



# **BUSINESS CASE FOR THE NATIONWIDE ROLLOUT OF TELEMEDICAL HOME MONITORING FOR CITIZENS WITH COPD**

3 March 2017





# THE PORTFOLIO STEERING GROUP'S FOREWORD

The government, Local Government Denmark and the Danish Regions have agreed to implement telemedical home monitoring for citizens suffering from COPD in the whole country by the end of 2019, and it is in connection with this that the present business case has been prepared.

A joint public portfolio steering group comprised of representatives from municipalities, the Ministry of Health, Danske Regioner, Local Government Denmark and the Danish Agency for Digitisation has approved this business case.

The joint public portfolio steering group has agreed, on the basis of the business case, that it can be concluded that there is both a financial and healthcare-related potential in offering telemedical home monitoring to citizens suffering from COPD.

The business case for the rollout of telemedical home monitoring for citizens with COPD is not a business case for any individual regional programme, since it is based on a number of assumptions that stem from the TeleCare Nord project. The concrete business case (costs and benefits) for a region will depend on how telemedical home monitoring for citizens with COPD will be implemented locally, e.g. which telemedical solution each regional programme chooses to implement. The regional programmes can therefore set their own input parameters for costs and economic potential and thereby use this business case as a planning tool. In connection with the rollout, however, it has been decided that the realisation of gains on both a national and regional programme level will be followed up on.

## **Telemedicine in the context of healthcare services of the future**

The Danish healthcare system is in a constant state of development and moving towards an organisational structure where clinical competences are concentrated in a few specialist hospitals. The rollout of telemedical home monitoring for citizens suffering from COPD, which this business case revolves around, should be considered as part of a major overhaul of the Danish healthcare services that will result in greater distances between citizens who do not live close to a hospital and the specialist medical competences they require.

The centralisation at hospitals will require that citizens are supported close to home so that they are still able to access high-quality healthcare services and feel confident and in charge of their own treatment. One tool to achieve such an outcome is telemedical home monitoring. The results from TeleCare Nord and this business case show that telemedical home monitoring provides patients with knowledge and competences that contribute to self-care, increased quality of life, patient safety and satisfaction. Telemedical home monitoring thereby contributes to enhancing the accessibility of healthcare services in a way that chronically ill patients experience improved treatment and rehabilitation. Telemedical home monitoring is therefore a tool that supports treatment programmes for the chronically ill.

The portfolio steering group therefore considers the rollout of telemedical home monitoring for citizens with COPD as one of several steps in the direction of a healthcare system that to a greater extent uses telemedicine

for prevention, treatment and rehabilitation for the benefit of citizens in municipalities and regions. In the long term, the service will be rolled out to other patients and citizens.

#### Business cases: Criticised yet necessary

The state, municipalities and regions agree that a business case is required for testing and rolling out telemedicine. The reasoning is that a business case can illustrate both the qualitative and quantitative potential and costs of implementing telemedicine. Such a basis for decision-making is necessary because the gains and costs must be made clear in a systematic and recognisable way.

Business cases are often criticised for not accurately representing the reality on the ground in the municipalities and regions they concern. However, the portfolio steering group agrees that a well-documented business case is necessary - regardless of the criticism directed at the use of business cases. Criticism would also arise if the decision to roll out the solution was not based on a financial consequence analysis.

In order to counter such criticism, however, it is important to ensure that the data used in a business case is valid. A preliminary business case has previously been prepared to clarify the financial consequences of telemedical home monitoring for citizens with COPD. This business case has subsequently been recalculated using data from the research project TeleCare Nord.

TeleCare Nord started as a large-scale project implemented as an RCT study in the North Denmark Region. A number of researchers were attached to the project, including one researcher tasked with investigating the health economics effects of introducing telemedical home monitoring for citizens with COPD. Data from this study has been included in the business case. Therefore, the portfolio steering group finds that the business case is based on the best possible data, and that the uncertainties in this business case are comparatively smaller than in other cases because it relies on robust data.

Finally, business cases are dynamic and should therefore be continuously revisited in local projects, for example, if the assumptions/circumstances change.

#### Stratification of subgroups in the business case

The financial and quality-related gains as well as expenses shown in the business case have been stratified by subgroups of citizens with COPD. What this means is that the business case is divided into subgroups within the old GOLD classification of COPD. The business case's calculations concern GOLD 3 (severe COPD) and GOLD 4 (very severe COPD) patients, since the results from TeleCare Nord show that it is these two groups who achieve both qualitative and quantitative gains from telemedical home monitoring.

#### The difference between the health economics study and the business case

The preliminary results from the health economics study carried out in connection with TeleCare Nord show that there is an additional cost associated with offering telemedical home monitoring to citizens classified as belonging to the old GOLD 4 group.

