Users\Jeppe\Dropbox\Specialet\Data\praklæge2012.DTA", clear
keep id kontakt_dato brutto_honorar_ialt indexdto slutdto
drop if kontakt_dato< indexdto
drop if kontakt_dato> slutdto
gen lægebesøg=1
collapse (sum) lægebesøg, by(id)
*alle de id numre som har 0 obsevatoner ved lægen er væk, de kommer på igen her*
set obs 78
replace id = 1 in 78
set obs 79
replace id = 3 in 79
set obs 80
replace id = 32 in 80
set obs 81
replace id = 37 in 81
set obs 82
replace id = 40 in 82
set obs 83
replace id = 77 in 83
replace lægebesøg = 0 in 78
replace lægebesøg = 0 in 79
replace lægebesøg = 0 in 80
replace lægebesøg = 0 in 81
replace lægebesøg = 0 in 82
replace lægebesøg = 0 in 83
gen aar=2012
append using antalbesøgvedlæge.dta
*og dermed kan vi måle antal besøg ved lægen*
hist lægebesøg, by (aar)
```

```
bysort aar: summ lægebesøg, det
ranksum lægebesøg, by (aar)
*kigger på ydelsesomkostninger ved disse besøg*
use "C:\Users\Jeppe\Dropbox\Specialet\Data\praklæge2009.DTA", clear
keep aar1 id kontakt_dato brutto_honorar_ialt indexdto slutdto
drop if kontakt_dato< indexdto
drop if kontakt_dato> slutdto
collapse (sum) brutto_honorar_ialt , by(id)
set obs 106
replace id = 2 in 106
set obs 107
replace id = 13 in 107
set obs 108
replace id = 18 in 108
set obs 109
replace id = 32 in 109
set obs 110
replace id = 36 in 110
set obs 111
replace id = 37 in 111
set obs 112
replace id = 53 in 112
set obs 113
replace id = 61 in 113
set obs 114
replace id = 76 in 114
set obs 115
replace id = 77 in 115
set obs 116
replace id = 94 in 116
set obs 117
replace id = 88 in 117
set obs 118
replace id = 116 in 118
replace brutto_honorar_ialt = 0 in 106
replace brutto_honorar_ialt = 0 in 107
replace brutto_honorar_ialt = 0 in 110
replace brutto_honorar_ialt = 0 in 111
replace brutto_honorar_ialt = 0 in 112
replace brutto_honorar_ialt = 0 in 109
replace brutto_honorar_ialt = 0 in 108
replace brutto_honorar_ialt = 0 in 113
replace brutto_honorar_ialt = 0 in 114
replace brutto_honorar_ialt = 0 in 115
replace brutto_honorar_ialt = 0 in 116
replace brutto_honorar_ialt = 0 in 117
replace brutto_honorar_ialt = 0 in 118
*inflationen. 2009 tal er trulket med 2010 takst, og skal "ganges" 4 gange op*
gen inflation1= brutto_honorar_ialt*1.025
gen inflation2= inflation1*1.025
gen inflation3= inflation2*1.025
gen pris_inf= inflation3*1.025
gen aar=2009
save ydelserlæge.dta, replace
use "C:\Users\Jeppe\Dropbox\Specialet\Data\praklæge2012.DTA", clear
keep id kontakt_dato brutto_honorar_ialt indexdto slutdto
drop if kontakt_dato< indexdto
drop if kontakt_dato> slutdto
collapse (sum) brutto_honorar_ialt , by(id)
set obs 78
replace id = 1 in 78
set obs 79
replace id = 3 in 79
set obs 80
replace id = 32 in 80
set obs 81
replace id = 37 in 81
set obs 82
replace id = 40 in 82
set obs 83
replace id = 77 in 83
replace brutto_honorar_ialt = 0 in 78
