Do the activity based financing in Norway incentivize hospitals to shift emergency patient with unspecific chest and abdominal pain from short stay inpatient to outpatient treatment?

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Abstract

Background

Currently the Norwegian hospital financing system refines hospitals reimbursement for the same diagnosis, when the hospital provides services to emergency patients seeking care at an accident and emergency department. The refinement is based on the patients' length of stay. Stavanger University Hospital argues that the financing system makes outpatient treatment unprofitable compared to short stay inpatient treatment of emergency patients. The Norwegian health and hospital plan 2016-2019 states the opposite.

Objective:

The purpose of this thesis is to analyse whether the Norwegian hospital financing system encourages Stavanger University Hospital to provide emergency patients with a more cost-efficient resource allocation or not. The objective is to answer the research question: *Do the activity based financing in Norway incentivize hospitals to shift emergency patient with unspecific chest and abdominal pain from short stay inpatient to outpatient treatment?*

Method

The methods applied are a cost-benefit analysis and a cost-minimization analysis. The two analysis use retrospective hospital reimbursement data and literature to calculate benefits of the different treatment pathways. Cost calculations are based on hospital accounting data and hospital staffs' expert opinion. The study derives the incremental net benefit between the outpatient pathways and the inpatient pathway based on the costs and benefits to evaluate the incentive for Stavanger University Hospital.

Results

The results indicate that Stavanger University Hospital suffer an average loss per patient between 735NOK-3,374NOK per unspecific abdominal pain patient they provide outpatient treatment. The average incremental net benefit for the hospital when patient with unspecific chest pain receives outpatient services compared to inpatient services ranges from -613NOK to 1,431NOK. The potential annual social cost savings confound with outpatient treatments are 7.7 million NOK.

Conclusion

The conclusion is that Stavanger University Hospital is lacking a financial incentive to shift emergency patients diagnosed with unspecific abdominal pain from inpatient treatment to outpatient treatment, given that they are profit maximizing. The incentive to treat the patients diagnosed with unspecific abdominal pain as inpatients for the hospital contradict the optimal from the social perspective. Society is best of when both patients with unspecific chest and abdominal pain receive outpatient treatments.

Foreword

"Today, for many economists, economics is to a large extent a matter of incentives: incentives to work hard, to produce good quality products, to study, to invest, to save, etc. How to design institutions that provide good incentives for economic agents has become a central question of economics" (Lafont & Martimort, 2002).

This master thesis is an empirical investigation that is built on the quote from Lafont and Martimort (2002). However, you would not be able to read this thesis if it were not for the vital contribution of especially two parties, Stavanger University Hospital and my supervisor Oddvar M. Kaarbøe.

I am grateful for the valuable resources Stavanger University Hospital have allocated to help me writing my master thesis. A special thanks to Gudrun D. Sigmo, Mari Larsen and Erna Harboe. They have been positive and solution oriented at every challenge faced on the way. Personally, I have to say working with them made me even more motivated, and that I felt I was in an environment where all questions could be asked. During my thesis, I have learnt that Stavanger University Hospital do not settle with how the Norwegian health care system is today. They take action to develop a better health care system in a holistic perspective. I hope this thesis can contribute to that.

The second party that deserve and have my token of appreciate is my supervisor Oddvar M. Kaarbøe. First, Oddvar triggered my interest for the topic and arranged the collaboration with Erna Harboe and Stavanger University Hospital. Secondly, Oddvar always provided his honest feedback and challenged me to take the step to the next level. Through that, I gained inspiration from every session of supervision. The fact is that without Oddvar it would not be possible to write my thesis on this topic and the result would have been many levels below.

At last, I would like to thank all fellow students making this master programme two good years of my life, including plenty of interesting experiences.

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1 Introduction

1.1 Background

Since the 1980s, there has been focus on reorganizing and restructuring the service provision of the specialist health care in Norway. It has been a policy goal to decrease the number of resource demanding and costly inpatient services, and replace these services with outpatient care that provide more health gain at a lower cost (Ringard, Sagan, Saunes, & Lindahl, 2013). An example is elective hip surgeries that earlier were performed as inpatient service, which are currently performed as day-surgeries.

In April 2015, Stavanger University Hospital (SUS) implemented measures to increase the share of outpatient treatments of patients seeking emergency care in their Accident and Emergency Department (AED, *Akuttmottaket*). The aim was to raise quality of care, improving patient safety and avoid unnecessary admissions. Consequently, patients are provided care within few hours as opposed to former waiting times of 24-48 hours. The economic consequences for SUS were dramatic. SUS receives different payments for inpatient and outpatient care – both based on Diagnosis Related Group (DRG) prices. Providing outpatient services are paid much less generously as inpatient services. SUS argues that they experience an income loss when they provide outpatient care compared to the inpatient alternative. (Stavanger Universitetssykehus, 2016).

SUS's argument contradicts what is stated in the Norwegian health and hospital plan 2016-2019 (Nasjonal Helse- og Sykehusplan). The plan states that both patients and hospitals benefit from rapid diagnostic and examination of the patients' health. Preferably, the patient should receive hospital services within the same day he/she seeks care, as quality of the care depends on fast and precise diagnostic. Further, the hospital plan specifies that to meet the demand for health care in the future, health services provision have to become more efficient. Demand is expected to increase due to the ageing of the Norwegian population (Helse- og Omsorgsdepartement, 2015).

From this context, some questions arise. Do Norwegian hospitals experience a profit loss when they provide the same services in less time, at lower cost and with fewer resources? Do the best patient pathways, seen from a public hospital and from the social perspective, contradict each other? Do the financing system for Norwegian hospitals incentivize SUS and other Norwegian hospitals to waste resources?

Lieng, Busund, Ræder, and Iversen (2013) investigate the effect of refining DRG prices for day-surgeries and surgeries requiring one-night hospitalization in 2010 in Norway. They found that the share of outpatient-surgeries relative to all elective surgeries declined after the refinement. The refinement was introduced to reflect more precisely the cost of the different treatment alternatives (outpatient and one-night inpatient stays). However, the refinement caused a price difference of 15,000 NOK for one-night-hospitalization-surgeries compared to the outpatient surgery. The study assumes the hospitals´ cost of one extra night of inpatient stay for a discharge ready patient to be about 1000-2000 NOK, and no differences in clinical benefit.

Lieng et al. (2013) argues that day-surgeries are better for the patient, the provider and the society. They state that the DRG refinement probably removes the hospitals´ financial incentive to perform day-surgeries. Consequently, they argue that the refinement is the cause of the decline in day-surgeries and probably entails an efficiency loss. In 2015, the DRG for outpatient-surgeries increased by 10% and one-night inpatient-surgeries price were reduced by 10%. The aim was to increase the incentive for day-surgeries (Helsedirektoratet, 2014). The effects of the refinements in 2015 are yet not know.

If Lieng et al. (2013) conclusions are correct about the DRG refinements in 2010, can the split between outpatient and inpatient DRG-prices entail the same effect? I.e., are hospitals incentivized to provide inpatient rather than outpatient care?

Both international and national health economic studies have shown that the income hospitals receive affects i) what services they choose to deliver, ii) the intensity of the service provided, and iii) the length of stay (Januleviciute, Askildsen, Kaarboe, Siciliani, & Sutton, 2016), (Dafny, 2005) (J. Yin, Lurås, Hagen, & Dahl, 2013) and (Ellis, 1997). Especially of interest for this study, is the study by Hafsteinsdottir and Siciliani (2010). They develop a theoretic model and analyse how refinements of DRG prices affect hospital incentives in situations when two or more treatment paths for the same diagnosis exist. A situation like this is analysed in this thesis.

1.2 Objective

The purpose of this thesis is to analyse whether the Norwegian hospital financing system encourages SUS to provide emergency patients with a more cost-efficient resource allocation or not. I will investigate this by looking at two specific diagnoses: unspecific chest pain and abdominal pain. The diagnoses are chosen since the treatment for them can be provided both as outpatient and as inpatient treatments.

The investigation will be preformed by a cost-benefit analysis (CBA) and a cost-minimization analysis (CMA) using patient data from SUS. The analyses will focus on whether the hospital´s and the societal perspective is aligned. Furthermore, the results of the CBA and CMA are discussed based on the presented cost-benefit and incentive theory. The research question in this master thesis is the following:

> **Do the activity based financing in Norway incentivize hospitals to shift emergency patient with unspecific chest and abdominal pain from short stay inpatient to outpatient treatment?**

1.3 The Structure of the Text

The first chapter provides the background of this thesis and its objective. Chapter 2 briefly presents the Norwegian specialist health care system, focusing on organization, governance, financing and provision of care. This chapter also presents relevant information about SUS. Chapter 3 presents relevant theory and literature, providing the reader prerequisites to understand activity based financing, cost-benefit analysis, cost-minimization analysis and DRG refinement theory. Chapter 4 describes the analysis applied in this thesis. In addition, the chapter provides justifications of assumptions in the CBA and CMA. The following chapter 5, 6 and 7, respectively presents the results, the discussion of the results and the conclusion of this thesis.

2 The Norwegian Specialist Health Care System

This chapter outlines the main characteristics of the public Norwegian specialist health care system. First, I describe its organization and governance. Next, the financing system towards hospitals is presented, and a brief description of provision of care. Thereafter, the chapter zooms in from the macro to the micro level by describing Stavanger University Hospital, its general financing and effort in increase outpatient services in the AED.

2.1 Organization and Governance

In 2002, the central government took over the responsibility for the specialist health care system from the counties. The Norwegian specialist health care system was organized into Regional Health Authorities (RHAs), and currently there are four. Each RHA owns the public hospital trusts in their region, and finances public and private-contracted hospital trusts within their regional area (Ringard et al., 2013). For example, the RHA “Helse Vest” owns the hospital SUS.

The core value of the Norwegian national healthcare system, is that access to health care service shall be based on patients´ need independently of any socio-economic factor, ethnicity and geographical place of residency (Helsedirektoratet, 2013; Ringard et al., 2013).

The RHAs are the entities that are responsible for both covering the need of specialist health services within their geographical region and purchase specialist health services (Pettersen, Magnussen, Nyland, & Bjørnenak, 2008). The RHAs divide the responsibility for service provision between the Hospital Trusts (Braut, 2009).

Each year, the Ministry of Health and Care services provides each of the four RHAs with an individually specified letter of instruction (*Oppdragsdokument*). This document specifies focus areas, in addition to short and long-term goals the Ministry requires the RHAs to fulfil. The RHAs sends a more detailed individual governing document (*Styringsdokument*) to each of their hospital trusts (Ringard et al., 2013). In 2016, SUS received an instruction from Helse Vest to have zero patients placed in corridors (Helse Vest RHF, 2016).

The mentioned governing structure outlined above can be interpreted as a relational contract between the principal (RHA) and the agent (the hospital trust). It is a relational contract since the RHAs own the hospital trusts, and can implement their understanding of the contract when disagreements occur. Another tool that the RHAs can use to influence how care is organized and provided, is the financial system. It is described in the next section.

2.2 Financing of Hospitals in Norway

The RHAs receives their financing from their owner, the central government, which the RHAs distribute to the hospital trusts based on a self-selected financing model. Since the 1st of July 1997, a mix of block grant and activity based financing (ABF) has financed somatic specialist health care. From 2014 until today, ABF has covered and is covering about 50% of somatic care running costs. Block grants cover approximately the remaining 50% of the running costs (Helsedirektoratet, 2016c).

The ABF depends on the quantity of patients and the patients DRGs weight. The block grant on the other hand, is dependent on the population size, the age distribution, and socioeconomic characteristics in the health region. Thus, independent of the activity level (Helsedirektoratet, 2016c).

A DRG system is a system where patients are grouped in DRGs based on medical conditions and that they are homogenous costly treatment groups (Helsedirektoratet, 2016a). To some extent, the cost of treatment is affected by the length of stay (LOS). The DRG system in Norway reflects this by differentiating between three types of patients. First, ambulatory patients, which are patients staying less than 5 hours in the hospital at the same day. The second category is day care patients, which stays more than 5 hours at the same day. Last, the inpatient group, which stay overnight. The patient classification with shortest LOS, has the lowest DRG weight (ABF financing the RHAs/Hospitals receive) per patient (Stavanger Universitetssykehus, 2016).

The Directorate of Health determines the DRG weights at the start of each year with a 2-year delay, based on hospital cost data from approximate 20 hospitals. The cost data from the hospitals are used to estimate an average cost within each DRG for all the hospitals (Helsedirektoratet, 2016c). For an explanation of how the Directorate derives the DRG weights see Januleviciute et al. (2016).

The primary purpose of the ABF part of the specialist health care financing in Norway is to support the responsibility the four RHAs have of providing the needed care, as a financial incentive. Another purpose is to incentivize cost-efficient patient treatment (Helsedirektoratet, 2016c).

The Directorate of Health (Helsedirektoratet, 2016c) specifically states the importance of that the financing system do not create a barrier for provision of services. Prioritizations of service provision shall follow laws and guidelines. There are three criteria for prioritization of health care in Norway; the severity of the patients' health state, the health benefit of the treatment and thirdly, a justifiable relationship between the cost and benefit of the treatment (Helsedirektoratet, 2015).

As mentioned, the RHAs determine the block grant and ABF system to the hospital trusts. The RHAs normally provide the expected amount of ABF during a year for each hospital trust in the trusts individual governing document. The document also announces the block grant amount (Helse Vest RHF, 2016). The financing for DRG weights produced at a given hospital department in a trust, normally follows from the central government via the RHAs to the department. Harsvik and Kjekshus (2007) found in 2005 that 75-82% of the clinical departments where financed partly by the ABF.

2.3 Provision of care at Norwegian Hospitals

The hospitals organizes somatic, psychiatric and rehabilitation from addictive substances, including concomitant laboratory and radiology services. Patients receive services either as inpatient or at the ambulatory and day care clinic. (Ringard et al., 2013).

There are two types of treatments at public somatic hospitals in Norway, emergency and elective treatments. There are three access points for emergency care. The two most common pathways are referral by the patient's general practitioner (GP) and referral by an Emergency Center (*Legevakten*). The third access point to emergency care is when the patient has an acute health states that justify direct admission to the AED (Ringard et al., 2013).

For elective treatments the GP or a specialist, refer the patient to the hospital. In this situation the patients' health state is not acute, and do not justify immediate treatment. I.e. the patient have to wait on turn for a scheduled treatment. (Januleviciute et al., 2016). Readers interested in a more extensive description of provision of care see Ringard et al. (2013).

2.4 2.4 Stavanger University Hospital

Stavanger University Hospital is located in Western Norway. The main branch is in the city of Stavanger in the county Rogaland. It is one of six university hospitals in Norway. The hospital employs over 7500 people, and had a budget at 6.8 billion NOK in 2016. The hospital are responsible for covering the specialist care need for about 360 000 people (Stavanger, 2017). SUS is the third largest Accident and Emergency hospitals in Norway and about 100 patients arrive at their AED every day (Stavanger Universitetssykehus, 2016).

2.4.1 Substitution of Short Stay Inpatient to Outpatient

At 20th of April 2015 SUS started a project to raise quality of care and improve patient safety. The project called substituting short stay inpatient to outpatient (DTD, *døgn til dag*), aims to compress the timeline of the patient pathway. Consequently avoiding unnecessary hospitalization (Stavanger Universitetssykehus, 2016).

Before DTD, it was standard practice to hospitalize the majority of the AED patients and providing them the necessary services within one or two days of admission. Today SUS can provide diagnostic and examination within few hours in the AED. The outpatient treatment of these patients is possible due implementation of new technology, decision-making algorithm, reorganization of hospital resources (Stavanger Universitetssykehus, 2016).

After the hospital started DTD, a remarkable drop in hallway patients was seen. The drop occurred when the number of emergency patients at SUS increased (see Figure 8 in section 4.3.2). However, SUS hypothesize that providing rapid treatment is unprofitable in comparison to the inpatient path. Their argument is that they provide about the same services, while their ABF revenue per patient decreases several times when providing services for the outpatient categories (ambulatory and day patient) compared to the inpatient. This makes the outpatient services provision unsustainable (Stavanger Universitetssykehus, 2016).

2.4.2 Provision of care

When treating several patient groups, the hospital has discretion to choose between two treatment options. Either an inpatient or an outpatient treatment without endangering penalties from the purchaser. Examples are the emergency patient diagnosed with unspecific chest pain (R07.4) or unspecific abdominal pain (R10.4). Independent if the emergency patients receive inpatient or outpatient treatment, they receive about the same examination and diagnostic services. The incremental difference is the duration of the treatment pathway and the financing the hospital receive from providing the services (Stavanger Universitetssykehus, 2016).

The treatment pathways for R07.4 and R10.4 emergency patient at SUS are described in section 4.2.6. These two diagnoses are selected by medical personnel at SUS, as these are examples of patients that it is unnecessary to admit and the hospital can use discretion towards the third party payer (Stavanger Universitetssykehus, 2016).

2.4.3 Financing

Every year SUS receives a governing document from the RHA in western Norway. The document specifies health related responsibilities, tasks and governing goals. In 2016, SUS received 6.25 billion NOK from Helse Vest to fulfil the requirements in the governing document. About 1.75 billion NOK where ABF, while the block grant consisted of approximate 4.4 billion NOK and other financing at 0.1 billion NOK. About the same ABF system as between the state and the RHA, is in place between the RHA and SUS (Helse Vest RHF, 2016).

3 Theoretical Foundation & Relevant Research

In this chapter, the theoretical foundation and relevant research for this thesis are presented. The first part is a description of ABF systems in general and briefly explaining the Norwegian system. The next section, presents Jegers, Kesteloot, De Graeve, and Gilles (2002) theory of how provider incentives is influenced by the financing system's characteristics. This is followed by an explanation of Hafsteinsdottir and Siciliani (2010) theory on how DRG refinements affect providers incentive. In the last section, there is a basic description of the two methodologies, cost-benefit analysis (CBA) and cost-minimization analysis (CMA).

3.1 Activity Based Financing

The activity based financing used in Norway is a DRG based system, thus that type of ABF is in focus in this thesis. In a financing system that is DRG based, the financing is dependent on the activity that corresponds with a given DRG. A DRG consist of several diagnosis that are relatively homogenous regarding their average resource use (Busse, Geissler, Quentin, & Wiley, 2011). The reimbursement level per activity are normally set prospectively of the cost occurring (Street, Vitikainen, Bjorvatn, & Hvenegaard, 2007).

Deriving the reimbursement for each DRG are done by different means in the countries that uses DRGs in their ABF system. There are two main method; one where the DRG price are directly calculated as an average cost per DRG; the second is to derive a reimbursement level for a benchmark treatment that are assigned a reference weight (Kjerstad, 2003; Street et al., 2007).

Within the branch of ABF systems, there are several versions. The most general version is a financing system where financing of hospital depends 100% on the activity.

Another ABF version is a system that have a mix between the ABF and block grant financing (Figure 1). This system is applied in Norway and is a more common form of ABF than then 100% ABF system (Helsedirektoratet, 2011; Street et al., 2007). The block grant can adjust for elements that impose systematic higher cost for some hospital than other, e.g. geographical size of a hospital's coverage area, latitude, longitude and age distribution of coverage population (Magnussen et al., 2008). In the model in Figure 1, the hospital revenue is the sum of the block grant (Z) and the DRG quantity within each DRG multiplied with a percentage X of the respective DRG price. The block grant Z will normally cover some of the financing that is provided as ABF in the 100% ABF system. Thus the unit price per DRG is expected to be lower in this mixed system (Street et al., 2007).

The third version of the ABF system is when the block grant and the ABF mix are supplemented with an activity goal Q̄. At higher activity than Q̄, the unit price per extra DRG is reduced with X percentage. In other words, the incentive to increase activity for the hospital are less after reaching the activity goal (Street et al., 2007).