This stands in contrast to the business case, which shows a slightly positive economic potential for the old GOLD 4 group.

There is not a clear explanation for this difference in results, but it is presumably due to PA Consulting Group not having had access to data at the individual level, which only the researchers have access to due to research ethics considerations.

#### What does the new GOLD classification mean for the business case and nationwide rollout?

Based on the new GOLD classification, healthcare guidelines recommend that telemedical home monitoring should be offered to all citizens in the new GOLD D group, and not groups 3 and 4 under the old GOLD classification scheme upon which the present business case is based.

The portfolio steering group's assessment is that this does not present a problem for the business case, as experiences from TeleCare Nord also showed a positive health economics effect for citizens who suffered from severe COPD and whose identities were already known to the municipality. The GOLD D group is expected to include 56% of those classified under the old GOLD 3 and 4 groups.

Telemedical home monitoring will still be offered to citizens with the most severe forms of COPD, as GOLD D group patients are a major strain on public health services and suffer from many of the symptoms associated with the condition.

Sincerely,

The national portfolio steering group for the nationwide rollout of telemedical home monitoring for citizens with COPD

## Recalculation of the business case for the nationwide rollout of telemedical home monitoring for citizens with COPD

During the period January-May 2015, PA Consulting Group prepared a preliminary business case for a nationwide rollout of telemedical home monitoring for citizens with COPD. The preliminary business case was based on data from a number of sources, including (and primarily) the large-scale project TeleCare Nord. The project was an RCT study carried out with the participation of a research group from Aalborg University and with a study design that entailed collecting data from a control group and an intervention group, both before and after the introduction of a telemedicine service for randomly selected citizens suffering from COPD. The data from the TeleCare Nord project that was used for the preliminary business case was obtained immediately after the end of the intervention period and prior to the data processing that commenced as part of the health economic research project connected to TeleCare Nord. On the basis of the preliminary business case, the Danish government, Local Government Denmark and Danske Regioner reached an agreement (in connection with the 2016 financing agreements) on the nationwide rollout of telemedicine by the end of 2019.

As a result of the agreement on the nationwide rollout, PA Consulting Group carried out a recalculation of the preliminary business case during the period May-September 2016, based on the processed data from the health economics research project. Access to processed data has made it possible to qualify the preliminary business case, first and foremost through a stratification of the collected data on the basis of the participants' severity of COPD. The recalculated business case is intended to support the planning and implementation work in the five regional programmes for the rollout of telemedical home monitoring for citizens with COPD. The results of this recalculation are presented in the present report.

The following sections summarise the most important characteristics of the recalculated business case, seen in relation to the previous and preliminary business case and the health economics research project carried out in connection with TeleCare Nord:

- Estimated economic potential on the basis of aggregated data. Both the preliminary and recalculated business case have been prepared on the basis of aggregated data, meaning average values for each of the investigated types of potential in the intervention and control groups, respectively, before and after the intervention. Thus, PA Consulting Group has been restricted from working with data from TeleCare Nord at the individual level, as for ethical reasons, only the researchers involved with the health economics research project carried out in connection with TeleCare Nord have had access to that level of data. Consequently, the business case relies on a different approach and another set of methodological tools than those used in the health economics research project. As a consequence, it can be expected that there will be differences between the calculated results in the recalculated business case and the health economics research project.
- Delimitation of the target group for telemedicine for citizens with severe and very severe COPD (GOLD 3 and 4). This business case is calculated on the basis of a target group for telemedicine which includes patients with severe and very severe COPD (GOLD 3 or 4). The preliminary results that have been published by the health economics research project carried out in connection with TeleCare Nord show with a high degree of confidence that, from a health economics perspective, it is most relevant to provide telemedical home monitoring to citizens with severe COPD (GOLD 3), rather than the other groups of citizens suffering from COPD (GOLD 1, 2 and 4). It is assumed that citizens in the GOLD 3 category will continue their telemedical treatment when their condition develops from severe to very severe COPD (GOLD 4). The selected target group is of particular importance in relation to the economic potential identified in the recalculated business case.
- Stratified data changes the business case's results. In extension of the above delimitation of the target group for citizens with severe COPD (GOLD 3) and very severe COPD (GOLD 4), the recalculated business case relies on stratified data, making it possible to

describe the development of the investigated types of economic potential broken down by the severity of the participants' COPD condition (GOLD 1-4). There was no opportunity to access stratified data in the preliminary business case, and the development of each type of potential was consequently calculated on the basis of the observed development in the total data set. However, the breakdown of data into subgroups (GOLD 1-4) shows that there are cost level differences across the different GOLD groups before the COPD patients/participants started with telemedicine. Stratification also shows that telemedical home monitoring affects citizens in each GOLD group differently. Therefore, having access to stratified data means that the economic potential in the recalculated business case differs significantly from the preliminary business case, where it was not possible to break down the data by each group.