replace brutto_honorar_ialt = 0 in 79
replace brutto_honorar_ialt = 0 in 80
replace brutto_honorar_ialt = 0 in 81
replace brutto_honorar_ialt = 0 in 82
replace brutto_honorar_ialt = 0 in 83
*inflationen*
gen pris_inf= brutto_honorar_ialt*1.025
gen aar=2012
append using ydelserlæge.dta
hist pris_inf, by (aar)
*og hermed kan man sammenligne ydelsesomkostnigerne for lægebesøg ved de 2 år
bysort aar: summ pris_inf , det
ranksum pris_inf , by (aar)
ttest pris_inf, by (aar)
```

This is the outpatient clinic part:

```
use
"C:\Users\Jeppe\Dropbox\Specialet\Data\DAGS.2009.dta", clear
drop id
rename newid id
*starter med antal besøg*
collapse (sum) behdag , by(id)
*alle 118 observationer er her (modsat ved lægebesøg), så vi kan fortsætte med statestikken)
gen aar=2009
save antalbesøgamb.dta, replace
*tilføjer 2012*
use "C:\Users\Jeppe\Dropbox\Specialet\Data\DAGS.2012.dta", clear
rename test1 behdag
collapse (sum) behdag , by(id)
gen aar=2012
append using antalbesøgamb.dta
*nu er vi klar til statestikken*
*starter med antal besøg*
hist behdag, by (aar)
bysort aar:summ behdag, det
ranksum behdag, by (aar)
*kigger på omkostningene*
use "C:\Users\Jeppe\Dropbox\Specialet\Data\DAGS.2009.dta", clear
drop id
rename newid id
*jeg ornder inflationen. skal ganges 4 gange op for at blive 2014 tal*
gen inflation1= PrisDags*1.025
gen inflation2= inflation1*1.025
gen inflation3= inflation2*1.025
gen pris_inf= inflation3*1.025
collapse (sum) pris_inf , by(id)
gen aar=2009
save omkostningeramb.dta, replace
use "C:\Users\Jeppe\Dropbox\Specialet\Data\DAGS.2012.dta", clear
rename prisdags PrisDags
*inflationen*
gen pris_inf= PrisDags*1.025
collapse (sum) pris_inf , by(id)
gen aar=2012
append using omkostningeramb.dta
hist pris_inf, by (aar)
bysort aar:summ pris_inf, det
ranksum pris_inf, by (aar)
ttest pris_inf, by (aar)
mortality and days hospitalised in the initial admission:
use"C:\Users\Jeppe\Dropbox\Specialet\Data\merged.data.2009.nip.dta", clear
kep adiag1 aar1 drg_1 inddato Pris_1 sengedage_1 Død newid Dato Ekko NYHA Genindlggelser ACEhmmere Betablokkere Aldesteron Fysisktrning Patientundervisning indm_1 _merge
drop aar1
gen aar=2009
save resultater1.dta, replace
use "C:\Users\Jeppe\Dropbox\Specialet\Data\merged.data.2012.dta", clear
drop aar_1
gen aar=2012
rename adiag_1 adiag1
rename inddto_1 inddato
rename pris_1 Pris_1
rename død Død
rename id newid
rename FysiskTrning Fysisktrning
keep adiag1 drg_1 aar inddato Pris_1 sengedage_1 Død newid Dato Ekko NYHA Genindlggelser ACEhmmere Betablokkere Aldesteron Fysisktrning Patientundervisning indm_1 _merge
append using resultater1.dta
sort aar newid
*Så er vi klar til at kigge på resultater. Jeg ligger ud med sengedage, som forventeligt er skewed*
hist sengedage_1
ranksum sengedage_1, by (aar)
bysort aar: summ sengedage_1, det
tab Død aar, chi2 col
drop if newid==.