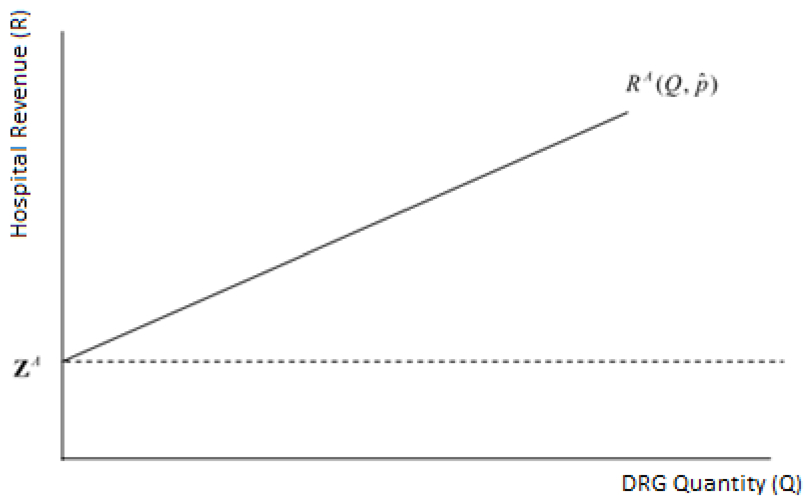

Figure 1: The figure from Street et al. (2007) illustrates a hospitals revenue in a financing system similar to the Norwegian system, were Z represents a fixed block grant and R is the revenue function given from quantity (Q) and price(weight (ṗ).

ABF have become a common method to finance health care systems because it defines the good produced by providers. The ABF defines the good indirectly by DRG weights/prices. Hence, the system provides more transparency in cost-effectiveness compared to global budget financing systems (Street et al., 2007).

Another benefit with the ABF system is that it provide an incentive for more efficient treatment. The DRG prices/weights introduces a benchmark that functions like a “yardstick competition” for the providers. However, large variation in actual cost within each DRG may incentivize profit-maximizing hospitals to engage in patient selection (creaming[1], dumping[2] and skimping[3]). That the reimbursement follows the patient are also considered a strength of the system (Januleviciute et al., 2016). For more elaboration about the ABF systems, their pros and cons see Ellis and McGuire (1986) and Ellis (1997). Note that Ellis and McGuire (1986) conclude that a mix between block grant and ABF provide better incentives for providers than the 100% ABF system.

3.2 Theory – Financing Specialist Health Care

Together with legislations and organizational structure, the financial system is a tool that regulates the incentives and principal-agent relationship in specialist health care systems. This section describes how the financing system affect providers incentive (Jegers et al., 2002).

3.2.1 Typologies of Financing Systems

Jegers et al. (2002) provides a typology of financing systems of health care providers. They explain how these typologies influence the provider under the assumption that they are profit maximizing and risk-averse. They categorize financing according to two dimension at both micro and macro level; fixed vs variable payment systems; and prospective and retrospective reimbursement systems. This thesis focuses on the incentives providers have under prospective fixed (block grant) and prospective variable financing (ABF), as these are the dimension in the Norwegian specialist healthcare financing system. Readers with interest of provider incentives under retrospective financing systems are referred to Jegers et al. (2002).

Prospective Financing

If financing system is prospective or retrospective, relates to whether the reimbursement fees/prices and block grants are either set before (prospective) and are independent of the

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[1] Cream skimming in health care can be defined as “easy money” for the provider and that the provider choose to provide treatment for patients that yield high net profit per patient (Martinussen & Hagen, 2009).

[2] Dumping is more or less the opposite of cream skimming, implying that a hospital choose not to provide services to un- or less profitable patient (Ellis, 1997).

[3] The last patient selection concept is skimping, which in this text is when a provider choose to reduce the number of services in a treatment to reduce the marginal cost (Ellis, 1997).

actual costs, or after (retrospective) and dependent on the actual costs of the health services provided (Jegers et al., 2002).

When the financing is prospective, the revenue the hospital receives from provision of services is independent of the actual cost. Then, the providers incentive are to contain their cost. As the providers total revenue or revenue per service provided are fixed, the provider can only affect the cost or volume of services (Jegers et al., 2002).

An adverse effect from a prospective system may be that providers choose to skimp service, which can impose financial savings in the short run. However, skimping may reduce quality of care, which in the long-term can increase the total cost e.g. due to a raise in readmission. It is therefore vital to have a realistic remuneration that reflect the actual cost of providing the service to avoid adverse effects. However, the cost of making the reimbursement level reflect the actual cost of the provider can be greater than the savings from the incentive to contain cost for the provider (Jegers et al., 2002).

Fixed vs Variable Financing

The dimensions fixed and variable relates to whether the revenue of the hospitals are dependent or independent of their activity. In a fixed system, the reimbursement the hospitals acquire is independent of their activity. In variable systems, the level of reimbursement depends on hospitals level of activity. These two dimensions can be at both micro and macro level. Micro level refers to how the financial incentives affect the individual provider, e.g. SUS. Macro level refers to how the financial incentives affect all hospitals within a region or a country (Jegers et al., 2002).

At micro level, the difference between the fixed and variable dimension is whether there exist a dependency or independency between provider’s revenue and volume of services provided. An illustration of this is the financing of Norwegian hospitals, which are 50% variable for somatic care. Then, the hospitals revenue are about 50% dependent of the quantity of services provided. In variable systems, a provider has a financial incentive to provide health care services until its marginal cost equals the marginal revenue per unit provided. Theoretical in health care system where this is directly applicable, a relatively high marginal revenue compared to marginal cost per unit stimulate production and cream skimming. Vice versa, a negative marginal income incentivize dumping of patients. Alternatively skimping services until the marginal cost equal marginal revenue (Jegers et al., 2002).

In fixed systems at micro level, the provider's revenue is independent of the quantity of units provided. Since the income of the provider is fixed, profit maximizing providers has an incentive to reduce their marginal costs (Jegers et al., 2002). That can imply skimping the services (e.g. blood test, X-ray, CT scan, etc.) provided within a treatment to reduce the cost, or dump to unprofitable patient (Ellis, 1997).

The Norwegian system is a semi-fixed/variable system at micro level (Helsedirektoratet, 2014), therefore incentives provided in theory are between the incentives for variable and fixed systems (Jegers et al., 2002).

At macro level, fixed systems imply that it is a finite reimbursement cap for the budget period for all hospitals, e.g. 12 months. Global budget ceiling within the public hospital sector is an example of such systems. Fixed systems at macro level can be useful for cost-containment. Variable systems at macro level imply no budget limit at a global level. Again, the Norwegian system is a mix of the two dimensions. The block grants imply that the level of reimbursement is fixed at a minimum level equal the sum of the block grants. Above that sum, the reimbursement level may vary (Jegers et al., 2002).

Different combinations of micro- and macro-level systems will provide different incentives for the providers. A system with variable financing at both level is likely to stimulate activity, while a fixed system on both levels stimulate cost-containment. The variable system at micro-level and fixed at macro-level provide the hospitals an incentive in-between the two other systems. If the budget is caped at macro level, the incentive depends on the providers marginal cost compared to the other hospital included in the budget. The providers with marginal cost below the marginal revenue will gain on increasing the activity. The providers with marginal cost exceeding marginal revenue are incentivized to either reduce their marginal cost by skimping services or dump the specific patients (Jegers et al., 2002).

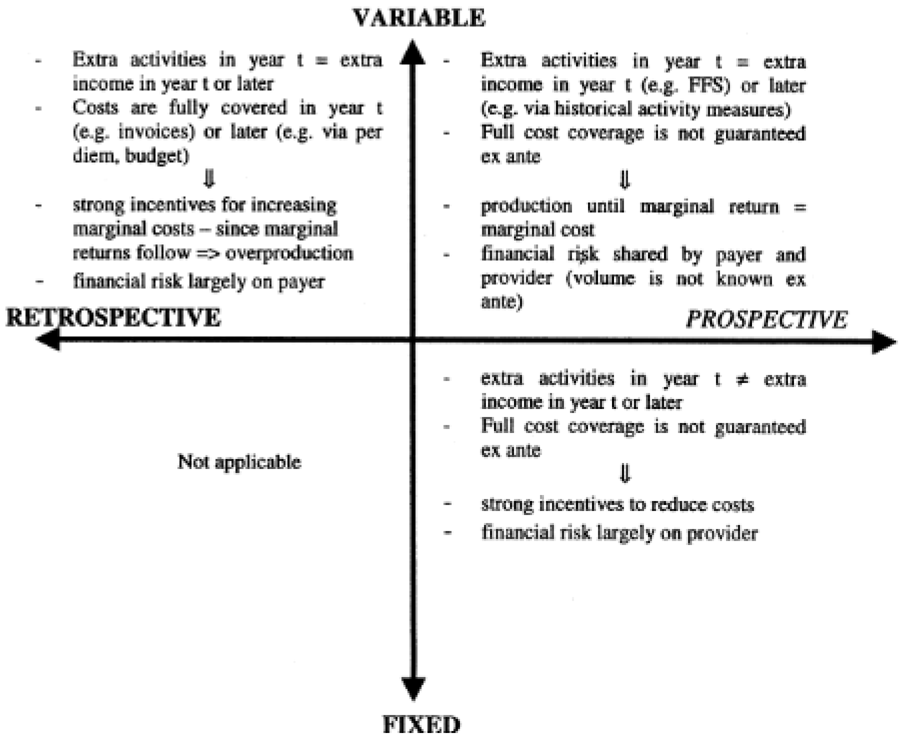

Figure 2: The figure from Jegers et al. (2002) summarizes risk allocation and the incentives the different combinations of dimensions of a financing system in theory provide to a profit maximizing hospital.

Prospective Fixed and Prospective Variable

Figure 2 above summarizes the effect of different combination of the financing dimensions.

A prospective fixed system incentivize the provider to cut costs, as the reimbursement level are prospectively and do not vary with the activity level. This system allocates the financial risk to the provider (Jegers et al., 2002).

The prospective variable system allocates the risk between the provider and the payer. The prospective variable system shares the risk between payer and provider. This is because increased activity yields larger reimbursement. However, the reimbursement level per unit is prospectively fixed. This incentivizes a profit-maximizing provider to increase the activity until the marginal revenue is offset by the marginal cost (Jegers et al., 2002).

3.3 Theoretical Model - DRG price refinements in ABF systems

In ABF financing systems, DRG prices/weights can be refined between two treatment alternatives for the same diagnosis because they have different resource requirements. Refinement means "splitting a single DRG category into two or more DRG categories relating to the same primary diagnosis" (Hafsteinsdottir & Siciliani, 2010, p. 1226). Hereafter the DRG prices/weights are referred to as the DRG prices.

Using their model, Hafsteinsdottir and Siciliani (2010) theoretically analyse the providers incentive when DRG prices are unrefined or refined. By doing so, they identify when it is optimal to refine DRG prices or not.

This section presents the model analysing the providers' incentive when DRG prices are refined. This study only presents the model for refined DRG prices, as the DRG prices for emergency patient with R07.4 or R10.4 are currently refined. Readers with interest of the unrefined model are referred to Hafsteinsdottir and Siciliani (2010).

Model Assumptions

In model by Hafsteinsdottir and Siciliani (2010) it exist two treatments for the same diagnosis. One more resource demanding surgical treatment ($\bar{\theta}$) and one less resource demanding medical treatment ($\underline{\theta}$). DRG prices can be refined or not refined for these two treatments. Both costs and benefits of the treatment depend on the severity of the patient's illness. Benefits are also dependent on which treatment the patient receives.

The general assumptions Hafsteinsdottir and Siciliani (2010) implement in their model are the following: First, that the given DRG price are based on the average cost of a sample of hospitals, which are semi-altruistic (taking into account patients' health benefit when providing treatment). Hospitals level of altruism is denoted α. Secondly, they assume that all hospitals are identical and that they cannot dump patients. In addition, only the providers have knowledge about the severity of the patient's health state.

Benefits (b) are a positive function of severity of illness, resulting in that the difference in benefit of the two treatments increases when patient's severity increases. Further, the patients with highest severity of illness ($\bar{s}$), benefit more from intensive treatment than the less intensive treatment (Hafsteinsdottir & Siciliani, 2010).

Costs (c) are assumed to increase with increasing severity of illness. However, severity have a larger impact (the function has a steeper positive slope) on the medical treatment costs than on the surgical treatment costs. For low severity patients($\underline{s}$), the model assume that costs are lower when providing medical treatment compared to surgical. Low (high) severity patient have higher net benefit from medical (surgical) treatment than surgical (medical) treatment. Net benefit are benefits minus cost, and cost can never exceed benefits (Hafsteinsdottir & Siciliani, 2010).

In the three models below, the vertical line A, B, C and D marks the point where the net benefit for providing the two different treatment are equivalent for both treatment options, given an altruism level of the hospital equal one. A and B respectively displays the concomitant benefit of the surgical and medical treatment. C and D shows respectively the corresponding cost of the surgical and medical treatment. In Figure 3 and Figure 5, E displays the point when a hospital with zero altruism is indifferent between providing the medical and surgical treatment.

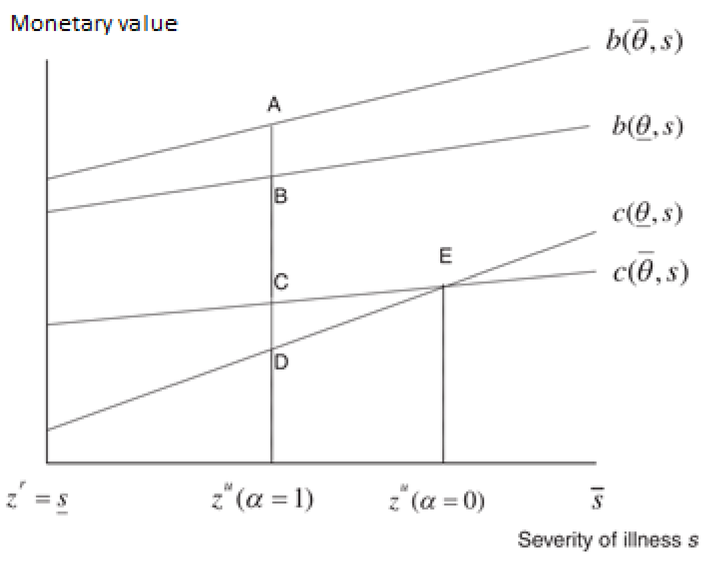

Figure 3: In this figure, medical treatment is always less beneficial than surgical treatment independent of severity of illness. However, the cost for medical treatment is assumed larger than surgical treatment at a high degree of severity (Hafsteinsdottir & Siciliani, 2010).

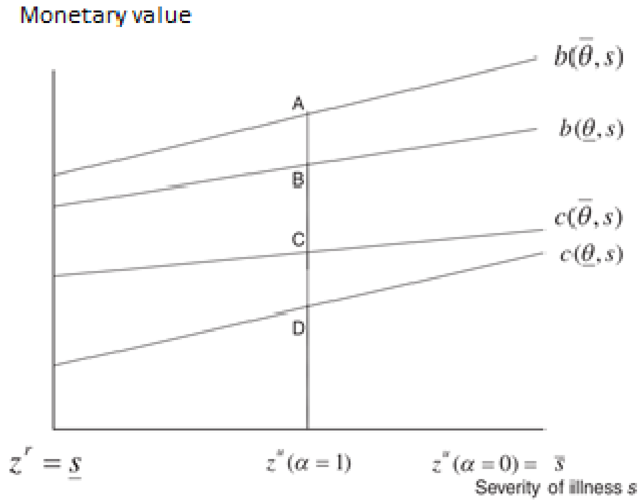

Figure 4: In this situation, benefit of the medical treatment is always lower than benefits of surgical treatment independent of severity of illness. The same assumption holds for the cost relationship between the two treatments (Hafsteinsdottir & Siciliani, 2010).

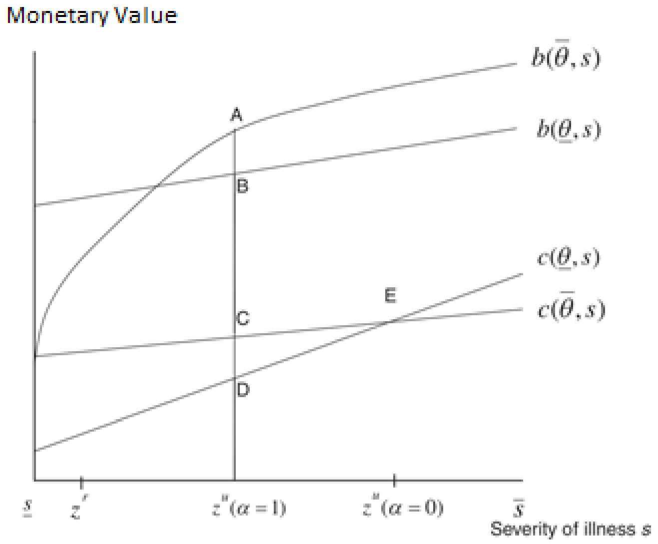

Figure 5: The figure assumes that surgical treatment for low severity patient have less benefit and are more costly, than treating these patient with the medical treatment (Hafsteinsdottir & Siciliani, 2010).

Hospital Incentives - Refined DRG Price

When the DRG prices are refined, the hospital receives different income for the two different treatments. Given that the assumption in Figure 3 and 4 holds, meaning the benefits with surgical treatment always exceed the medical treatment. Supplemented with that DRG prices are based on average cost. Then, costs increases when severity increase and the optimal point of substitution (OPS)[4] equals z^r. Then, the average cost for surgical treatment (hospitals marginal revenue) in the severity range z^r-$\bar{s}$ always exceed the marginal cost at severity z^r. However, the effect is opposite for the medical treatment at severity z^r. Since that is the most severe health state before the OPS to surgical treatment, i.e. marginal revenue never exceeds or equals the average cost for medical treatment. Hence, under these conditions the hospital has an incentive to always provide surgical treatment (Hafsteinsdottir & Siciliani, 2010).

The incentive under refined prices changes if the hospital is altruistic enough, given the assumption in Figure 5. That the benefits for lower severity patients are higher when they receive medical treatment rather than surgical. Then, the marginal income loss per patient at severity z^r is offset by the marginal benefit gain for a medical treatment compared to the surgical treatment. Thereby incentivizing the hospital to provide medical treatments until z^r and at higher severities provide surgical treatment (Hafsteinsdottir & Siciliani, 2010).

When to refine or not – Purchasers perspective

Hafsteinsdottir and Siciliani (2010) also derived the optimal provision of treatments from the purchaser's perspective. Then, they assume that the purchaser can decide which treatment to provide to the patient and that the purchaser finances the treatments through taxes. The taxation imply a societal deadweight loss. Further, it is assumed that the purchaser maximizes social welfare, constrained by that the hospitals at minimum have a revenue equal to the cost of treatment.

The purchaser maximize a welfare function consisting of the total patient benefit of treatment minus the societal transaction cost for financing treatments at the hospital (Hafsteinsdottir & Siciliani, 2010).

The implication of the assumptions make the societal transaction cost equal the hospitals cost. This again yields the optimal number of medical treatment based on severity, at the point where the marginal benefit of the extra treatment equals the social marginal cost. Implying that the marginal cost saved at OPS equal to the marginal benefit lost, when substituting from

[4] The OPS for the hospital are where their marginal benefit is identical to the marginal cost of treating one additional medical patient. Therefore the level of severity where the hospital have an incentive to substitute from one treatment to the other.

surgical to medical treatment. The OPS from the purchasers perspective is denoted as severity z^* (Hafsteinsdottir & Siciliani, 2010)

Hafsteinsdottir and Siciliani (2010) argue that, the OPS depends on the size of the deadweight loss of taxation for financing treatments. When the deadweight loss increases, the opportunity loss of public funds increases. Meaning, the same treatment benefit as previous now has a higher societal cost than before. Ceteris paribus, then both treatment cost relatively more than previous compared to other societal investments. Incentivizing the purchaser to minimize treatment cost. Hence, contracting more of the treatment with lowest cost (the medical treatment) and less surgical treatment.