# MAIN FINDINGS

The business case identifies a number of significant qualitative gains for citizens suffering from COPD who make use of telemedical home monitoring. Among other things, these benefits relate to increased knowledge and competences in terms of self-care as well as an increased quality of life.

In financial terms, the business case is positive, identifying an accumulative net economic potential of DKK 483 million over a period of five years by rolling out telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 & 4). The total annual net potential with a full phasing-in of the business case amounts to DKK 202 million on the national level.

The potential identified in the business case relates largely to citizens suffering from severe COPD (GOLD 3), and the main driver for this financial potential is a decrease in expenses for hospital admissions. In addition, there is a slightly positive economic potential arising from a decrease in expenditure for practical assistance and care in municipalities.

The business case is associated with some degree of uncertainty, which is why the total economic potential can turn out to be both higher and lower than what has been estimated. Therefore, the business case includes an uncertainty spread in the form of a worst case scenario of DKK 388 million and a best case scenario of DKK 578 million for the accumulative net economic potential over a period of five years.

## Mission and aim

The government, Local Government Denmark and Danske Regioner have, as part of the common public 2013-2020 Strategy for Digital Welfare (in Danish: Strategi for Digital Velfærd 2013-2020), launched an initiative for a nationwide rollout of telemedicine (initiative 1.1 *Rollout of telemedicine in the whole country*).

In extension thereof, PA Consulting Group prepared a preliminary business case during the period January-April 2015 for a nationwide rollout of telemedical home monitoring for citizens with COPD. The preliminary business case was based on data from a number of sources, including (and primarily) the large-scale project TeleCare Nord. The project started as an RCT study carried out with the participation of a research group from Aalborg University. It used a study design that entailed collecting data from a control group and an intervention group, both before and after the introduction of a telemedicine service for randomly selected citizens suffering from COPD.



The data from the TeleCare Nord project that was used for the preliminary business case was obtained immediately after the end of the intervention period and prior to the data processing that commenced as part of the health economic research project carried out in connection with TeleCare Nord.

On the basis of this preliminary business case, the government, Local Government Denmark and Danske Regioner reached an agreement (in connection with the 2016 financing agreements) on the nationwide rollout of telemedicine by the end of 2019.

In extension of the agreement that was reached on the nationwide rollout, PA Consulting Group carried out a recalculation of the preliminary business case during the period May-September 2016, based on the processed data from the health economics research project. Access to processed data has made it possible to qualify the preliminary business case, first and foremost through a stratification of the observed results on the basis of the participants' severity of COPD. The recalculated business case is intended to support the planning and implementation work in the five regional programmes for the rollout of telemedical home monitoring for citizens with COPD. The results of this recalculation are presented in the present report.

## Main findings of the business case

These are the main findings of the business case for the nationwide rollout of telemedical home monitoring:

1. Significant qualitative gains for citizens suffering from COPD
2. The business case has a positive economic potential of an estimated DKK 483 million over five years
3. A degree of uncertainty has been factored into the business case
4. New guidelines for the selection of target groups can impact the business case

### 1. Significant qualitative gains for citizens suffering from COPD

In the large-scale projects TeleCare Nord and KIH, a number of qualitative gains have been identified for citizens with COPD through a nationwide rollout of telemedical home monitoring. The qualitative gains have not been ascribed financial value in the business case.

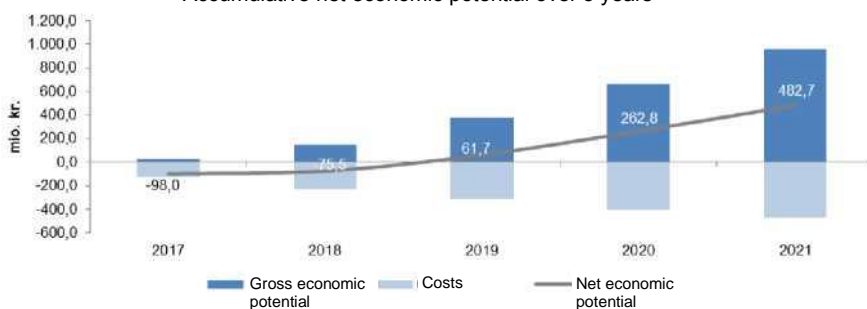
These are the main qualitative gains:

- Increased knowledge and competences for self-care. Telemedical home monitoring for relevant COPD patients can contribute to increasing their understanding of the condition and their self-care competences. Prior knowledge of the technology used and the patients' own illness is not a crucial prerequisite for success in connection with the use of telemedical home monitoring.
- Influence on their own condition. Telemedical home monitoring can make citizens with COPD more active and involved in their own treatment process.
- Increased quality of life, patient confidence and satisfaction. Telemedical home monitoring for citizens with COPD is very likely to have a life-quality-enhancing potential, particularly for citizens with severe COPD (GOLD 3). In the large-scale projects, the level of patient confidence and self-perception of their health has had a positive development as a result of the home monitoring.