*der er 2 der ikke har fået registret det ordentligt. gør det manuelt*
replace Død = 0 in 2
replace Død = 1 in 107
tab Død aar, chi2 col
```

APPENDIX 4 – STATA12 CODES HOSPITALISATION

```
*kigger på cumulative sengedage*
use "C:\Users\Jeppe\Dropbox\Specialet\Data \indl2009.dta", clear
keep id nr indexdto slutdto uddato sengedage_1 inddato
collapse (sum) sengedage_1 , by(id)
gen aar=2009
save cumulative.dta, replace
*tilføre 2012*
use "C:\Users\Jeppe\Dropbox\Specialet\Data \indl2012.dta", clear
collapse (sum) sengedage_1, by (id)
gen aar=2012
append using cumulative.dta
hist sengedage_1, by (aar)
bysort aar: summ sengedage_1, det
ranksum sengedage_1, by (aar)
*Jeg kigger på antal genindlæggelser:
use "C:\Users\Jeppe\Dropbox\Specialet\Data \indl2009.dta", clear
keep inddato sengedage_1 indlggelsestid id nr indexdto indexdto uddto
gen antal=1
collapse (sum) antal , by(id)
gen aar=2009
save antalgenind.dta, replace
use "C:\Users\Jeppe\Dropbox\Specialet\Data \indl2012.dta", clear
gen antal=1
collapse (sum) antal , by(id)
gen aar=2012
append using antalgenind.dta
hist antal
bysort aar: summ antal,det
ranksum antal, by (aar)
ttest antal, by (aar)
*kigger på omkostninger målt på DRG*
use "C:\Users\Jeppe\Dropbox\Specialet\Data \indl2009.dta", clear
keep drg_1 Pris_1 sengedage_1 totpris_1 id
sort drg_1
*jeg ordner det med inflationen så tallene kan sammenlignes. "2009" perioden er hentet med 2010 takster, og skal således "ganges" 4 gange op for at komme til 2013 tal"
gen inflation1= totpris_1*1.025
gen inflation2= inflation1*1.025
gen inflation3= inflation2*1.025
gen pris_inf= inflation3*1.025
collapse (sum) pris_inf, by (id)
gen aar=2009
save drgomkost.dta, replace
use "C:\Users\Jeppe\Dropbox\Specialet\Data \indl2012.dta", clear
keep drg_1 sengedage_1 totpris_1 id
*2012 tallene er trukket med 2013 takster, og skal således blot ganges “en” gang op*
gen pris_inf= totpris_1*1.025
collapse (sum) pris_inf, by (id)
gen aar=2012
append using drgomkost.dta
qqplot pris_inf id
*histogrammet var lidt utydligt, men qqplot viser at det ikke er normalt fordelt*
bysort aar: summ pris_inf, det
ranksum pris_inf, by (aar)
ttest pris_inf, by (aar)
```

APPENDIX 5 – CALCULATIONS FOR THE ICER

From the HR department and 'Finance and Economics' department, the following costs were identified:

	DKK	Reference
Planning, administration	*14,573.36 (37 hours)*	*(15)*
Planning, nurses	*6,991.09 (37 hours)*	*(15)*
Equipment	*Unknown, set to zero*	
Day-to-day running, wages	*7,141.96 (37 hours)*	*(15)*
Day-to-day running, overhead	*5403 pr day (entire M1)*	*(16)*

Mean costs per patient, planning:

Under the assumption that the nurses and administration does not spend an equal amount of time each year on planning the HFC.

From the administration, a guestimate was made that the nurses spend 37 hours planning the clinic, and the administration itself also spend 37 hours. A personal assumption from the author is that the administration and nurses will have to spend the same amount of hours every two years to keep the HFC running, a cost that is not included in the day-to-day running. So for the 83 patients recorded in the 2012-period, the mean cost can be calculated : $\frac{(14573.36+6991.09)*0,5}{83} = 129.9$

Mean costs pr. Patient, day-to-day running:

The clinic is only open once a week, and a maximum of six patients can be seen (1 hour pr patient between 8-14, and 'preparation'- and 'concluding'-time from 7-8 and 14-15), hence the costs must be divided by six.

One day of pay for the nurse is DKK 1020.28, divided by 6, DKK 170.05

The overhead costs is calculated by square meters. The overhead costs for the M1 for one day is DKK 5403, and with 10 wards, and one third of a ward, this will be DKK 180.1. As this also will have be split by the six patients, this will be DKK 30.0

The mean costs pr. Patiens for the day-to-day running is : 170.05+30 = DKK 200.05

All in all, the mean costs pr patient is 129.9+200.05 = DKK 329.95