When the purchaser choose to refine prices, Hafsteinsdottir and Siciliani (2010) states that the hospital will provide too much of the resource intensive treatment (surgical). The reason for this is that the provider OPS is z^r, which is at a lower severity than the purchaser point of maximum welfare z^*. Notice that at severity z^r the hospitals marginal revenue exceed the marginal cost when providing the surgical treatment. While the social marginal cost exceed the marginal benefit from that treatment. Excess provision of surgical treatment will occur in Figure 3 and 4, when the lowest severity equal OPS for providers ($z^r=\underline{s}$). Given the assumptions in Figure 5, excess provision will be to a less extent, as the hospital have an incentive to provide some medical treatments.

Refine – Purchaser's welfare perspective

In the model, it is welfare increasing from the purchaser's perspective to refine DRG prices if the marginal net benefit from providing a medical treatment is less than a surgical treatment between the severity range z^r and z^u. Thus, providing the surgical treatment increases total welfare.

Assume that the provider considers refining DRG prices and that the provision of surgical treatment already are at a higher level than optimal from the purchaser`s perspective ($z^* > z^u$). Ceteris paribus, refining would yield a higher DRG price for the surgical treatment. Causing the existing overprovision to increase. Hence, refining DRG prices will decrease welfare in this situation.

The opposite situation can also be the case, where medical treatments are overprovided. Implementing refinement in this case can lead to overprovision of surgical treatments.

However, the suboptimal overprovision of surgeries may yield a larger welfare than overprovision of medical treatments. If the purchaser shall refine or not refine, depends on which option that minimizes welfare loss.

Study Conclusion:

The conclusion of Hafsteinsdottir and Siciliani (2010) study is that DRG refinement are not always optimal from a welfare perspective. They find that under refinement, providers are incentivized to oversupply the more resource demanding treatment alternative. When there is no refinement, both under and over provision of the most resource demanding treatment may occur. If overprovision of the most resource demanding treatment exist before refinement, then in theory refinement of DRG prices will increase the incentive for this treatment and increase the welfare loss.

3.4 Cost-Benefit & Cost-Minimization Analysis

The CBA and CMA are two types of economic evaluation. Drummond, Sculpher, Claxton, Stodart, and Torrance (2015) explain that economic evaluations always compare the input and output of two or more alternative options. Then, prioritization decisions can be based on transparent criteria, which are systematically valued and judged. The difference between a CBA and a CMA is that in the CMA benefit are considered identical for the compared options. Implying that the option that has the lowest cost is the optimal option. However, in the CBA benefits can be different for the alternative options (D. Yin & Forman, 1995).

Both the CBA and the CMA are economic evaluations where all costs and benefit of options are measured in monetary benefits. Both analyses can compare options across sectors. The result can be presented as the incremental difference between benefits and cost (net benefit) (Drummond et al., 2015), see e.g. the CBA study of Cavassini, Lima, Calderon, and Rudge (2012). Result can also be presented as a ratio between cost and benefits (Drummond et al., 2015).

In the two analyses the main rule for monetary valuation of costs and benefits are to assign them their market value (price). However, markets do not always exist or the market can suffer from market failure. Then, the willingness to pay for a benefit or the willingness to avoid a cost/adverse effect are measured by performing hypothetical valuation of the different benefits/adverse effects. Benefits in healthcare often have to be valued by performing this type of valuation study (Drummond et al., 2015). Still, Drummond et al. (2015) emphasizes that in all economic evaluation there will be normative judgements undertaken. In this thesis, Drummond et al. (2015, pp. 42-44) checklist for economic evaluation are used to perform the CBA and CMA.

4 Data and Research Method

This chapter provides a description of the data in the conducted analysis. Followed by a description of the research method with the confounding assumptions and justification of necessary normative choices.

4.1 Data

The cost-benefit analysis of outpatient treatment compared to inpatient treatment for patient with either unspecific chest or abdominal pain in this thesis utilizes several data types from SUS.

The benefit calculations uses unidentifiable patient data from SUS's hospital record. The data contains patient diagnosed with R07.4 and R10.4 from 2014-2016, and the variables are respectively patient`s DRG weight, DRG description, length of stay, year, clinic and department. The dataset was attained through an internal application process to the patient safety representatives at SUS.

Table 1 below presents the key descriptive statistic for the benefit calculations from year 2014-2016. The table lists the patients groups according to their diagnosis, the type of patient (medical or surgical) and the patients pathway. An example is the patient group with the diagnosis R07.4. In that group, all patients are medical; hence, it is not differentiated between types of patient for this diagnosis. However, the hospital receives different reimbursement between the patients grouped as ambulatory, day and inpatient. The last group is the weighted average of the ambulatory & day patients. This cluster is hereafter denoted as the outpatient group. The R10.4 patients distinguished between surgical or medical patients, as their pathways differs. See the definition of the three different patient groups in section 2.2.

All averages in the table are per patient. Table 1 displays that the average LOS for inpatients are relatively low for all the three types of inpatients (1.17-1.36 days). Knowing that the duration inclusion criteria for the inpatients are that their LOS are between 1.0-2.9 days (see Appendix 1). Implying that when these patients stay overnight, their average stay are just more than a day.

Of all the patients diagnosed with R07.4, 2038 patients received inpatient treatment and 160 outpatient treatment, in the period 2014-2016 at SUS. The medical R10.4 patients are the smallest group, in total less than 500 patients during the three years. This group had approximately 16% ambulatory patients, 32% day patients and 52% inpatients. The number of surgical R10.4 ambulatory patients is only about 150 patients less than the number of inpatients (1128). The majority of the surgical R10.4 patients were provided outpatient care.

The average DRG price (reimbursement hospital receive) per patient in the table, ranges between 896.97 NOK and 11,552.37 NOK. The average incremental difference in reimbursement between inpatients and day patients ranges from approximate 4000-9000NOK. The average incremental reimbursement difference for medical R10.4 is the highest among the patient groups. It is about 9000-10,000 NOK more for the inpatients treatment relatively to the two other groups.

Table 1 shows that more than 50% of every patients group (a given diagnosis, type of patient and pathway) are between 25-65 years old. Later in the study, these patients are used to estimate the employment rate.

Table 1: Descriptive statistics of the final sample (2014-2016). All averages displayed in the table are per patient.

Diagnosis	Type of Patient	Pathway	Average length of stay	Average DRG weight	Average DRG Price	Number of patients	Number of Patient 25-65 years of age
R07.4		Ambulatory	3.33 hours	0.046	NOK 967.91	575	452
R07.4		Day	9.68 hours	0.145	NOK 3,081.25	685	517
R07.4		Inpatient	1.17 days	0.327	NOK 7,158.42	2038	1411
R10.4	Medical	Ambulatory	2.16 hours	0.053	NOK 1,126.33	159	96
R10.4	Medical	Day	8.78 hours	0.121	NOK 2,572.50	77	48
R10.4	Medical	Inpatient	1.36 days	0.54	NOK 11,552.37	244	138
R10.4	Surgical	Ambulatory	3.19 hours	0.042	NOK 896.97	987	486
R10.4	Surgical	Day	8.50 hours	0.134	NOK 2,864.55	505	269
R10.4	Surgical	Inpatient	1.29 days	0.48	NOK 10,236.70	1128	588
R07.4		Ambulatory & Day	6.78 hours	0.099	NOK 2,116.82	1260	969
R10.4	Medical	Ambulatory & Day	4.32 hours	0.075	NOK 1,598.17	236	144
R10.4	Surgical	Ambulatory & Day	4.99 hours	0.073	NOK 1,562.93	1492	755

Other data the analysis use to estimate benefits are empirical data based on the number of surgical and medical hallway patients at SUS, the number of surgical and medical patient treated at the AED and the number of medical patients seeking care at the AED. These data are important to support the assumption that increasing number of outpatient treatments decreases the number of hallway patients.

The costs are estimated in collaboration with SUS clinicians and analytic staff based on their expert opinion in combination with SUS internal cost data. This was the best possible approach, because accessing detailed patient records required approval from the regional ethic committee. Acquiring that approval was not feasible within the timeline of this thesis. On the other hand, it is not given that retrospective cost analysis of patient records is a more objective approach than expert opinions. Note that patient's records are designed for medical purposes and is therefore not cost journals.

4.2 Research Method

The purpose of this section is to describe the research method applied in this study. It contains a stepwise description of the calculation that provides insight into the reasoning and assumptions behind the analysis.

4.2.1 Study Design & Perspective

The study design is both a CBA and a CMA based on retrospective direct monetary benefit data from 2014-2016.

The CBA applies one perspective. Namely Stavanger University Hospital's perspective, hereafter the hospital perspective. The hospital perspective aims at allocating resource that maximizes the utility from the hospital's perspective.

The CMA has a social perspective. The social perspective aims at maximizing the welfare for the society as a whole, therefore a more macro economical perspective (Tande & Munch-Ellingsen, 2010). Applying these two perspectives will enable this research to state whether the optimal from both perspective coincide. Thus, if SUS have an incentive to provide the optimal treatment from society's perspective as well as from their own.

4.2.2 Choice of Analysis

The choice of analysis arrived at a CBA from the hospital perspective. The reason for this is that, first to not treat these patients is not an option. As a public hospital, SUS cannot dump these patients, even if they consider them unprofitable. The second aspect is that from the hospital perspective, benefits (ABF) variates dependent on whether they provide inpatient, day or ambulatory services. According to SUS the health outcome of the two treatment can be considered equivalent (Stavanger Universitetssykehus, 2016), excluding the necessity of a cost-effectiveness analysis. That reimbursement for SUS is different at the different paths makes a CMA unsuitable and a CBA preferable.

The reason for applying a CMA from the social perspective is that when we impose that SUS cannot dump patients and that the patients' clinical benefit are identical when providing outpatient and inpatient treatment. Then, the optimal option for society's welfare is to minimize costs.

It is important to specify that a CBA (CMA) aim to identify all direct and indirect costs and benefits (costs) in monetary value. However, due to the nature of some costs and benefits of being intangible, it is difficult to identify their monetary value. Combined with that this research's timeline is too short to perform any valuation study. Therefore, the nature of some costs and benefits excludes them from the analysis in this thesis. However, the large incremental cost and benefits are likely included. Potential non-monetary costs and benefits excluded from the analysis are discussed in the Discussion section below.

4.2.3 Scope Limitations & Definitions

The scope of this research is limited to evaluate the research question from an economic perspective. Excluding the medical perspective, and more precise any incremental differences in patient health outcomes. Researching from both a medical and an economic perspective are not feasible within the timeline of the research. Thus, this study assume identical health gain for both outpatient and inpatient treatment.

Note that the block grant SUS receive is not included in the analysis. This is because the grant is provided independent of activity, thus not causing any incremental difference in hospital benefit whether SUS decide to provide outpatient or inpatient treatment. Consequently, not affecting SUS's incentive to provide any of the pathways.

Another scope limitation is that it only concerns patients diagnosed with unspecific chest or abdominal pain. Additional diagnosis could have be included, if the duration of the study were longer.

Within the economic perspective, the research will be conducted from cost-benefit theory's perspective, thus to a less extent focusing on Incentive theory. Still, I recognize that it may be equally valid and relevant to assess the research question at hand, mainly from Incentive theory's perspective. However, the discussion of the result will integrate Incentive theory to evaluate the result.

Incentive is according to Dictionary.com (2017) something (e.g. a reward) that motivates to action and effort to increase output. This master thesis is limited to view incentives from a purely economic point of view. However, an incentive to treat patient at the AED may arise from a bundle of other non-financial factors. Healthcare personnel's intrinsic motivation for providing patient best possible care and motivation from treating patient faster etc. shall not be underestimated. Therefore, it is underlined that this thesis only concerns the financial incentives for Norwegian hospitals to treat patients diagnosed with R07.4 or R10.4 as outpatients at the AED, instead of hospitalizing them for one or two nights.

The incentive relevant for this research is the difference between average benefits and cost/investment for treating a patient with a given diagnosis. The technical definition of an incentive to shift patients diagnosed with R07.4 and R10.4 from inpatient to outpatient follows equation 1. Where C denotes the estimated average cost/investment of treatment for a patient. B denotes the average benefits the hospital receive from the specific activity/patient treatment. ICD denotes the patients´ diagnosis, T and P respectively denoting the type of patient and the patient's pathway.

$$Equation\ 1: \qquad \left(B_{ICD}^{T,P} - C_{ICD}^{T,P}\right) > \left(B_{ICD}^{T,P} - C_{ICD}^{T,P}\right)$$

Verbally, in this thesis the incentive for SUS to substitute clinical practice to treat patient at the AED instead of hospitalizing them, are defined as when the average net benefit for outpatients are larger than the average net benefit for inpatients.

4.2.4 Population

As mentioned the population in this study are emergency patient diagnosed with R07.4 or R10.4 at SUS. Typically, these patients would stay at SUS from 1 hour until 2.9 days; hence, only patients staying within that range are included in the study. The severity of these patients are on average relatively low, and according to SUS patients benefit equally from outpatient and inpatient treatment (Stavanger Universitetssykehus, 2016). This is an assumption in this study. In addition, as described in section 4.2.6 several of the R07.4 and R10.4 patients receive imaging services in their treatment. SUS do not normally perform e.g. CT coronary angiography in weekends, thus patients may have to wait up to 72 hours for imaging services. Further, as Table 1 states, the revenue SUS receive varies between these patients. Hence, retrospective income data per patient is useful to determine expected benefits.

The patient groups assed are ambulatory, day and outpatient vs inpatient treatment, for respectively R07.4, surgical and medical R10.4 patients. The analysis differentiates between the two outpatient groups, ambulatory care patient and day care patients, since they have incremental differences in revenue for SUS.

4.2.5 Time-horizon

The time-horizon of the CMA and CBA covers the duration of the treatment pathway. With no access to patient journals, modelling e.g. readmission cost over longer time durations is not possible. First, since the data at hand do not have readmission rates for the final sample. Secondly, the nature of the diagnosis is not chronic for the patient population; it is a short-term incident with relatively low severity. Hence, not likely to cause long-term consequences. The short time-horizon justifies that no discounting is applied in this study.

4.2.6 Patient Treatment Pathways:

This section presents the different treatment pathways for R10.4 and R07.4 emergency patients at SUS. This will enable the reader to understand what treatment the different patient receives and what the CBA and CMA in this study actually compares.

Patients Diagnosed with Unspecific Abdominal Pain - R10.4

In general, the pathway starts when the patient with unspecific abdominal pain arrives the AED. First, the patient registers to the secretary (see path diagram Figure 6 on p.30). Secondly, a nurse triages these patients to be able to prioritize the patients with the most emergent health state first. The triage consist of a nurse registering the patient’s blood pressure, heart rate, performs ECG, measures the body temperature and takes a urine test. This is supplemented with a short conversation with the patient to map the patient’s general health state and the health state during the last days. In addition, SUS has placed a MD with the nurse to perform the triage. They have done that to sort out the patients that do not need further medical examination. Then, these patients avoid unnecessary waiting time and can be “fast-tracked” directly to the “Discharge Conversation” and return home, normally without any follow-up consultation (Sigmo, 2017c).

In the examination (step 3, Figure 6), the R10.4 patients follow two different pathways, depending if they are surgical or medical patients. This determines the care that is provided in the following examination. About 30% of these patients are medical and 70% surgical at SUS. According to Sigmo (2017c) the path the patient follows depends roughly if the pain is situated in the upper abdomen (medical path) or the remaining parts (surgical path).

Normally the medical outpatients (3a) receives an examination comprising anamnesis, blood tests, clinical examination, ECG test, urine test, X-ray scan (e.g. CT scan or ultrasonography of the abdomen). If the MD cannot find any pathologic evidence for what causes the abdominal pain or find a gastro intestinal bleeding (indicated by the decision-making support algorithm “Glasgow-Blatchford Bleeding Scale”). Then, the patient receives the “Discharge Conversation” (4a) and return home without any follow-up consultation (5a). However, if there is a stabile pathological cause, the patient can receive the “Discharge Conversation” and return home with a follow-up consultation within few days for e.g. a gastroscopy (5b) (Sigmo, 2017c). The percentage receiving a follow-up consultation are by MDs at SUS estimate to be 35% (Sigmo, 2017a).

The medical inpatients receive the same examination by the MD (3a), though the patient will be admitted to the ward before all the results of the examination are ready (4b). Then, the patient will await the results of the examination until the MD at the ward has examined the test results or decided upon further examination, e.g. the next day. The LOS for these patients are normally one night (sometimes two) at either the Gastro Medical Department or the Observational Ward. Further examinations normally consist of control blood tests and haematuria test, in addition to gastroscopy. These examinations are normally conducted within one-day, though if the patient needs a colonoscopy or involvement of other departments, it may take two nights. The final step of the medical inpatient path is the “Discharge Conversation”, which is almost equivalent for in- and outpatients 5b) (Sigmo, 2017c).

There are few differences between the examination for the medical (3a) and surgical outpatients (3b). The main difference is that the surgical examination more often includes an ultrasonography or CT scan of the abdomen than the medical examination. If the surgeon considers it necessary, a gynaecologist will examine the patient as well. When these patients are treated as outpatient, usually they return home without a follow-up consultation after they are declared “good to go” (5d) (Sigmo, 2017c).

The surgical inpatients in general receive the same examination at the AED as the surgical outpatients (3b), though they are admitted to the ward before all the results of their examination are ready (4d). They are usual admitted to the Gastro Surgical Department or Observational Ward for a one-night stay. The surgeon at the ward will examine the results of the tests at the AED and decide upon further examination. Further examination normally consists of control blood tests, clinical observations, X-ray, ultrasonography and CT, possibly also involving other departments such as the Department of Gynaecology. When it is clinical feasible the patient will be discharged and return home, step 5f) (Sigmo, 2017c).

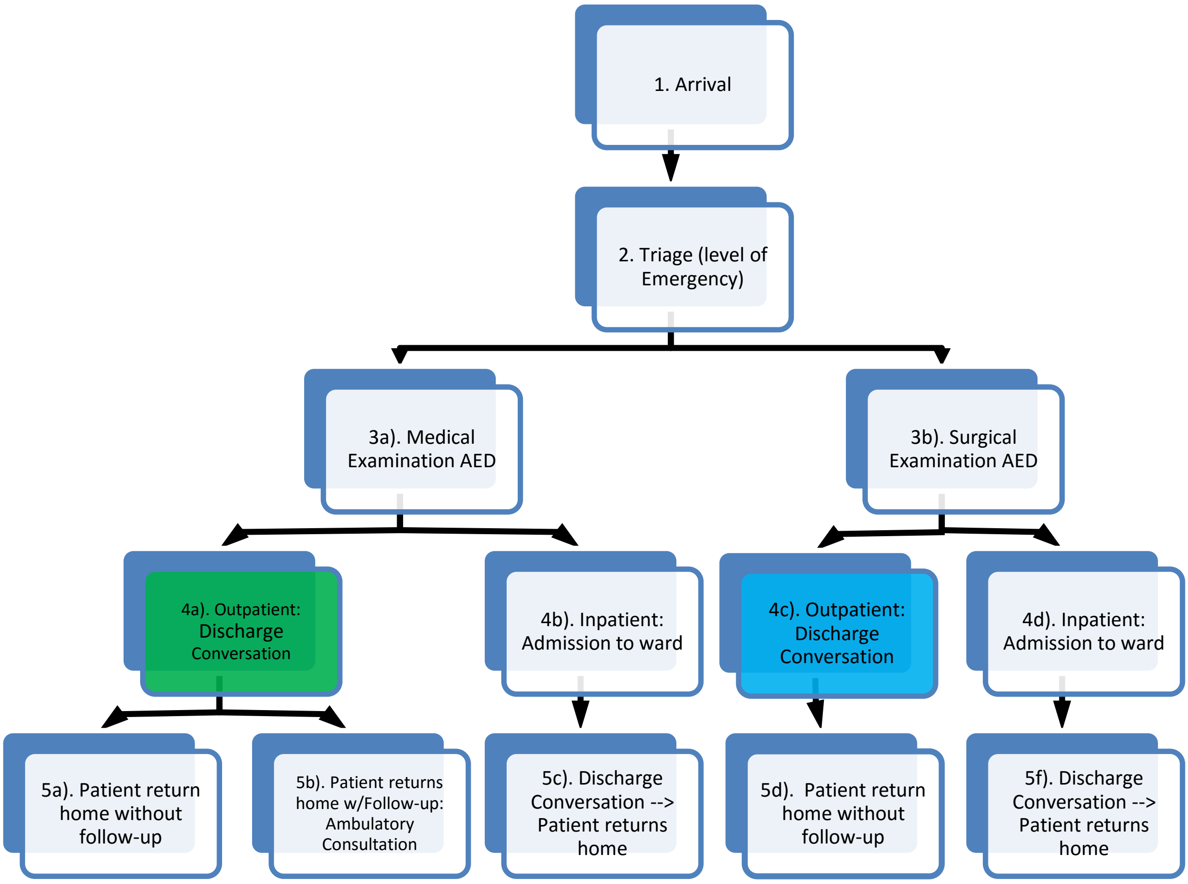

Figure 6: The figure depict the patient pathway for emergency patients diagnosed with R10.4 at the AED at SUS.

Patients Diagnosed with Unspecific Chest Pain - R07.4

Sigmo (2017b); (2017c) explains that patients diagnosed with chest pain follows about the same procedure in Step 1 and 2 as the patients diagnosed with R10.4 (see illustration of R07.4 pathway in **Error! Reference source not found.**Figure 7).

How time consuming the medical examination (step 3) at the AED is, depends on whether the MD decides to admit the patient to the Cardiac Ward or to discharge the patient safely the same day (Stavanger Universitetssykehus, 2016). For both the outpatient and the inpatient path, the medical examination normally includes anamnesis, assessing clinical discoveries, taking a blood test, X-ray of the Thorax and an arterial blood gas (ABG) test. If necessary, the patient also receives a CT lung scan and an Echocardiography. If the MD can exclude any pathological emergency (e.g. heart attack) or an unstable pathological cause, the path continues to 4a). Since 20th of April 2015, SUS MDs have focused on increasing the number of patient taking the pathway 4a). At 4a), the MD informs the patient about the clinical findings, medications and schedule potential follow-up. At SUS, they use a decision-making algorithm as a support tool to decide the further pathway for the patient. Most patients that take the outpatient path do not need further follow up and take path 5a). Those that do have a stabile pathologic cause receives an ambulatory consultation within few days, path 5b) (Sigmo, 2017b).

However, if the MD makes the decision to treat the patient as inpatient; then the MD will not examine all the results at the AED, as the MD do with outpatients. That implies that the patient is admitted to the ward before all the results from the AED are ready. The patient awaits the result at the ward. These patients are normally admitted for one and sometimes to nights, either at the Cardiac Ward or at the Observational Ward. Often the MD at the ward have to examine the test result from the AED and evaluate the need for further assessment of the patient the day after the examination are performed. Further examination may vary at the ward, though the standard examination consists of observation of development in the patients' health status and equivalent examination as provided to the outpatient. In addition, examination at other departments, may in some cases be necessary, e.g. with gastroscopic and lung examination. The final step in this branch is 5c), the discharge conversation were the patients are informed about their health state and possible medications (Sigmo, 2017b).

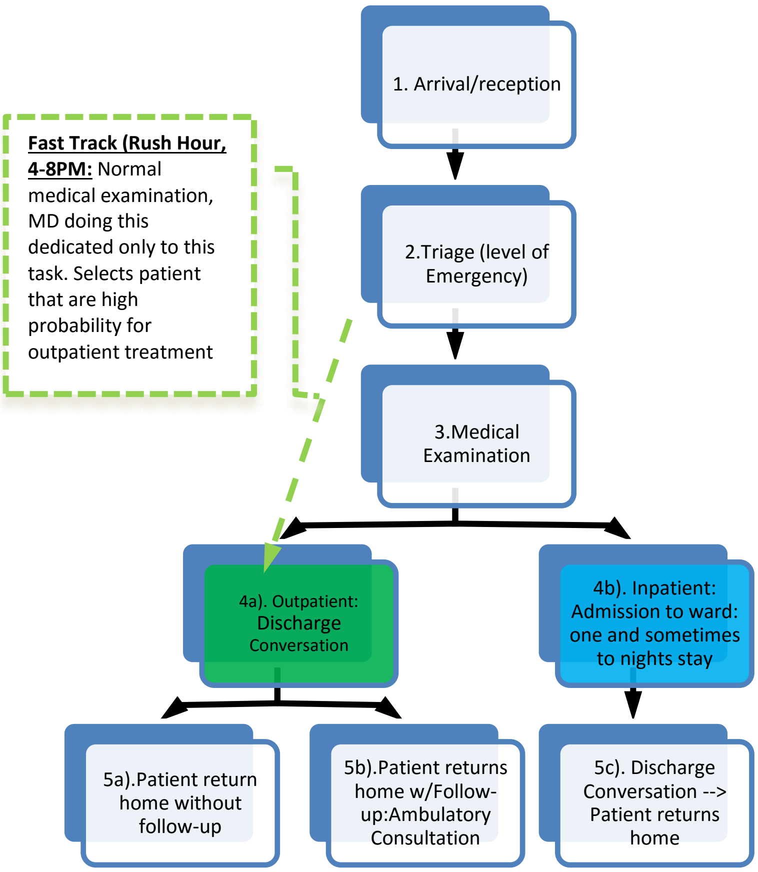

Figure 7: The figure illustrates the patient pathway for emergency patients diagnosed with R07.4 at the AED at SUS.

4.2.7 Cost Parameters

This study calculates average cost per patient. Despite that, the optimal situation in theory when performing this analysis is to use marginal cost per patient. Then, it is possible to estimate the extra cost the marginal patient imposes on the hospital and compare it with the hospital marginal increase in revenue. However, deriving those costs are a great challenge within this research's timeline, as it requires access to more data.

Another aspect that justifies the use of average cost are that SUS's annual salary cost for only nurses at the AED are about 62 million NOK, while cost of goods are only 6 million NOK (see Appendix 2). The fixed costs (salary) are high relatively to the variable cost (goods). However, hospital AEDs will always have large initial cost due to that they have to be in emergency preparedness for the unexpected. Therefore, the number of staff will not necessarily change in the same pace as the patient number increase. Assuming that cost of goods is dependent on the number of patients, i.e. in this example the cost of goods equal the marginal cost per patient. Given that, SUS's AED marginal cost is that low for compared to the average cost as in the example above. Then, the hospital will not cover its cost, if the marginal cost of patients do not excessively exceeds the average cost at a given number of patients. Therefore, to determine the hospital incentive the analysis have to compare average cost per patient with marginal revenue, since the hospital have to retain its cost.

4.2.8 Outcomes

The analysis considers two categories of results, which all are given in 2016 Norwegian kroner. The first category, are the four intermediate results; total opportunity loss for not maximizing net benefit in 2014-2016, potential societal cost saving if minimizing cost from 2014-2016, average costs and benefits per patient.

The second category is the end results. The primary results are the average difference between benefit and cost per patient (net benefit) and the average incremental net benefit per patient pathway compared to the inpatient treatment. Secondary outcomes are the following; SUS's average annual total opportunity loss when not maximizing net benefit, average annual social cost savings when costs are minimized and the hospital's cost-benefit acceptability curve (CBAC).

4.3 The Analysis

The following section describes the cost and benefit calculations. Note that all costs and benefits are measured in 2016 Norwegian kroner.

4.3.1 Cost Calculation

The cost calculation is largely based on average cost of the treatment paths described in section 4.2.6. The elaboration of cost calculation in this subchapter refers back to that description. An overview of all calculations are provided in Appendix 2, Appendix 3 and Appendix 4.

The analysis assumes that the ambulatory and day patients have identical costs. This is because the patient with highest severity receives treatment first at the AED. Meaning that the cost do not necessarily increase as the LOS increases. The treatment the two outpatient groups receives are identical and independent of their LOS.

Independent of diagnosis, the cost at the arrival at the AED for each patient is identical. This consist of the salary cost, estimated to be 161NOK. At this step, the secretary spends about 30min on admitting the patient into the hospital system and arranging associated practicalities. This cost is considered relatively standardized and were estimated by combing time consumption and salary cost.

The cost of the triage and medical examination has a small discrepancy between the two diagnoses. However, similarities between them are costs of blood tests, salary cost for medical doctors, nurses, X-ray, cleaning of room and bed and cost of treatment related goods. The discrepancy is that the R07.4 patients receive a CT of the thorax, while the surgical R10.4 patients´ have costs of CT/ultrasound and a gynaecologist visit. Cost calculation of blood test, X-ray, CT and treatment related goods are all based on SUS cost of goods and services accounting. They are calculated as an average cost of the total number of services purchased or provided. Salary cost for doctors are estimated assuming that all involved MD spends together about 2 hours in total and an estimated salary cost of 500NOK per hour. Nurse salary costs are calculated through annual total nurse salary cost at the AED and the number of patients treated at the AED. Hence, the cost are average salary cost per patient at the AED. Cost bed cleaning, are derived from accounting records from the department responsible for cleaning beds (*Driftsservice*). The analysis assumes that cleaning personnel spends 10min for cleaning activities per patient. In the sensitivity analysis, MDs and nurse salary costs are assumed to have a standard error (SE) at 50%, and the rest of the costs at 25%, as these are more standardized tasks.

Independent of the diagnosis, all outpatients receive the discharge conversation and therefore the confounding cost of it. This cost consists of the time the MD/surgeon spends analysing the test results, preparing prescriptions, providing the patient with health advice and answering questions from the patient etc. The secretary also spends 30min on the discharge and solving related logistic issues. Both costs are estimated multiplying assumed time spent on the task and the corresponding salary cost per hour. However, for inpatients the discharge conversation cost less, as SUS MDs argue that they spend more time discharging an outpatient. Discharging the outpatient, the MD has to interpret the test results and arrange more logistics, which they do not do for the inpatient. Consequently discharging outpatient is more costly.

Follow-up consultations are provided some days after the outpatients are discharged. Assuming that only 35% of the patients receive follow-up, the estimated average cost per R07.4 patient is approximate 231NOK. The assumption that 35% of all outpatients in the AED receive follow-up is based on the opinion of MDs working at the AED at SUS. Gastroscopic follow-up consultation are provided when necessary to R10.4 medical patients. The cost of these consultations consist of treatment related goods, secretary, MDs, registered nurse and certified nursing assistant. The cost is in average 232NOK per patient. Since surgical patients treated as outpatient do not receive a follow-up consultation, they do not have a follow-up cost.

The cost of admission to a ward for all patients consist of the salary cost for SUS of employing nurses at the ward, cost of treatment related goods, cost of a MDs patient visit and cost of porter services. The porter spends about 20min on transporting each patient on average and the MDs spends approximate 30min on average on a patient visit. Nurse salary cost are based on the respectively wards annual total nurse salary cost, divided by total number of stay at the given ward in 2015. This is multiplied by average LOS for the given patient group at the ward (see Table 1). Further, the cost for echocardiography, ECG cycle test, CT coronary angiography and other examination as e.g. spirometry are attributed to R07.4 patients. These costs are derived based on a combination of cost of goods and salary costs. R10.4 medical patients may be provided a gastroscopy or ultrasound at the ward. These cost items are based on assumptions about the percentage of patients receiving them, supplemented with the assumptions about the time usage of personnel to provide the service and treatment related goods consumption (again see Appendix 2, 3 and 4). Surgical patients may be provided ultrasound and a CT scan of the abdomen. The costs of these services are based on average cost per service.

The analysis assumes that MDs have to admit 12,5% of all patient, which they originally attempt to discharge. Thus, these patient receive a discharge conversation, while in the end receiving inpatient treatment. This is a cost, which is attributed to the inpatients. Causes for this can be sudden emergent events at the AED, logistics (to late for the patient to go home) and e.g. that the patient is afraid to go home etc.

4.3.2 Hospital Benefit & Social Cost Savings

The hospital benefit calculations uses two different approaches, one for direct and another for indirect benefit confound with the different patient pathways. For an overview of the calculation in this section, see Appendix 5.

Direct Hospital Benefits

The calculation of average direct benefits per patient utilizes the patient data from SUS. To find the correct average for the analysis population, a three-step selection procedure are in place: It starts with selecting the relevant DRG-descriptions. Second, excluding the non-relevant clinic (department, ward) at SUS. At last, the step mentioned previous, only including patients staying from 1 hour until 2.9 days. A SUS MD took part in deriving all the selection criteria, such that the sample is valid according to clinical practice. See a comprehensive overview of the inclusion criteria for each patient group in Appendix 1.

The criteria aim to avoid biases and inclusion of patients that are irrelevant for this study. Through the filtering process, the high severity patients are excluded. Excluding these patients are crucial for the validity of the assumption that patients health outcome are identical for all treatment pathways. The selection criteria's target to maintain comparable patient groups, thereby avoiding comparing apples with oranges. Patients with a LOS of less than an hour at the hospital are likely to be attending a scheduled outpatient consultation. Since this examination are less than an hour, it is likely not involved in any of the pathways this study analyse. Therefore, these patients are excluded.

Calculations of the hospital ABF revenue per patient are according to Equation 2 below. That yields SUS's average ABF revenue for each patient group (see Table 1).

$$Equation\ 2: \quad ABF = \sum DRG\ weight \times Unit\ Cost \times 50\%$$

Another direct benefit for SUS is the out-of-pocket payment all patients pay, when they are provided an ambulatory follow-up consultation. In 2016 that payment was 320NOK (Stavanger Universitetssykehus, 2016). As it is assumed that 35% of all R07.4 and medical R10.4 outpatients receive a follow-up consultation. The average out-of-pocket payment for follow-up costs per patient is 35% of 320NOK. In addition, SUS receive 320NOK in revenue for all ambulatory patients treated at the AED

Indirect Hospital Benefits

As most indirect benefits are intangible values, they require valuation studies. Due to the timeline of this thesis, assessment of literature was the only option to elicit monetary values of intangible benefits. Valuation studies with results representative for this study's context are limited.

Increasing the number of outpatient treatments seems to have an effect in reducing the number of hallway patients and therefore department's occupancy level. Looking closely at Figure 8 below; when more people receive treatment at the AED, the number of hallway patients reduces, even when the total number of patients arriving to the AED are increasing. The graph illustrates that the number of hallway patients decreases after the start of 2015 until today, when SUS implements measures to increase the number of outpatient services.

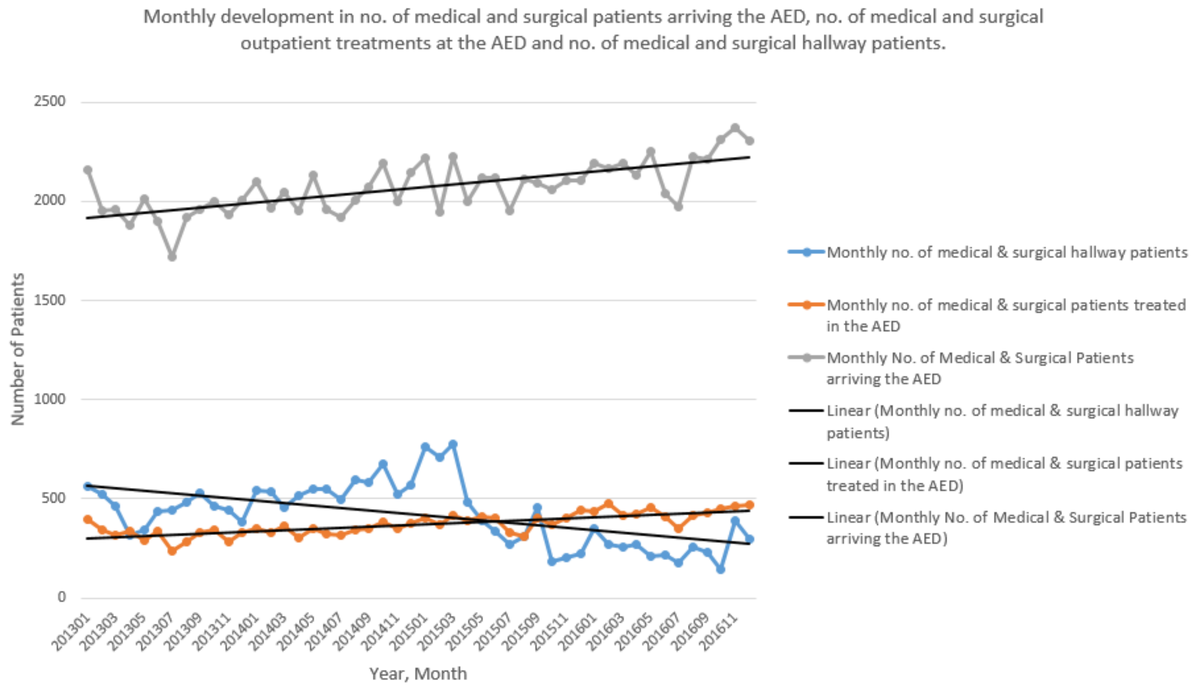

Figure 8: The graph displays the monthly development in the following values at SUS at 2013-2016: The numbers of patients arriving the AED, patients receiving treatment in the AED, hallway patients at medical wards and their corresponding linear development in the period.

Based on Figure 8, this study assumes that outpatient treatments yield an indirect benefit by reducing the number of hallway patients. The value of avoiding one hallway patient equals about 300NOK. This estimate is based on Boardman and Forbes (2011) study. They found the willingness-to-pay (WTP) for a single room in hospital compared to a shared room to be 36CAD in 2008 in Canada. The author of this thesis argues that the WTP to go from being a hallway patient to outpatient/admission in a room is at minimum the WTP Boardman and Forbes (2011) found.

When purchase power parity adjusting and inflation adjusting 36CAD to NOK in 2016, it equals 303NOK (Canada, 2017; OECD, 2017). The analysis assume that every outpatient treatment reduce the number of hallway patient with 0.3 patients. Before making this assumption an interruptive time design analysis and a regression analysis was initiated. However, while performing these analyses it became clear that the data in Figure 8 is insufficient to identify the causal relationship between outpatient treatments and hallway patients.

This reduction in hallway patients is a benefit from both social and hospital perspective. From the social because the contamination risk is anticipated to be higher for hallway patients (Boardman & Forbes, 2011; Larsen, Skretting, & Farstad, 2000). It has also been an explicit goal from the Directorate of Health to reduce the number of hallway patients (Helse- og Omsorgsdepartementet, 2016). From the hospitals perspective it is relevant, as SUS has been given an explicit goal to have zero hallway patients from the RHA in western Norway (Helse Vest RHF, 2016). Supplement this with reducing hallway patient reduces stress for employees and hospital fatality due lower occupancy level of patients (Kuntz, Mennicken, & Scholtes, 2015).

Social Cost Savings when providing outpatient care

In the CMA, it is essential to identify the potential social cost savings confound with providing outpatient treatment. Many of these cost savings are indirect benefits of provision of outpatient treatments, and therefore the same challenges arise as with indirect hospital benefits.

Thayer, Chestnut, Lazo, and Van Den Eeden (2003) WTP and cost of illness study provide findings with high relevance to this thesis. They find patient's WTP to avoid one day of hospitalization to equal $1.600 USD for patient with respiratory and cardiovascular diseases. They also estimate the total social cost for one-day hospitalization of the equivalent patient to range between $4,800-$7,300 USD. However, since their study concern relatively different patient groups than this study, while being in a completely different health care system, it is questionable if these values are representative for patients in this study. SUS clinician's states that some of the patient in this study prefers admission, which contradict Thayer et al. (2003) findings. Preferring admission can be due to attributes as patient feeling safer at the hospital or a long travel distance home. Because of the questionable representativeness of Thayer et al. (2003) for this study, their values are not incorporated in the analysis.

The obvious indirect benefit from a societal perspective is the reduction in resource use, when treating an outpatient compared to inpatient. The analysis estimates this for each diagnosis, by subtracting the average pathway cost of treatment for ambulatory & day patients from the average pathway cost per inpatient. However, this is only a benefit from the societal perspective, as SUS's net benefit not necessarily is higher when costs are reduced.

The last indirect monetary benefit is the labour productivity benefit. The clinicians assisting this thesis at SUS stated that patient treated as outpatient are not prescribed any sick leave due to their treatment. Hence, they are expected to work the consecutive day. Inpatient on the other hand, loses one day of work. Thus, it is a productivity loss when admitting a patient. This indirect loss is mainly from the social perspective, as this do not affect the hospital. The productivity loss was derived by multiplying the average monthly salary with 12. This was divided by 1950 hours, which corresponds to one work year (Statistics Norway, 2017). Then, multiplying the hourly salary with 7.5 hours, yielding the monetary value of the productivity loss equal one workday.

Further, by assuming that only patient between 25-65 years of age are in the work force, the employment rate is estimated (see Table 1). All other patients are considered unemployed. Within the group of patients 25-65 years of age, 10.78% are either unemployed or receive disability payment (NAV, 2017a, 2017b). Multiplying the patient employment rate with the value of a workday, yield the average productivity increase when an inpatient receives outpatient treatment.

4.3.3 Calculating the Results

The average cost and benefit per patient for the different pathways are calculated by summing their respectively costs and benefit (see details in Appendix 2. 3, 4 and 5). Then, the difference between average benefit per patient and the average cost per patient yield the average net benefit per patient for that given pathway. Multiplying the average cost and benefit by the number of patients that were provided that path in 2014-2016 yields the total expected cost and benefit in the period. The difference between the total cost and benefits yields the total net benefit of the sample population for SUS (see Table 3).

Further, SUS's opportunity loss is the difference between the expected total net benefit SUS have gained and the expected total net benefit if they maximized net benefit. The social cost savings are the sum of all the savings if all patient in the period 2014-2016 were provided outpatient treatment.

4.3.4 Probabilistic Sensitivity Analysis and Scenario Analysis

The analysis use both probabilistic sensitivity analysis (PSA) and scenario analysis to investigate the uncertainty in the results.

The scenario analysis, display the uncertainty in the results by changes key input parameters one by one. This study changes the two largest cost items for the inpatient for all diagnosis by a decrease of 20% and 40%. Since benefits are prospectively fixed in the ABF system, it is only relevant to change the percentage of patient receiving follow-up consultation. The analysis varies the benefit parameter by a de- and increasing of 25%. The scenario analysis goes in two directions for the benefit as it can possibly change to a lower and a higher value than the deterministic value.

The scenario analysis only changes inpatient's costs, since the largest costs for ambulatory and day patients are cost for inpatients as well. Thus, changing these parameters do not affect the incremental net benefit between the alternatives. The argument for only decreasing inpatients costs, are that these patients have a low severity, thus when admitted it is plausible that they require less services than the average patient does.

The PSA in this thesis consist of a combination of a Monte Carlo simulation and bootstrapping. The Monte Carlo simulation draws random number within a given distribution and the bootstrapping extends the current sample by drawing randomly with resampling.

Since the prospectively fixed ABF revenue is provided in the data from SUS. Except the probability for receiving follow-up consultation, only the sample composition of patients can vary the ABF SUS retrieve. Hence, bootstrapping the final sample can derive uncertainty within the ABF benefits. In the PSA, the uncertainty was investigated by increase the sample to minimum 1000 patients in each patient group, or to make the sample size of each patient group for a given diagnosis equivalent to the number of patients in the largest patient group for that particular diagnosis. Bootstrapping was applied to do this. For example, increasing all surgical R10.4 groups to 1492 patient, similar to the surgical R10.4 Ambulatory & Day patient group.

In the Monte Carlo simulation, all parameters can vary at the same time. All cost parameters are fitted an Gamma distribution, as Briggs, Claxton, and Sculpher (2006) recommends. The properties of the Gamma distribution constrain the cost to range between zero and positive infinity and reflect the skewness that often are attributed to cost data (Briggs et al., 2006). Since the cost estimate in the deterministic analysis do not have corresponding SE, elicitation of SEs from literature or expert opinion is necessary. In the simulation, the costs SEs are either 25% (relatively standardized cost) or 50% (less standardized cost) after discussing with a SUS MD. Most of the cost items are relatively standardized by nature, while average nursing time use, MDs time use and cost of goods are less standardized costs. In the triage and medical examination, the simulation assumes that costs of goods are dependent on average MD cost per patient. While at the ward, costs of goods are dependent on average nurse cost at the given ward. The analysis considers the two cost items the driver of the cost of goods, since MDs and nurses use the goods when providing services.

The probabilities in the simulation follow the Beta distribution. This is suitable as all the probabilities in the simulation concern binominal option (Briggs et al., 2006). The probabilities for attempting to treat a patient as outpatient while ending up treating the patient as inpatient and the probability of receiving follow-up consultation have both an SE at 25% in the simulation. The *methods of moments* approach described in Briggs et al. (2006) was applied to fit the beta distribution for these two probabilities. To fit the unemployment rate beta distribution is straightforward, α = number of patients between 25-65 year of age for a given patient group, and β = the total number of patients for the given patient group minus α (Briggs et al., 2006).

5 Results & Findings

This chapter presents the results and findings of the two analysis in this study and the results of the PSA and the scenario analysis.

5.1 The Optimal Patient Pathway from the Hospital Perspective

The optimal patient pathway from the hospitals view depends on if one assume that the hospital can control whether a patient becomes an ambulatory or a day patient. If SUS can control this, then the two groups are two separate groups. This assumption is hereafter referred to as the two-group assumption (TGA).

Do we assume that SUS cannot control if a patient become ambulatory or day patient. Then, both ambulatory and day patients are considered as one group (Ambulatory & Day/outpatients), which is referred to as the one group assumption (OGA).

Table 2 below displays all patient groups determinstic CBA results.

5.1.1 The R07.4 Patients

When the TGA holds, the result of patient diagnosed with R07.4 is the opposite of the hypothesis before performing the analysis. The pathway with the highest net benefit is the day patient pathway and not inpatient. The net benefit is -1,586NOK. On average SUS reduces their loss with 1,431NOK per patient if they treat the patient as day patient relatively to inpatient treatment. If they treat the patient within 5 hours (ambulatory patients), they increase the loss with 362NOK per patient when comparing with the inpatient. The net benefit for an average inpatient and ambulatory patient are respectively -3,017NOK and -3,380NOK. Even when the inpatient doubles the cost, it has a higher net benefit for SUS to treat the R07.4 patient through the inpatient path relative to the ambulatory. This is due to that the benefit for SUS is 3.9 times higher when providing the inpatient path than the ambulatory.

However, when we assume that the OGA holds the resulting average net benefit per patient for the Ambulatory & Day patients group is -2,405NOK. In this situation, SUS's optimal way of treatment is to treat the patients as Ambulatory & Day patients. Therefore the average net benefit gain for this group is less than for the day patient group when the TGA holds.

Table 3 shows the total benefits, costs and net benefit for all patient groups from SUS's perspective in year 2014-2016. It shows, that the R07.4 patient group that has the largest negative net benefit is the inpatient group. Logically as that is the largest group. Notice that the 575 ambulatory patient have about 850,000NOK less in total net benefit than the day patient, while the day patients are 110 patients more.

Table 2: Deterministic results of the CBA from the hospital perspective. The areas marked yellow show the pathway with the largest net benefit, and the comparator pathway.

Deterministic Results				
Hospital Perspective				
	Average Benefit per patient	Average cost per patient	Average net benefit per patient	SUS's loss per patient compared if not providing inpatient path
R07.4				
Ambulatory	NOK 1,829.59	NOK 5,209.79	-NOK 3,380.21	NOK 362.24
Day	NOK 3,622.93	NOK 5,209.79	-NOK 1,586.87	-NOK 1,431.10
Inpatient	NOK 7,158.42	NOK 10,176.39	-NOK 3,017.97	Comparator
Ambulatory & Day	NOK 2,804.53	NOK 5,209.79	-NOK 2,405.26	-NOK 612.70
R10.4-Medical				
Ambulatory	NOK 2,043.46	NOK 5,070.63	-NOK 3,027.18	NOK 3,373.96
Day	NOK 3,169.63	NOK 5,070.63	-NOK 1,901.01	NOK 2,247.79
Inpatient	NOK 11,552.37	NOK 11,205.59	NOK 346.78	Comparator
Ambulatory & Day	NOK 2,410.89	NOK 5,070.63	-NOK 2,659.75	NOK 3,006.52
R10.4 Surgical				
Ambulatory	NOK 1,307.88	NOK 5,258.37	-NOK 3,950.49	NOK 2,382.79
Day	NOK 2,955.46	NOK 5,258.37	-NOK 2,302.91	NOK 735.21
Inpatient	NOK 10,236.70	NOK 11,804.40	-NOK 1,567.70	Comparator
Ambulatory & Day	NOK 1,865.53	NOK 5,258.37	-NOK 3,392.85	NOK 1,825.14

5.1.2 The medical R10.4 patients

The medical R10.4 patient's results show that the average net benefit per patient is highest for the inpatients, given that the TGA holds. This is the only patient group in this study with a positive average net benefit, which is 347NOK. The results show that per day patient SUS treat, they suffer a loss at 2,247NOK per patient compared to inpatient. When the average net benefit is -3,027NOK per patient for the ambulatory path, the loss is even greater for SUS than when they provide the day path.

Assuming the OGA is valid, the average net benefit for outpatients are about -2,659NOK This yields a loss at approximately 3,000NOK per patient for SUS when they provide outpatient services compared to the inpatient.

Table 2 shows that the inpatients provide SUS approximate with four and six times higher benefit relative to respectively the day and ambulatory pathway.

According to the results from the analysis, SUS's total net benefit during the three years of the analysis is 84,613NOK for all the inpatients treated, while the net benefit in total is negative 627,699NOK for the two outpatient groups. The ambulatory patients cause about 80% of the loss.

5.1.3 The surgical R10.4 patients

Similar to the medical R10.4, the surgical R10.4 patient's results show that the inpatient path is the path with the highest average net benefit per patient, when the TGA is valid. The net benefit is -1,568NOK. Providing the day path yields SUS a loss at 735NOK per patient relatively to the inpatient. If SUS treat the patient through the ambulatory pathway, the loss increases to 2,383NOK.

When the OGA holds for the ambulatory and day patients, the net benefit loss per patient are closer two the ambulatory loss. This is because most patients in this group receive ambulatory treatment. The average net benefit loss per patient for the outpatient pathway is 1,825NOK compared to if SUS provided the inpatient path.

Notice that the total net benefit for the inpatient pathway is just 1.5 times larger than the day pathway, while the inpatient group is 2.2 times the size of the outpatient group.

Table 3: Total benefits, costs and net benefits for the sample population for SUS (2014-2016).

	Total Benefit from 2014-2016 per pathway	Total cost from 2014-2016 per pathway	Total net benefit from 2014-2016 per pathway
R07.4			
Ambulatory	NOK 1,052,013.39	NOK 2,995,631.55	-NOK 1,943,618.16
Day	NOK 2,481,706.02	NOK 3,568,708.89	-NOK 1,087,002.87
Inpatient	NOK 14,588,859.96	NOK 20,739,476.64	-NOK 6,150,616.68
Ambulatory & Day	NOK 3,533,708.11	NOK 6,564,340.44	-NOK 3,030,632.33
R10.4-Medical			
Ambulatory	NOK 324,909.42	NOK 806,230.81	-NOK 481,321.38
Day	NOK 244,061.16	NOK 390,438.82	-NOK 146,377.65
Inpatient	NOK 2,818,778.28	NOK 2,734,164.66	NOK 84,613.62
Ambulatory & Day	NOK 568,969.74	NOK 1,196,669.62	-NOK 627,699.89
R10.4 Surgical			
Ambulatory	NOK 1,290,877.56	NOK 5,190,015.73	-NOK 3,899,138.17
Day	NOK 1,492,507.30	NOK 2,655,479.17	-NOK 1,162,971.87
Inpatient	NOK 11,546,997.60	NOK 13,315,364.08	-NOK 1,768,366.48
Ambulatory & Day	NOK 2,783,369.28	NOK 7,845,494.90	-NOK 5,062,125.62

5.1.4 SUS's opportunity loss

Of all the patients SUS has treated in the period 2014-2016, they have suffered an opportunity loss when they provided suboptimal pathways (see Table 4). If they allocated all R07.4 patients to the day pathway, then SUS would have saved approximately 4 million NOK and an annual average saving at about 1.3 million NOK. For this diagnosis, about 75% of the loss is due to inpatients and 25% due to ambulatory patients.

Since the medical R10.4 patients group consist of much less patients than the two other main patient groups (R07.4 and surgical R10.4), it is the group creating the smallest opportunity loss for SUS. However, in average per patient it creates the largest loss (see Table 2). The annual average loss this group has caused is 236,512.81NOK.

The losses created by providing ambulatory services to surgical R10.4 patients are 2,351,817.50NOK. This is larger than the loss created by day patient at 371,282.98NOK. This yields a total loss (average annual) at 2,723,100.48NOK (907,700.16NOK) for providing suboptimal treatment path to surgical R10.4 patients.

The three groups in Table 4 together directly implies an opportunity loss for SUS at 2,460,131.41NOK per year.

Table 4: SUS's total opportunity loss for treating suboptimal patient pathways in the period 2014-2016.

Hospital Perspective - Total Opportunity loss 2014-2016 - Deterministic Results				SUS's Total loss of not providing optimal path from 2014-2016	
	Ambulatory Patient	Day Patient	Inpatient	SUM of Loss per pathway (2014-2016)	SUM of loss per pathway per year
R074	-NOK 1,031,170.50	Optimal Path	-NOK 2,916,584.79	-NOK 3,947,755.29	-NOK 1,315,918.43
R104 - Medical	-NOK 536,458.95	-NOK 173,079.49	Optimal Path	-NOK 709,538.44	-NOK 236,512.81
R104 - Surgical	-NOK 2,351,817.50	-NOK 371,282.98	Optimal Path	-NOK 2,723,100.48	-NOK 907,700.16
SUM of all pathways				-NOK 7,380,394.22	-NOK 2,460,131.41

5.2 Results of the CMA – The Social Cost Savings

Given the assumptions that all patients included in this study have equivalent health benefits from outpatient and inpatient treatment, that SUS cannot dump the patients and that the cost for the two outpatient paths have identical cost. Then, society minimizes its costs to maximize welfare. From Table 5 below we can see that the average amount saved per ambulatory/day patient ranges between 6,291.91NOK–7,566.39NOK for the three different groups. This implies, if all inpatient received outpatient treatment instead, social savings would be above 23 million NOK during the three years (annually about 7.7 million NOK). Analysing the results in Table 4 and Table 5Table 5, together they indicate that for society it is cost-minimizing to treat all patients as outpatient.

Table 5: Social cost savings when SUS provides outpatient services.

	Social cost savings per ambulatory/day patients compared to inpatients treatments	95% Confidence Interval	Social cost savings from 2014-2016 if all inpatient were treated as outpatient	Social cost savings per year if all inpatient were treated as outpatient
R07.4				
Ambulatory/Day	NOK 6,291.97	1,623.96NOK - 11,601.64NOK	NOK 12,823,040.91	NOK 4,274,346.97
R10.4-Medical				
Ambulatory/Day	NOK 7,234.30	1,428.91NOK - 13,983.31NOK	NOK 1,765,168.92	NOK 588,389.64
R10.4 Surgical				
Ambulatory/Day	NOK 7,566.39	2,648.27NOK - 13,167.86NOK	NOK 8,534,883.61	NOK 2,844,961.20
SUM			**NOK 23,123,093.44**	**NOK 7,707,697.81**

5.3 Result of the PSA & Scenario Analysis

This section presents the results of the PSA and the scenario analysis.

5.3.1 Scenario Analysis

When comparing the net benefit of the cost scenario analysis (Table 6) to the net benefit in the deterministic results (Table 2). We see that the average nurses salary cost at the ward per patient (ANSCWPP), is the cost affecting the net benefit the most of the two costs in the analysis. Decreasing the ANSCWPP with 40% for the R07.4 inpatients, yields incremental net benefit between day patients and inpatient at only 13NOK. Reducing ANSCWPP also changes the net benefit largely for both R10.4 inpatient groups. The change makes the two inpatient treatments even more beneficial compared to the outpatient treatment. However, changing the average cost of goods has a minor impact on the net benefit. This is expected since the cost is only 10-20% of the ANSCWPP for each inpatient pathway.

As expected, when decreasing the cost for the inpatient, the social cost savings confound with providing outpatient service diminishes. When the ANSCWPP for medical R10.4 patients decreases with 20%, the social cost savings decrease from 7,234NOK to 6,199NOK. Reducing ANSCWPP by 20% for the R07.4 and surgical inpatients decreases social cost savings by 700NOK-800NOK. Table 6 displays the small impact the average cost of goods per pathway have on social cost savings. Decreasing cost of goods with 40% yields a decrease in social cost savings between 200-300NOK.

Table 6: Results of the scenario analysis for the two largest cost parameter for each inpatient pathway.

Scenario Analysis - Costs				
	Decrease: 20% --> Net Benefit	Decrease: 40% --> Net Benefit	Decrease: 20% --> Social cost Savings	Decrease: 40% --> Social Cost Savings
R07.4 Inpatient				
Average nurses salary cost at Ward per patient	-NOK 2,309.06	-NOK 1,600.15	NOK 5,583.06	NOK 4,874.15
Average cost of goods per patient at 3H	-NOK 2,894.38	-NOK 2,770.79	NOK 6,168.38	NOK 6,044.70
R10.4 Medical				
Average nurse cost at gastro ward 4H	NOK 1,382.45	NOK 2,418.12	NOK 6,198.63	NOK 5,162.96
Average cost of goods per patient 4H	NOK 452.35	NOK 557.92	NOK 7,128.73	NOK 7,023.16
R10.4 Surgical				
Average nurse cost at gastro sugical ward 6H	-NOK 779.98	NOK 7.75	NOK 6,778.66	NOK 5,990.94
Average cost of goods per patient 6H	-NOK 1,435.42	-NOK 1,303.14	NOK 7,434.11	NOK 7,301.82

The results of the scenario analysis for the benefit parameter, percentage of patients receiving follow-up consultation are visual in Table 7 below. Decreasing or increasing this parameter by 25% only have an impact on the net benefit and social cost saving at about 60NOK for the different pathways. Implying that this parameter does not have a large impact on the result.

Table 7: The table displays the results of the scenario analysis of the benefit parameter.

Scenario Analysis - Benefits				
	Decrease: 25% --> Net Benefit	Increase: 25% --> Net Benefit	Decrease: 25% --> Social Cost Savings	Increase: 25% --> Social Cost Savings
R07.4				
Percentage of patients receiving Follow-up Consultation	Ambulatory: -3434.88NOK Day: -1641.54NOK	Ambulatory: -3325.53NOK Day: -1532.19NOK	NOK 6,349.99	NOK 6,233.96
R10.4 Medical				
Percentage of patients receiving Follow-up Consultation	Ambulatory: -3,067.54NOK Day: -1,941.37NOK	Ambulatory: -2,986.81NOK Day: -1,860.64NOK	NOK 7,292.49	NOK 7,155.02
R10.4 Surgical				
Percentage of patients receiving Follow-up Consultation	Not applicable - Do not receive Follow-up Consultation			

5.3.2 The PSA

The PSA result of the CBA – Hospital perspective

The Figures 9, 10 and 11 displays the results of the PSA for each patient group in the CBA. Figure 9, displays SUS's CBAC for the R07.4 patients, given the current assumptions of the PSA. The hospital has a probability of about 70% to receive a higher net-benefit when providing the day path than the inpatient path. Then, a profit maximizing behaviour is assumed (altruism level equal 0NOK). Naturally, as the ambulatory patients have a lower net benefit they have a lower probability of being more profitable than inpatients at 0NOK altruism level.

If the OGA holds, then SUS has a probability of 55% of having a larger net benefit when providing an outpatient path than the inpatient path. Again, assuming zero altruism.

As seen in the CBAC for the R07.4 patients, the probability for the outpatient treatments being higher than the inpatient increase with SUS's level of altruism. When the altruism level equals 5000NOK, the graph shows that the probability of the outpatient treatment being more beneficial for SUS than the inpatient path approaches 1.

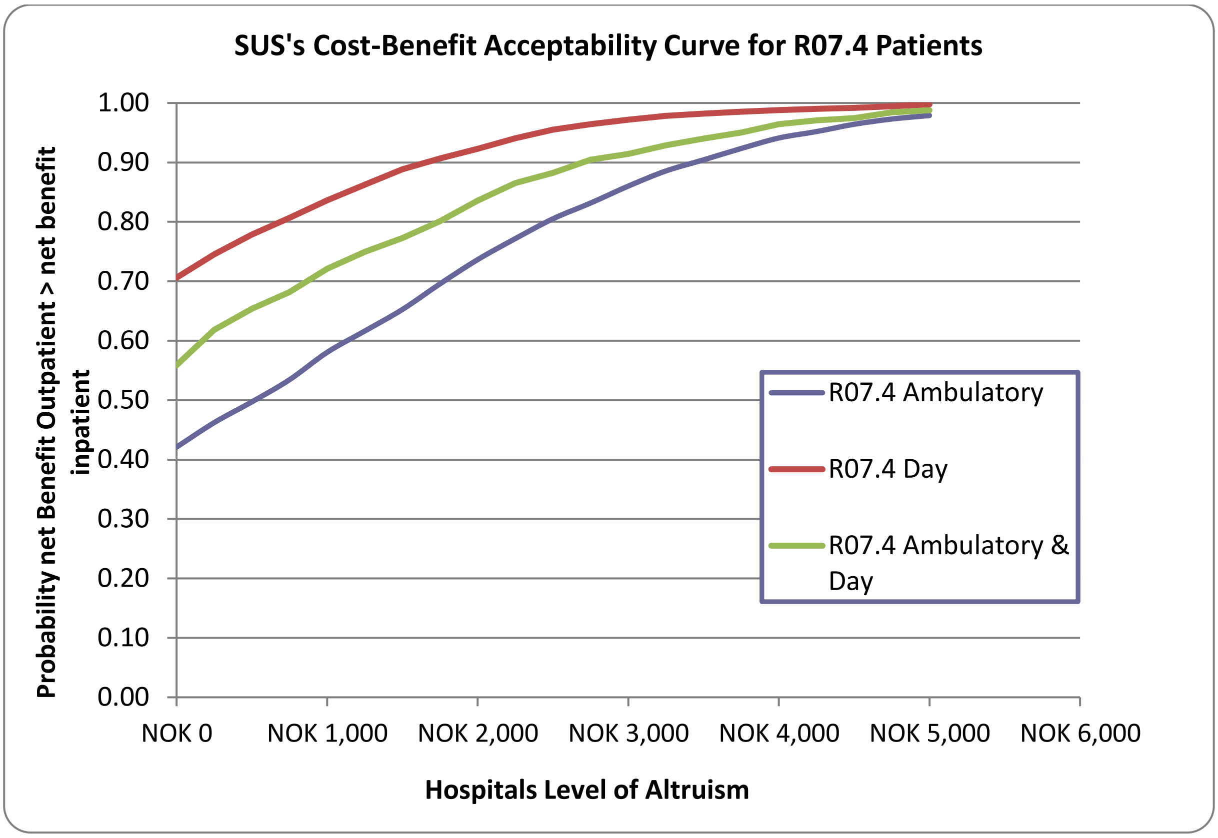

Figure 9: The CBAC for the R07.4 patients displays the probability that the net benefit of the different outpatient treatments are larger than inpatient treatment at different levels of hospital altruism.

The CBAC for the medical R10.4 patients shows a lower probability of the outpatient path, yielding a higher net benefit than the inpatient path, relatively to the R07.4 patients. At zero altruism, the medical R10.4 day patients have a probability of 45% to yield a higher net benefit than inpatients for SUS. The ambulatory pathway have a probability of 20%. When the OGA is valid, the outpatient groups together have a probability just below 20% given that SUS profit maximizes. However, for the day patient group an altruism level at 250NOK yield a 50% probability that the net benefit for a day patient is larger than net benefit for the inpatient. For the two other groups, the probability of 50% first occurs at a hospital altruism level at about 3750NOK.

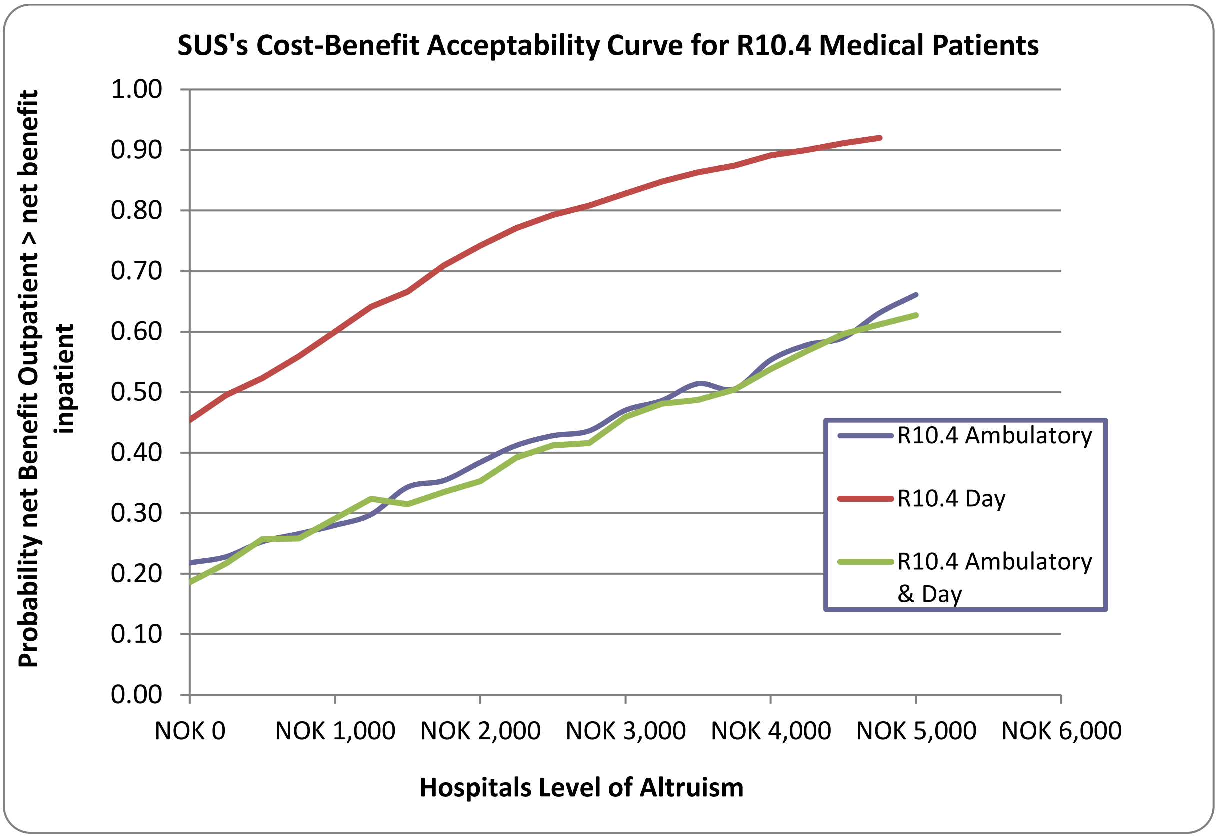

Figure 10: The CBAC for the medical R10.4 patients displays the probability that the net benefit of the different outpatient treatments are larger than inpatient treatment at different level of hospital altruism.

The surgical R10.4 patient's CBAC (Figure 11) depicts about the same probability for day patients, as the medical R10.4 day patients at 0NOK altruism. However, both the ambulatory and the outpatient group have respectively 10% higher probability of returning a higher net benefit than inpatients, compared to their respectively medical R10.4 patient groups at the equivalent altruism level. At 2000NOK and higher hospital altruism level, the ambulatory patients have a probability above 50% of yielding higher net benefit than inpatients. The outpatient group on the other exceed that probability at an altruism level equal 1750NOK.

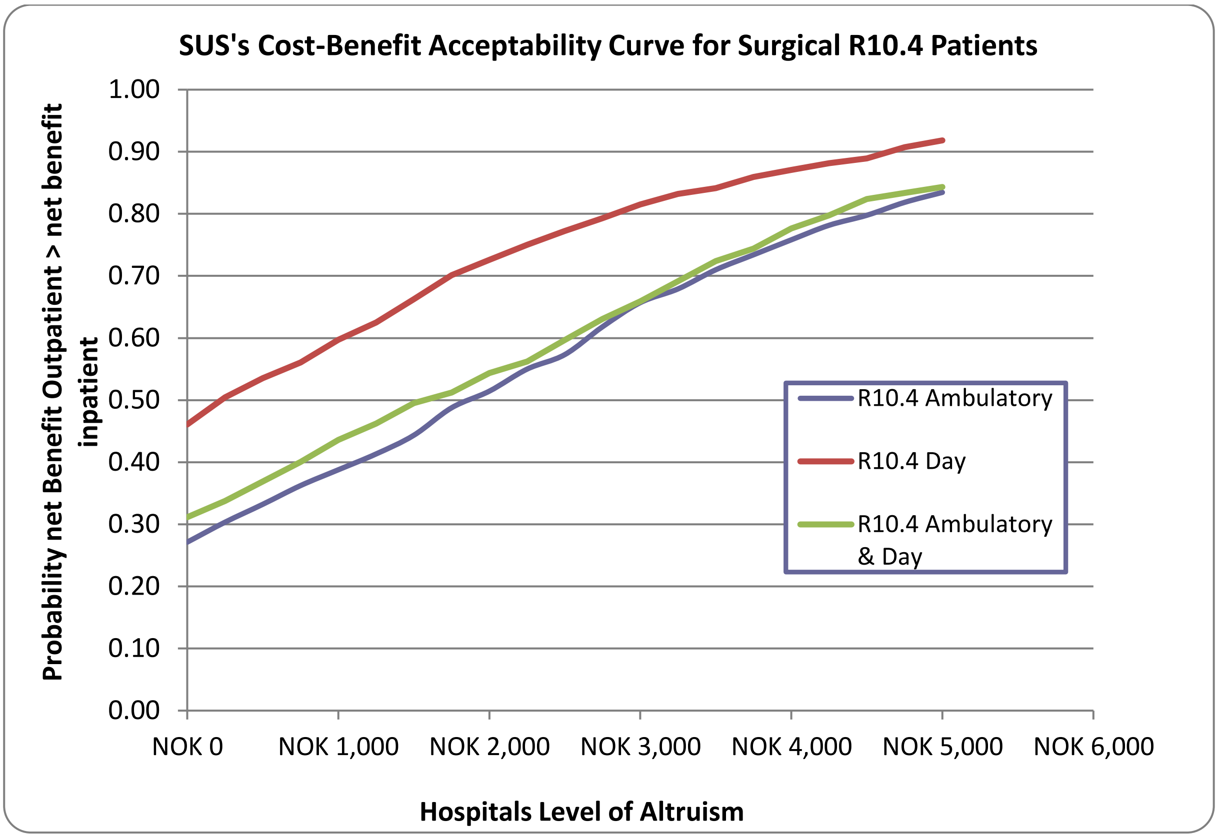

Figure 11: The CBAC for the surgical R10.4 patients - displaying the probability that net benefit for the different outpatient treatments are larger than inpatient treatment at different level of hospital altruism.

PSA results of the CMA - Social Perspective

Table 5 displays the 95% confidence interval of the CMA's PSA. When investigating the confidence intervals, we see that they are relatively large. The R07.4, medical and surgical R10.4 group respectively have a confidence interval ranging between 26%-184%, 20%-193% and 35%-174% of the average.

6 Discussion & Limitations

The objective of this thesis is to answer the research question: *Does the activity based financing in Norway incentivize hospitals to shift emergency patient with unspecific chest and abdominal pain from short stay inpatient to outpatient treatment?* This chapter interprets and evaluates the results in relation to the research question. If SUS has an incentive to provide emergency patients with outpatient or inpatient treatment can be judged by Equation 1. Meaning that SUS has an incentive to provide the pathway that yields the largest net benefit from their perspective.

6.1 Interpreting the CBA and CMA results

6.1.1 Assuming that the TGA holds

Assuming that the TGA holds. Then, for the R07.4 patients the financial incentive for treating them as day patients is present for SUS. This is because this group has a larger net benefit than both alternatives (see Table 2). However, they do not have an incentive to treat the patients in less than 5 hours (ambulatory), as that reduce their net benefit with about 100% . Even when the inpatient doubles the cost, SUS's incentive to treat these patients is stronger (larger net benefit) than for the ambulatory patients.

The interpretation of the R07.4 results in Table 2 under the TGA, is illustrated in Figure 12 below. It depicts how the difference between average cost (AC) per patient and the benefit per patient (B) are dependent on the LOS. Notice that the figure reflects the relationship between the results in Table 2.

In Figure 12 and 13: at a lower t than t_1, the patient is a ambulatory patient, at t between t_1 and t_2, the patient is a day patient and at t longer than t_2 the patient is a inpatient.. From Figure 12 we see that the difference between benefits (c) and average cost (d) for day patients is less than for the ambulatory (ab) and the inpatients (ef).

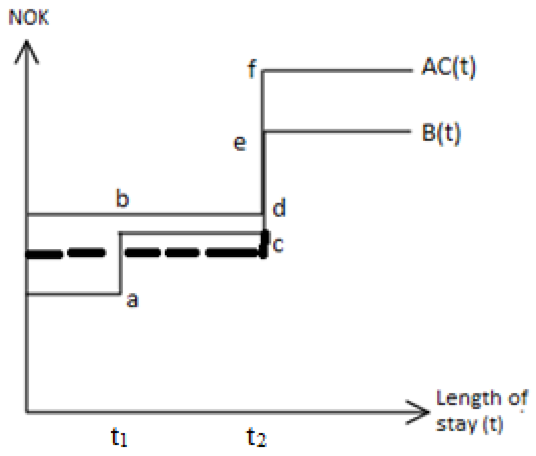

Figure 12: An illustration of the relationship between benefit and cost from the hospital perspective for R07.4 patients under the TGA. The OGA holds, for the dashed benefit line at shorter t than t_2. The OGA benefit are equivalent with the TGA benefit line at longer t than t_2. The Benefit-curve starts below the average cost curve.

However, for both types of R10.4 patients, the financial incentive to treat day and ambulatory patients are weaker than the incentive for providing inpatient care. Treating patients in less than 5 hours are SUS's worst option, given that they maximize net benefit. This relationship between cost and benefit are visualized in Figure 13.

The difference between benefits (e) and average cost (f) minimizes the net benefit loss. This results in that the inpatient path is the best option. This illustrates that SUS's incentive to provide the inpatient pathway is strongest, followed by the day path (cd) and last ambulatory (ab) path.

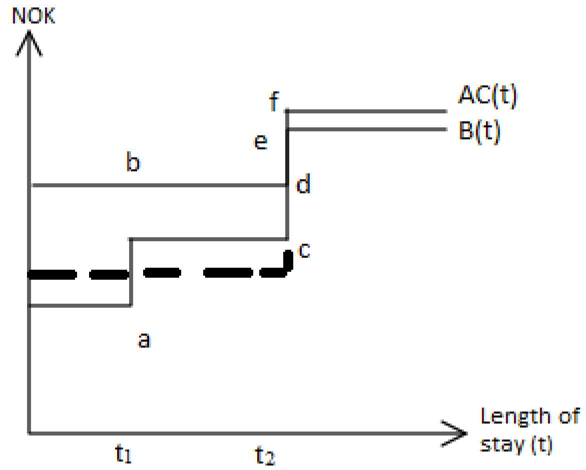

Figure 13: Depicting the difference between benefit and cost for R10.4 patients from the hospital perspective under the TGA. The OGA holds, for the dashed benefit line at shorter t than t_2. The OGA benefit are equivalent with the TGA benefit line at longer t than t_2. The Benefit-curve starts below the average cost curve.

6.1.2 Assuming that the OGA holds

When the OGA holds, then the hospital considers the average benefit for outpatients relatively to inpatients. Implying that from the hospital perspective, it is only one “jump” (increase) in benefit. As seen at t_2, following the dashed benefit lines in Figure 12 and 13. The OGA assumption affects the strength of the financial incentives as it changes the net benefit.

Since ambulatory pathways were the worst option for the R07.4 patients from the hospitals view under the TGA, the OGA assumption decreases the incremental net benefit between the optimal option (outpatient path) and the inpatient path. In this situation the average incremental benefit gain for SUS of providing outpatient care to the R07.4 patients is only 613NOK per patient relatively to inpatients (Table 2). Providing SUS with an incentive to treat outpatients that is weaker than the incentive to treat day patients under the TGA.

The OGA creates an identical effect for both medical and surgical R10.4 patients, as it does for the R07.4 patients. The outpatient path becomes less (more) financial attractive than the day (ambulatory) path for the hospital, since the average net benefit decreases (increase) under the OGA. Figure 13 illustrates this by the dashed line. Thus, SUS’s incentive for providing the inpatient path increases.

6.1.3 Hospital perspective vs Social perspective

Interestingly, under the assumption that health benefits are identical for the inpatient and outpatient path, the interpretation of the CMA is that the outpatients’ path are better for society compared to the inpatients’ path. The reason is that the costs for the society are reduced when SUS provides the outpatient path. Hence, for both medical and surgical R10.4 patient the incentive from the hospital perspective contradicts the optimal from the social perspective. Implying that SUS is encouraged to unnecessary admit these patients, which results in suboptimal resource use from the social perspective.

6.1.4 Interpretation in relation to Theory & Literature

Incentives according to DRG Price Refinement Theory

When interpreting the results in relation to Hafsteinsdottir and Siciliani (2010) theory, it is important to mention that they assume that benefit and cost of treatment increases with severity. However, in this study severity is assumed identical for all patients. Making the incentive to over- or underprovide a given treatment pathway only dependent on the net benefit of the hospital when we assume an altruism level at zero.

Under the given assumption of this study we see that the results for the R10.4 patients are according to Hafsteinsdottir and Siciliani (2010) results under refined DRG prices. This is independent of whether the TGA and the OGA holds. This implies that SUS has an incentive for overprovision of the resource demanding R10.4 treatments under the current refined DRG prices. This is due to their net benefit being higher for the inpatient than the outpatient pathway.

However, the results for the R07.4 patients points in the opposite direction of Hafsteinsdottir and Siciliani (2010) theory. For these patients the hospital has an incentive to overprovide the day patient path when the TGA holds and both outpatient paths when the OGA holds, under the current refinement of DRG prices.

Incentives according to Financing Typology Theory

As presented, financing of the Norwegian specialist healthcare system is through a mix of block grant and ABF. How do this prospective mix of fixed and variable financing affect the incentive that SUS has in this study when we analyse according to Jegers et al. (2002) typologies? Dumping these patients is not an alternative in this analysis, due to the universal access to care in the Norwegian system (Helsedirektoratet, 2013; Ringard et al., 2013). Therefore, the hospital will provide the path with the largest incremental net benefit compared to the alternative pathway, even when patients yield a negative net benefit. Another assumption is that the average cost and benefit per patient are equal to respectively marginal cost and marginal revenue.

Applying the theory, SUS has the majority of the risk confound when they provide R07.4 ambulatory and inpatients path. This count for R10.4 outpatients as well (Jegers et al., 2002). This is due to that the providers are not guaranteed fully financing by either the block grant or the ABF share. The results of this thesis imply that SUS have one incentive. This is to provide the R10.4 inpatient path and R07.4 day path when TGA holds (R10.4 inpatients and R07.4 outpatients when OGA holds), since this yields the largest average net benefit.

Assume that SUS is in the following situation: Occupancy level at the relevant wards are about 100% and that the RHA Helse Vest provides the hospital with a goal to have zero hallway patients (Helse Vest RHF, 2016; Stavanger Universitetssykehus, 2016). Then, SUS will have an increased incentive to provide the second best pathway for the R10.4 patients, i.e. the day path.

However, then the average net profit decreases. This loss in average net profit imposes an opportunity loss on SUS. Treating the patients faster in the present year t (short term), implies that SUS has to cover the opportunity loss during the following years t + x (long term).

SUS has two options in this situation. One, to provide the R10.4 patients one of the outpatient path and retrieve the loss in the long term, e.g. by skimping the services for future patients provided the pathway. The second option is to reduce the R10.4 path's marginal cost until their marginal net benefit exceeds the R10.4 inpatient path's marginal net benefit, both in short and long term. Thus, avoiding the opportunity loss imposed by not providing inpatient care and maximizing profit. Applying Jegers et al. (2002) theory, the second option would be the incentive for a profit-maximizing provider, since it maximizes net benefit.

6.2 Limitations of the Analysis

The analysis performed in this study has several limitations that needs to be acknowledge. This section evaluates the main limitations' impact on the validity and reliability of the results.

6.2.1 The Representativeness of Result

The study performed in this thesis has a limited size of the scope, which affects the generalizability of the results. Since the study only concerns three types of patient groups (R07.4 patients, medical and surgical R10.4 patients) and two diagnosis, it does not cover all emergency patients that can benefit from outpatient treatment rather than inpatient treatment. Assuming that outpatient treatment always has lower cost than inpatient, then the potential social cost savings are larger than what the two diagnoses analysed here displays. SUS's opportunity loss may also be larger.

Further, as this study only includes one Norwegian hospital the results of the study are not necessary valid for all hospitals in Norway. This is due to that cost for hospitals are dependent on a bundle of factors, e.g. geographic location and age distribution of coverage population (Magnussen et al., 2008; Tande & Munch-Ellingsen, 2010). Meaning that hospitals with smaller AED may have very different net benefit from a given pathway than hospitals with larger AEDs. This can be due to that larger AEDs get emergency patients with higher complexity or that hospitals have different inpatient volumes. Larger inpatient volumes and higher emergency costs has previous been found in the US (Grannemann, Brown, & Pauly, 1986, p. 123).

6.2.2 Limitations of the Cost Assumptions

A limitation of this study is that it uses expert opinion and average cost based on accounting data at department/ward level. See the justification why this assumption is valid in section 4.2.7. This assumption may affect the accuracy of the results in a negative way. However, in this analysis the PSA should account for this limitation through large SEs. The PSA focuses on not underestimating the uncertainty, likely displaying larger uncertainty than there exist. Since the SE are also estimates from experts, they are also a limitation of the analysis. The consequences of these limitations are to interpret the results as guiding estimates and not as definite results.

Another limitation of this study is that it does not predict the impact on SUS's cost of providing more outpatient or inpatient services. The study assume that the marginal net benefit is constant, independent of how many patient SUS treat in a given path.

Potentially there can be economy of scale (EOS) for outpatient services at the AED at SUS. Previous research from the US healthcare system both support an assumption of imposing economic of scale and contradict it (Bamezai & Melnick, 2006; Grannemann et al., 1986; Kim, Carey K Fau - Burgess, & Burgess, 2009). In other terms, they find that the average cost of treatment at the AED can be larger and smaller than the marginal cost per patient. Therefore, using average cost are likely a reasonable approximate to evaluate the incentive of a treatment in the AED.

If there is EOS at the AED at SUS. Then, providing more outpatient services reduces the average outpatient cost, given that the marginal cost are below the average cost for the outpatient treatments at the AED, as according to Kim et al. (2009). Resulting in an increased average net benefit for the outpatient path while keeping the inpatient average net benefit the same. This increases the incentive for provision of the outpatient path relatively to the inpatient path from both hospital and social perspective relatively to the results in this thesis.

Turning to the opposite situation with diminishing marginal return. Then the opposite effect on the result of this thesis occurs. When the number of patients increases the marginal productivity of the clinical staff decreases, which increasing the marginal cost. Given that the number of patients are that high that the marginal cost exceed the average cost, the marginal patient will decrease the average net benefit for the outpatient path. Thereby decreasing the incentive to provide the outpatient path at the AED comparatively to inpatient path, as the number of patients increase.

6.2.3 Validity of the Benefit

The practice of assigning the diagnosis R07.4 and R10.4 can be different at different hospitals across Norway. The time pressure or the number of patients arriving the AED at a given day may for example affect the assigning of a patient’s diagnosis. It is plausible to think that when the number of patients arriving increase, the time pressure increase and the stress increase, leading to more unspecific diagnosis. SUS has focused on improving coding accuracy of diagnosis. They have medical staff double-checking if the assigned diagnosis are correct. It is therefore arguable that this increase the probability of that the included patients in this study are the patients with actually unspecific diagnosis. This again, increases the validity of the calculation of hospital ABF revenue.

6.2.4 Non-Monetary Values not Valuated in the Analysis

Because of this study’s timeline, several non-monetary values were not included in the CBA and the CMA. Examples of these are i) the value of changed patient flow arising in the AED when providing more outpatient services, ii) the value of receiving outpatient service compared to inpatient care, iii) the value of the quality impact on inpatient from providing more outpatient care (mortality, readmission), iv) the value of not having hallway patients for hospital staff, and v) how many inpatient beds one outpatient treatment free. These values may influence the results of the CBA and the CMA, which is why this section discusses their potential impact.

In a discussion about changing clinical practice from admitting the relevant patients in this thesis, to treating them as outpatient in the AED. An MD at SUS argued that maintaining good patient flow became a greater challenge when providing outpatient services compared to inpatient services. The reason for this is that the medical staff have to juggle more patients at the time. When sending the patient through the inpatient pathway, the medical personnel treats less patient parallel. From the discussion, this occurred as cost for the medical personnel. Hence, likely to increase the cost, reduce the net benefit and reduce the social cost savings confound with the outpatient pathways. However, from the discussion with the MD it did not occur as an incremental cost that would change the SUS's incentive.

The discussion with the MD at SUS also concerned the pathway preferences of patients and their next of kin (e.g. children of patient). It became clear that some patients want to finish the treatment as rapid as possible. Other patients or their next of kin asks the MD to admit the patient, as it may increase their feeling of safety. Judging the patient and their next of kin's preferences for outpatient and inpatient treatment is difficult and likely to be dependent on the life situation of the patient and its next in kin. Based on the current information, determining the direction of impact on the social cost savings of this value is difficult.

The next two values that are not accounted for in this study are the quality impact on inpatients from providing more outpatient services and value of reducing hallway patient for hospital staff. A German study shows that an occupancy level above 92.5% increase the mortality and argues that the reason for increased mortality are elevated stress of clinical staff (Kuntz et al., 2015). If increasing the number of outpatients can lead to fewer inpatients, reducing the occupancy level at the relevant department at SUS below 92.5%. Then, mortality decreases and likely distresses clinical staff. A survey at Norwegian hospitals also impose that avoiding hallway patients increases the quality of care, reduce probability for mistakes and accidents. The negative impact on quality of care impacts both patients in the corridor and the patients admitted to a room (Larsen et al., 2000). Larsen et al. (2000) and Kuntz et al. (2015) studies makes it reasonable to expect that both the two concepts is a benefit confounded with outpatient treatment. Reducing medical staffs stress is arguable a benefit from the hospital perspective, which implies that both values increase the benefit for the hospital. That increases the incentive for outpatient treatment for SUS. The two conceptual values in this paragraph are also benefit from the social perspective, thus increasing the social cost savings when patients receive outpatient services. However, determining the magnitude of the increased incentive for outpatient services and social cost savings is up to future researchers.

The last aspect that was not included in the study is the number of inpatients beds one outpatient treated patient frees. Knowing that value would make it possible to estimate the number of R10.4 outpatient treatments SUS needs to provide before they can admit a new patient. If the outpatient treatments frees enough inpatient bed capacity that the hospital can admit new inpatients, which in sum with the outpatient treatment exceeds the net benefit of the inpatient treatment. Then, SUS has an incentive to provide outpatient treatment for the R10.4 patient given that they profit maximize. Social cost savings may also increase in this situation, e.g. if waiting lists for elective treatments are reduced because of the free bed capacity. If outpatient treatments do not free any inpatient beds, then SUS's incentive and social cost savings remain unchanged.

6.2.5 Opportunity Costs

From the society's perspective there always exist an opportunity cost confound with an investment. The CMA analysis in this study is limited in scope, to calculate the social cost savings when the outpatient paths are provided in comparison to inpatient. It does not include the social opportunity cost.

Despite, that the society/third-party payer saves cost when SUS provides the outpatient path, the social welfare can be higher when investing in other options. The analysis performed here; do not account for that new project in the transportation sector, reducing taxes, other treatments not included in this study or providing equivalent treatments at another hospital may yield relatively higher social welfare. Hence, the results of this study are able to state the relative incentive SUS has for providing any of the analysed pathways. In addition to that, the analysis can state how much the society saves cost when SUS provides outpatient treatment relative to inpatient treatment. This implies indirectly that consequences outside the analysis scope, e.g. *domino effects* from providing more outpatient services may affect the results in ways that this analysis do not cover.

6.2.6 Summing up – Are the Results valid and Reliable?

The results from the sensitivity analysis displays that there exist relative uncertainties in the results under the current assumptions, both in the CMA and the CBA. Based on the scenario analysis we see that ANSCWPP is a large source of variation in the results. Thus, it may be a starting point for further investigation to reduce uncertainty.

Under the TGA, the results for the R07.4 patients are reliable. Based on the large probability of that the day patient path yields larger net benefit than the inpatient path from the hospital perspective. SUS has the relatively weakest incentive to provide ambulatory services. However, for both R10.4 patient types, the PSA displays that the uncertainties are that large that it is not possible to determine whether SUS has an incentive for day or inpatient treatment provision. Still, it is clear that the society saves cost when SUS provides outpatient care relatively to inpatient services.

From a discussion with SUS medical personnel, it appears that the OGA is more valid according to clinical practice than the TGA. From their perspective, patients receiving treatment in the AED are either outpatients or inpatient, as they aim to provide the patient with best quality care within their available resources. This makes it reasonable to state that the results when the OGA holds have a greater validity than the results under the TGA.

The results reliability under the OGA are different from the reliability under the TGA. The PSA displays that the results for the R10.4 patients are more certain under the OGA than under the TGA. The probability of the outpatient group providing SUS with a higher net benefit than the inpatient is about 20%-30%. Implying that SUS's incentive for providing inpatient services is larger when the OGA holds compared to the TGA. This is opposite for the R07.4 patients. The uncertainty that outpatients yields a larger net benefit than inpatients is larger under the OGA, than what it is for day patients vs inpatients under the TGA. The result for the R10.4 and R07.4 are respectively reliable and unreliable given the OGA. Based on that clinical practice follows the OGA, the OGA results are arguable more valid than the TGA results.

7 Conclusion

This study has investigated a Norwegian hospital's incentive to shift emergency patients diagnosed with unspecific chest pain or unspecific abdominal pain from short stay inpatient to outpatient treatment under the current Norwegian ABF system. This is important, as to whether the hospitals´ incentives are in line with the Norwegian health and hospital plan 2016-2019, the RHAs requirements of the hospital and that the ABF system do not act as a barrier for efficient use of resources (Helse- og Omsorgsdepartement, 2015; Helse Vest RHF, 2016; Helsedirektoratet, 2016b).

The conclusion of this study is that from a financial perspective SUS does not have an incentive to shift emergency patients diagnosed with unspecific abdominal pain from inpatient treatment to outpatient treatment, given that they are profit maximizing (altruism = 0NOK). Still, when allowing for large variations in the largest cost items, it is most probable that inpatient yields a higher net benefit than day patients for SUS. The conclusion for patients with R10.4 are according to the DRG refinement theory (Hafsteinsdottir & Siciliani, 2010), and the opposite of what the Norwegian health and hospital plan 2016-2019 states (Helse- og Omsorgsdepartement, 2015). The incentives are also encouraging unnecessary admissions, which at SUS implies increased number of hallway patients.

The extent of uncertainty in the result for the emergency patient diagnosed with R07.4 is too large to determine if the incentive is stronger for outpatient or inpatient treatment. Further research is required to determine this.

Another conclusion of this study is that the society saves cost when SUS provides outpatient services. The amount of cost savings is difficult to determine from the conducted study, as the reliability of the results are not high. However, treating more outpatient will at SUS likely improve quality of care and reduce mortality (Kuntz et al., 2015), implying larger social cost savings than this study displays.

When conduct this study two interesting questions arouse. Is it optimal to refine reimbursement between ambulatory, day and short stay inpatient for emergency patients at Norwegian hospitals AED? Is it possible that today's ABF system is a barrier against providing rapid diagnostic and examination?

At last, I will provide some recommendations to future studies within this topic, which has not been addressed in this study. Further study should aim at measuring the cost for a sample of the patients at each given pathway. That can improve this study limitation, as expert opinion and average cost estimate may be biased. This can especially increase the value of the probabilistic sensitivity analysis, by gaining more certainty about the standard error of the costs.

Another limitation of this study, future studies can address is to perform valuation of non-monetary indirect benefits and costs. That can identify potential costs and benefit not accounted for in this study. The last encouragement to future studies is to conduct this analysis at several hospital with different characteristic, e.g. local and regional hospitals. Since the ABF system in Norway is a benchmarking system, an incentive for one hospital can be no incentive at all for another hospital.

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Appendix

Appendix 1: Overview of the final sample inclusion criteria's.

Diagnosis	Type of Patient	Pathway	Final sample - Inclusion Criteria
R07.4		Ambulatory	1. DRG-descriptions: - Annen poliklinisk kons vedr. smerterelaterte tilstander - Innleggelse uten overnattting for ØH-relaterte hjerte- og kartilstander 2. Clinic: Mottaksklinikken 3. LOS range: >1 - 5.0 hours, at the same date
R07.4		Day	1. DRG-descriptions: - Annen poliklinisk kons vedr. smerterelaterte tilstander - Innleggelse uten overnattting for ØH-relaterte hjerte- og kartilstander 2. Clinic: Mottaksklinikken 3. LOS range: >5 - 23.9 hours, at the same date
R07.4		Inpatient	1. DRG-descriptions: - Brystsmerter 2. Clinic: Mottaksklinikken 3. LOS range: 1.0 - 2.9 days
R10.4	Medical	Ambulatory	1. DRG-descriptions: - Innleggelse uten overnatting for ØH-relaterte tilstander i fordøyelsessystemet - Koloskopi - Poliklinisk endoskopi av øvre magetarmkanal - Kombinert gastrointestinal endoskopi - Poliklinisk konsultasjon vedr smerte i mageregionen 2. Clinic: Mottaksklinikken 3. LOS range: >1 - 5.0 hours, at the same date
R10.4	Medical	Day	1. DRG-descriptions: - Innleggelse uten overnatting for ØH-relaterte tilstander i fordøyelsessystemet - Koloskopi - Poliklinisk endoskopi av øvre magetarmkanal - Kombinert gastrointestinal endoskopi - Poliklinisk konsultasjon vedr smerte i mageregionen 2. Clinic: Mottaksklinikken 3. LOS range: >5 - 23.9 hours, at the same date
R10.4	Medical	Inpatient	1. DRG-descriptions: - Øsofagitt, gastroenteritt & diverse >17år m/bk - Øsofagitt, gastroenteritt & diverse >17år u/bk - Øsofagitt, gastroenteritt & diverse 0-17 år u/bk 2. Clinic: Mottaksklinikken 3. LOS range: 1.0 - 2.9 days
R10.4	Surgical	Ambulatory	1. DRG-descriptions: - Annen poliklinisk konsultasjon vedr smerterelaterte tilstander - Innleggelse uten overnatting for ØH-relaterte tilstander i fordøyelsessystemet - Poliklinisk endoskopi av øvre magetarmkanal - Poliklinisk konsultasjon vedr smerte i mageregionen 2. Clinic: Kirurgisk Klinikk 3. LOS range: >1 - 5.0 hours, at the same date
R10.4	Surgical	Day	1. DRG-descriptions: - Annen poliklinisk konsultasjon vedr smerterelaterte tilstander - Innleggelse uten overnatting for ØH-relaterte tilstander i fordøyelsessystemet - Poliklinisk endoskopi av øvre magetarmkanal - Poliklinisk konsultasjon vedr smerte i mageregionen 2. Clinic: Kirurgisk Klinikk 3. LOS range: >5.0 - 23.9 hours, at the same date
R10.4	Surgical	Inpatient	1. DRG-descriptions: - Øsofagitt, gastroenteritt & diverse >17år m/bk - Øsofagitt, gastroenteritt & diverse >17år u/bk - Øsofagitt, gastroenteritt & diverse 0-17 år u/bk - Øsofagitt, gastroenteritt & diverse 0-17 år m/bk 2. Clinic: Kirurgisk Klinikk 3. LOS range: 1.0 - 2.9 days
R07.4		Ambulatory & Day	1. DRG-descriptions: - Annen poliklinisk kons vedr. smerterelaterte tilstander - Innleggelse uten overnattting for ØH-relaterte hjerte- og kartilstander 2. Clinic: Mottaksklinikken 3. LOS range: >1 - 23.9 hours, at the same date
R10.4	Medical	Ambulatory & Day	1. DRG-descriptions: - Innleggelse uten overnatting for ØH-relaterte tilstander i fordøyelsessystemet - Koloskopi - Poliklinisk endoskopi av øvre magetarmkanal - Kombinert gastrointestinal endoskopi - Poliklinisk konsultasjon vedr smerte i mageregionen 2. Clinic: Mottaksklinikken 3. LOS range: >1 - 23.9 hours, at the same date
R10.4	Surgical	Ambulatory & Day	1. DRG-descriptions: - Annen poliklinisk konsultasjon vedr smerterelaterte tilstander - Innleggelse uten overnatting for ØH-relaterte tilstander i fordøyelsessystemet - Poliklinisk endoskopi av øvre magetarmkanal - Poliklinisk konsultasjon vedr smerte i mageregionen 2. Clinic: Kirurgisk Klinikk 3. LOS range: >1 - 23.9 hours, at the same date

Appendix 2: Cost calculation and explanation for patients with unspecific chest pain (R07.4).

Pathway Stage	Costs	Unspecific Chest Pain Patients (R07.4) Inpatient	Unspecific Chest Pain Patients (R07.4) Outpatient (Day & ambulator	Explanation	Source
Arrival	Average secretary cost per patient**	NOK 161.00		Time use = 30min, Secretary cost per hour for SUS = 322NOK	SUS
Triage & Medical Examination	Average blood test cost per patient**	NOK 20.00		Estimate average cost per blood test at 20NOK from SUS cost accounting data	SUS
	Average MD costs per patient***	NOK 1,000.00		Time use = 2 hours, MD cost per hour for SUS = 500NOK	SUS
	Average cleaning cost per patient**	NOK 48.00		Time use = 10min, Cleaner cost per hour for SUS = 288NOK	SUS
	Average X-ray Thorax cost per patient**	NOK 226.88		Average estimate per X-ray at 219NOK from SUS cost accounting data (2015)	SUS
	Average CT Thorax cost per patient**	NOK 139.86		5% of patients receive, estimate average cost per CT scan at 2709NOK from SUS cost accounting data (2015)	SUS
	Average cost bed disinfected per patient**	NOK 125.00		Cost based on average cost from SUS Driftservice department cost accounting	SUS
	Average registered nurse AED ward cost per patient***	NOK 2,366.00		Estimated by taking total nurse salary cost at "Mottaksklinikken" in 2016 (100,095,513NOK) multiplying by the share of salary cost allocated to the AED (62%), and then dividing on the total number of patients provided care in the AED during 2016 (26,225 persons).	SUS
	Average cost of goods per patient in the AED*****	NOK 230.00		Estimated by dividing total cost of goods in 2016 for the AED (6,034,218NOK) by total number of patients provided care in the AED in 2016 (26,225 persons), equals 230NOK.	SUS
SUM-Three first stages		**NOK 4,316.74**			
Admission at 3H - Cardiac Ward	Average nurses salary cost at Ward per patient***	NOK 3,544.55		Average salary nurse cost per stay with LOS at 1.17 days at 3H - Cardiac Ward. Estimated by dividing total salary cost for nurses in 2016 at the Cardiac Ward, 3H (47,336,440NOK) by the total number of stay (15,625). Average LOS at for R07.4 is estimated to be 1.17	SUS
	Average cost of goods per patient at 3H****	NOK 617.95		Estimated by dividing total cost of goods in 2016 at the 3H - Cardiac Ward (8,252,582NOK) divided by the total number of stays at 3H in 2016 (15,625), multiplied with the average LOS for R07.4 inpatient (1.17 days).	SUS
	Average MD patient visit cost**	NOK 250.00		Time use = 30min, MD cost per hour for SUS = 500NOK	SUS
	ECG cycle test - Average MD cost per patient**	NOK 125.00		50% of the patients takes this test, MD time use = 30min, MD cost per hour for SUS = 500NOK	SUS
	ECG cycle test - Average nurse cost per patient**	NOK 96.00		50% of the patients takes this test, nurse time use = 30min, nurse cost per hour for SUS = 384NOK	SUS
	Average porter cost per patient**	NOK 109.00		Time use = 20min, porter cost per hour for SUS = 327NOK	SUS
	Echocardiography - Average MD cost per patient**	NOK 50.00		20% of the patients receive this, Time use = 30min, MD cost per hour for SUS = 500NOK	SUS
	Average cost for CT coronary angiography per patient**	NOK 561.51		20% of the patients receive this, average cost of performing an CT scan is estimated to be 2709NOK from SUS accounting (2015)	SUS
	Average cost per patient for other examinations**	NOK 48.00		10% of the patient receives one of these examinations. 67% of these examinations are assumed to be Gastroscopic examination (cost 665NOK) and 33% assumed to be Spirometric examinations (cost 106NOK).	SUS
SUM-Stage		**NOK 5,402.02**			
Outpatient Discharge Conversation (attempt to treat as outpatient)	Average MD cost per patient**	NOK 62.50		12,5% of patients treated that are attempted treated as outpatient, they are admitted in the end. MD time use = 60min, MD cost per hour for SUS = 500NOK	SUS
	Average secretary cost per patient**	NOK 20.13		12,5% of patients treated that are attempted treated as outpatient, they are admitted in the end. MD time use = 30min, MD cost per hour for SUS = 322NOK	SUS
Discharge Conversation	Average MD cost per patient**	NOK 375.00	NOK 500.00	Inpatient: Time use = 45min; Outpatient:Time use = 60min, MD cost per hour for SUS = 500NOK	SUS
	Average secretary cost per patient**		NOK 161.00	Time use = 30min, Secretary cost per hour for SUS = 322NOK	SUS
Follow-up Consultation	Average MD cost per patient**		NOK 131.25	35% of patients receive this, time use = 45min, MD cost per hour for SUS = 500NOK	SUS
	Average Secretary cost per patient**		NOK 100.80	35% of patients receive this, time use = 45min, Secretary cost per hour for SUS = 322NOK	SUS
Average Total Pathway costs per patient		**NOK 10,176.39**	**NOK 5,209.79**		

* MD = Medical doctor
**Assumed to be relatively Standardized task, standard error assumed to be 25%
*** Assumed to be a less standardized task, standard error assumed to be 50%
**** Variation in sensitivity analysis assumed to be fixed ratio of average nurse cost
*****Variation in sensitivity analysis assumed to be fixed ratio dependent of average MD costs

Appendix 3: Cost calculation and explanation of R10.4 medical patients.

Pathway Stage	Costs	Unspecific Abdominal Pain (R10.4) - Medical Patients: Inpatient	Outpatient (Day & ambulatory)	Explanation	Source
Arrival	Average secretary cost per patient**	NOK 161.00		Time use = 30min, Secretary cost per hour for SUS = 322NOK	SUS
Triage & Medical Examination	Average blood test cost per patient**	NOK 20.00		Estimate average cost per blood test at 20NOK from SUS cost accounting data	SUS
	Average MD costs per patient***	NOK 1,000.00		Time use = 2 hours, MD cost per hour for SUS = 500NOK	SUS
	Average cleaning cost per patient**	NOK 48.00		Time use = 10min, Cleaner cost per hour for SUS = 288NOK	SUS
	Average X-ray Abdomen cost per patient**	NOK 226.88		Average estimate per X-ray at 219NOK from SUS cost accounting data (2015)	SUS
	Average cost bed disinfected per patient**	NOK 125.00		Cost based on average cost from SUS Driftservice department cost accounting	SUS
	Average registered nurse AED ward cost per patient***	NOK 2,366.00		Estimated by taking total nurse salary cost at "Mottaksklinikken" in 2016 (100,095,513NOK) multiplying by the share of salary cost allocated to the AED (62%), and then dividing on the total number of patients provided care in the AED during 2016 (26,225 persons).	SUS
	Average cost of goods per patient in the AED*****	NOK 230.00		Estimated by dividing total cost of goods in 2016 for the AED (6,034,218NOK) by total number of patients provided care in the AED in 2016 (26,225 persons), equals 230NOK.	SUS
SUM-Three first stages		**NOK 4,176.88**			
Admission at 4H - Gastro Medical Ward	Average nurse cost at gastro ward 4H***	NOK 5,178.35		Average salary Nurse cost per stay with LOS at 1.36 days at 4H - Gastro Ward. Estimated by dividing total salary cost for nurses in 2016 at the Ward, 4H (22.091.771NOK) by the total number of stay (5.802 stay), muliplied with Average LOS for medical R10.4 patients is estimated to be 1.36 days.	SUS
	Average blood test cost per patient**	NOK 20.00		Estimate average cost per blood test at 20NOK from SUS cost accounting data	SUS
	Average cost of goods per patient 4H****	NOK 527.85		Average cost of goods related to treatment with a LOS at 1.36 days. Estimated by dividing total cost of goods in 2016 at the 4H Ward (2.251.913NOK) divided by the total number of stays at 4H in 2016 (5.802), multiplied with the average LOS for medical R10.4 patients at 1.36 days.	SUS
	Average cost for MD patient vist at ward**	NOK 250.00		Time use = 30min, MD cost per hour for SUS = 500NOK	SUS
	Average gastroscopic services cost per patient**	NOK 399.00		60% of patients receive, same cost as providing a gastroscopic follow-up cost (total 665NOK)	SUS
	Average ultrasound cost per patient**	NOK 159.54		20% of patients receive this service, average cost of ultrasound at SUS in 2015, 768NOK	SUS
	Average porter cost per patient**	NOK 36.33		33.33% of patients receive this, time use = 20min, porter cost per hour for SUS = 327NOK	SUS
SUM-Stage		**NOK 6,571.08**			
Outpatient Discharge Conversation (attempt to treat as outpatient)	Average MD cost per patient**	NOK 62.50		12,5% of patients treated that are attempted treated as outpatient, they are admitted in the end. MD time use = 60min, MD cost per hour for SUS = 500NOK	SUS
	Average secretary cost per patient**	NOK 20.13		12,5% of patients treated that are attempted treated as outpatient, they are admitted in the end. MD time use = 30min, MD cost per hour for SUS = 322NOK	SUS
Discharge Conversation	Average MD cost per patient**	NOK 375.00	NOK 500.00	Inpatient: Time use = 45min; Outpatient:Time use = 60min, MD cost per hour for SUS = 500NOK	SUS
	Average secretary cost per patient**		NOK 161.00	Time use = 30min, Secretary cost per hour for SUS = 322NOK	SUS
Follow-up Consultation	Average MD cost Gastro consultation per patient**		NOK 87.50	35% of patient receive this, time use = 30min, MD cost per hour for SUS = 500NOK	SUS
	Average nurse cost Gastro consultation per patient**		NOK 67.20	35% of patient receive this, time use = 30min, nurse cost per hour for SUS = 384NOK	SUS
	Average certified nursing assistant cost Gastro consultation per patient**		NOK 29.75	35% of patient receive this, time use = 15min, Certified nursing assistant cost per hour for SUS = 340NOK	SUS
	Average secretary cost Gastro consultation per patient**		NOK 39.55	35% of patients receive this, time use = 0.35 hour, secretary cost per hour for SUS = 322NOK	SUS
	Average cost of goods Gastro consultation per patient**		NOK 8.75	35% of patients receive this, cost Mouthpiece = 9NOK, Oval cup = 10, other goods cost estimate= 6NOK	SUS
Average Total Pathway costs per patient		**NOK 11,205.59**	**NOK 5,070.63**		

* MD = Medical doctor

**Assumed to be relatively Standardized task, standard error assumed to be 25%

*** Assumed to be a less standardized task, standard error assumed to be 50%

**** Variation in sensitivity analysis assumed to be fixed ratio of average nurse cost

*****Variation in sensitivity analysis assumed to be fixed ratio dependent of average MD costs

Appendix 4: Cost calculation and explanation of R10.4 surgical patients.

Pathway Stage	Costs	Unspecific Abdominal Pain (R10.4) - Surgical Patients: Inpatient	Outpatient (Day & ambulatory)	Explanation	Source
Arrival	Average secretary cost per patient**	NOK 161.00		Time use = 30min, Secretary cost per hour for SUS = 322NOK	SUS
Triage & Medical Examination	Average blood test cost per patient**	NOK 20.00		Estimate average cost per blood test at 20NOK from SUS cost accounting data	SUS
	Average MD costs per patient***	NOK 1,000.00		Time use = 2 hours, MD cost per hour for SUS = 500NOK	SUS
	Average cleaning cost per patient**	NOK 48.00		Time use = 10min, Cleaner cost per hour for SUS = 288NOK	SUS
	Average X-ray Abdomen cost per patient**	NOK 226.88		Average estimate per X-ray at 219NOK from SUS cost accounting data (2015)	SUS
	Average cost bed disinfected per patient**	NOK 125.00		Cost based on average cost from SUS Driftservice department cost accounting	SUS
	Average registered nurse AED ward cost per patient***	NOK 2,366.00		Estimated by taking total nurse salary cost at "Mottaksklinikken" in 2016 (100,095,513NOK) multiplying by the share of salary cost allocated to the AED (62%), and then dividing on the total number of patients provided care in the AED during 2016 (26,225 persons).	SUS
	Average cost of goods per patient in the AED*****	NOK 230.00		Estimated by dividing total cost of goods in 2016 for the AED (6,034,218NOK) by total number of patients provided care in the AED in 2016 (26,225 persons), equals 230NOK.	SUS
	Average CT scan/ultrasound abdomen per patient**	NOK 270.24		15% of patients receive one of the services, unweigthed average for ultrasound and CT at SUS is 1739NOK (2015)	SUS
	Average porter --> gynacologist cost per patient**	NOK 27.25		Assume that 50% of all women receive this service and that 50% of all patients are women. Time use = 20min, porter cost per hour for SUS = 327NOK	SUS
	Average nurse cost at gynacologist per patient**	NOK 48.00		Assume that 50% of all women receive this service and that 50% of all patients are women. Time use = 30min, nurse cost per hour for SUS = 384NOK	SUS
	Average gynacologist cost per patient**	NOK 62.50		Assume that 50% of all women receive this service and that 50% of all patients are women. Time use = 30min, gynacologist assumed equal MD cost per hour for SUS = 500NOK	SUS
	Average cost of goods at gynacologist per patient**	NOK 12.50		25% of patients receive this (fetile women),Estimated cost of goods for a gynacologist based on SUS accounting data	SUS
SUM-Three first stages		**NOK 4,597.37**			
Admission at 6H - Gastro Surgical Ward	Average nurse cost at gastro sugical ward 6H***	NOK 3,938.62		Estimated through dividing total salary cost in 2016 (26,278,815NOK) at the ward 6H, by the total amount of days of stay in 2016 (8,607 stays), multiply this with the average LOS for surgical R10.4 patients at 1.29 days.	SUS
	Average blood test cost per patient**	NOK 20.00		Estimate average cost per blood test at 20NOK from SUS cost accounting data	SUS
	Average cost of goods per patient 6H****	NOK 661.41		Estimated through dividing the total cost of goods at the 6H ward in 2016 (4,412,972NOK) by on the total amount of stay during 2016 (8,607 stays), multiplied by the average LOS for surgical R10.4 patients at 1.29 days.	SUS
	Average cost for MD patient vist at ward**	NOK 250.00		Time use = 30min, MD cost per hour for SUS = 500NOK	SUS
	Average CT scan cost per patient**	NOK 1,683.50		60% of the patients take a CT scan of the abdom, average cost of CT at SUS was 2709NOK (2015)	SUS
	Average ultrasound abdomen cost per patient**	NOK 159.54		20% of patients receive this service, average cost of ultrasound at SUS in 2015, 768NOK	SUS
	Average porter cost per patient**	NOK 36.33		33.33% of patients receive this, time use = 20min, porter cost per hour for SUS = 327NOK	SUS
SUM-Stage		**NOK 6,749.40**			
Outpatient Discharge Conversation (attempt to treat as outpatient)	Average MD cost per patient**	NOK 62.50		12,5% of patients treated that are attempted treated as outpatient, they are admitted in the end. MD time use = 60min, MD cost per hour for SUS = 500NOK	SUS
	Average secretary cost per patient**	NOK 20.13		12,5% of patients treated that are attempted treated as outpatient, they are admitted in the end. MD time use = 30min, MD cost per hour for SUS = 322NOK	SUS
Discharge Conversation	Average MD cost per patient**	NOK 375.00	NOK 500.00	Inpatient: Time use = 45min; Outpatient:Time use = 60min, MD cost per hour for SUS = 500NOK	SUS
	Average secretary cost per patient**		NOK 161.00	Time use = 30min, Secretary cost per hour for SUS = 322NOK	SUS
Average Total Pathway costs per patient		**NOK 11,804.40**	**NOK 5,258.37**		

* MD = Medical doctor
**Assumed to be relatively Standardized task, standard error assumed to be 25%
*** Assumed to be a less standardized task, standard error assumed to be 50%
**** Variation in sensitivity analysis assumed to be fixed ratio of average nurse cost
*****Variation in sensitivity analysis assumed to be fixed ratio dependent of average MD costs

Appendix 5: Benefit calculation and explanation for all patient groups

Classification	Benefits			Explanation	Source
		Ambulatory Patient			
D7-A	Average ABF revenue per R07.4 ambulatory patient	NOK	967.91	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10M-A	Average ABF revenue per R10.4 medical ambulatory patient	NOK	1,126.33	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10S-A	Average ABF revenue per R10.4 surgical ambulatory patient	NOK	896.97	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
		Day Patient			
D7-D	Average ABF revenue per R07.4 day patient	NOK	3,081.25	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10M-D	Average ABF revenue per R10.4 medical day patient	NOK	2,572.50	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10S-D	Average ABF revenue per R10.4 surgical day patient	NOK	2,864.55	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
		Inpatient			
D7-I	Average ABF revenue per R07.4 inpatient	NOK	7,158.42	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10M-I	Average ABF revenue per R10.4 medical inpatient	NOK	11,552.37	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10S-I	Average ABF revenue per R10.4 surgical inpatient	NOK	10,236.70	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
		Ambulatory & Day Patient			
D7-AD	Average ABF revenue per R07.4 ambulatory & day patient	NOK	2,116.82	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10M-AD	Average ABF revenue per R10.4 medical ambulatory & day patient	NOK	1,598.17	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
D10S-AD	Average ABF revenue per R10.4 surgical ambulatory & day patient	NOK	1,562.93	Average ABF revenue (2014-2016) based on inclusion criteria from hospital data	SUS
		Benefits attributed to several patient groups & Social Cost Savings			
D7-A D7-D D7-AD	Average ABF revenue Follow-up Consultation per R07.4 ambulatory/day patient	NOK	338.77	35% of patients receive follow-up consultation (963.82NOK)	SUS
D10M-A D10M-D D10M-AD	Average ABF revenue Follow-up Consultation per medical R10.4 ambulatory/day patient	NOK	394.22	35% of patients receive follow-up consultation (903.46NOK)	SUS
D7-A D10M-A D7-D D10M-D D7-AD D10M-AD	Average out-of-pocket payment Follow-up consultation per ambulatory/day patient	NOK	112.00	35% of ambulatory/day medical R10.4 and R07.4 patients receive follow-up, out-of-pocket payment was 320NOK (2016)	
D7-A D10S-A D10M-A	Average out-of-pocket payment per ambulatory patient	NOK	320.00	Out-of-pocket was 320NOK at SUS (2016)	SUS
S7	Average productivity increase if all R07.4 inpatient were treated as outpatient	NOK	1,234.47	Assume that work force are only patient 25-65 years of age. Thats 69.23% of patient R07.4 inpatient population at SUS (2014-2016). 10.78% of these are either unemployed or receive disability payment, yield working patients 61.77%. Estimate average productivity per work hour in Norway at 262.15NOK (average monht salary = 43,300NOK (2016), work hours per year = 1950, 7.5 hours per working day)	
S10M	Average productivity increase if all medical R10.4 inpatient were treated as outpatient	NOK	1,008.43	Assume that work force are only patient 25-65 years of age. Thats 56.56% of medical patient R10.4 inpatient population at SUS (2014-2016). 10.78% of these are either unemployed or receive disability payment, yield working patients 50.46%. Estimate average productivity per work hour in Norway at 262.15NOK (average monthly salary = 43,300NOK (2016), work hours per year = 1950, 7.5 hours per working day)	NAV Rogaland; Statistics Norway
S10S	Average productivity increase if all surgical R10.4 inpatient were treated as outpatient	NOK	929.45	Assume that work force are only patient 25-65 years of age. Thats 52.13% of medical patient R10.4 inpatient population at SUS (2014-2016). 10.78% of these are either unemployed or receive disability payment, yield working patients 46.51%. Estimate average productivity per work hour in Norway at 262.15NOK (average month salary = 43,300NOK (2016), work hours per year = 1950, 7.5 hours per working day)	NAV Rogaland; Statistics Norway
D7-A D10M-A D7-D D10M-D D7-AD D10M-AD D10S-A S7 D10S-D S10M D10S-AD S10S	Average benefit of outpatient treatment effect on decrease in no. of hallway patients	NOK	90.91	Assumed that every outptient reduce hallway patients with 30%. Boardman and Forbes (2011) found WTP at 36CAD (2008) for moving from shared to single patient room. Assume that value is equal to value of avoiding one hallway patient. Purchase power parity adjusted and inflation adjusted for Norway, 2016	Boardman and Forbes (2011); Inflation Calculator Canada; OCED Purchaser Powerity Index
S10M	Average cost saving by treating medical R10.4 outpatient compared to inpatient	NOK	6,134.96	Incremental cost saved when treating outpatient compared to inpatient	SUS
S10S	Average cost saving by treating surgical R10.4 outpatient compared to inpatient	NOK	6,546.03	Incremental cost saved when treating outpatient compared to inpatient	SUS
S7	Average cost saving by treating R07.4 outpatient compared to inpatient	NOK	4,966.59	Incremental cost saved when treating outpatient compared to inpatient	SUS

<u>Explanation classifications</u>: D7-A = Benefit attributed to R07.4 ambulatory patients; D7-D = Benefit attributed to R07.4 day patients; D7-I = Benefit attributed to R07.4 inpatients; D7-AD = Benefit attributed to R07.4ambulatory & day patient. The identical logic system of classifications is applied for the medical (10M) and surgical (10S) R10.4 patients. When S is the first letter of the classification, the item is a social cost saving item, e.g. S7, S10S and S10M.