### 2. The business case has a positive economic potential of an estimated DKK 483 million over five years

The business case for a nationwide rollout of telemedical home monitoring for citizens with COPD is positive with an accumulative net economic potential over the business case's five-year duration amounting to DKK 483 million on a national level (using 2016 prices). The annual net economic potential of a full phasing-in of the business case is positive, with DKK 202 million at the national level after 2020 (calculated average for the annual result in a future operational situation; 2016 prices). A degree of uncertainty has been factored into the business case (see point 3 below).

Accumulative net economic potential over 5 years



The business case's accumulative gross economic potential over five years is DKK 956 million and consists of positive effects that are essentially linked to a decrease in costs related to hospital admissions as well as (to a lesser extent) a decrease in costs for practical assistance and care in municipalities. The total costs over this five-year period amounts to DKK 474 million and is essentially linked to the acquisition and operation of the telemedicine equipment that will be provided to citizens with COPD as well as time spent by health professionals on ongoing monitoring and follow-ups of the patient's recorded health measurements.

### 3. A degree of uncertainty has been factored into the business case

The business case factors in a degree of uncertainty on key parameters. The uncertainties mean that the figures stated in the business case may prove to be either lower or higher than estimated on the basis of the available data.

Therefore, the business case has an uncertainty spread with a worst case scenario of DKK 388 million and a best case scenario of DKK 578 million. The spread between the best case and worst case scenario is determined by the uncertainty of the input variables used in the business case if a given value is associated with uncertainty – and, if at the same time, it is characterised by a high degree of sensitivity and therefore has significant implications on the overall results of the business case.

### 4. New guidelines for the selection of target groups can change the business case

The business case focuses on citizens who in the old COPD classification scheme belonged to the GOLD 3 and GOLD 4 groups. The new clinical guidelines recommend (based on the new COPD classification scheme) that the target group for telemedical home monitoring should be citizens in the GOLD D group due to the medical assessment that this group will be able to benefit the most from the service.

A perspective calculation has been done to shed light on the financial effects of this change in the target group. The perspective calculation shows an accumulative net economic potential over five years of between DKK 141-619 million. The annual net economic potential of a full phasing-in is between DKK 94-240 million. The spread reflects two scenarios that together outline the possible consequences of the adjustment of the target group. Scenario 1 assumes that the effect per patient classified as GOLD D is at least the same as for citizens who were classified as GOLD 3 and 4. Scenario 2 assumes that there are citizens with GOLD D who achieve all the beneficial effects observed in TeleCare Nord and thereby drive the entire economic potential described in this business case. The perspective calculation is, however, marked by a high degree of uncertainty.

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# 1 INTRODUCTION

The Danish government, Local Government Denmark and Danske Regioner have, as part of the common public 2013-2020 Strategy for Digital Welfare, launched the initiative *Rollout of telemedicine in the whole country* (initiative 1.1c). In connection with this initiative, the government, Local Government Denmark and Danske Regioner reached an agreement (in connection with the 2016 financing agreements) for a national rollout of telemedicine by the end of 2019. As part of the agreement, a business case concerning the qualitative and financial gains of a national rollout of telemedical home monitoring for citizens with COPD was prepared.

The business case was prepared by PA Consulting Group and was made available in a preliminary version in mid-2015, with a subsequent recalculation that took place during the period of May to September 2016.

## 1.1 Aim and background

The government, Local Government Denmark and Danske Regioner have, as part of the common public 2013-2020 Strategy for Digital Welfare (in Danish: Strategi for Digital Velfærd 2013-2020), launched an initiative for a nationwide rollout of telemedicine (initiative 1.1 *Rollout of telemedicine in the whole country*).

In extension thereof, PA Consulting Group prepared a preliminary business case during the period January-April 2015 for a nationwide rollout of telemedical home monitoring for citizens with COPD. The preliminary business case was based on data from a number of sources, including (and primarily) the large-scale project TeleCare Nord. The data from the TeleCare Nord project that was used for the preliminary business case was obtained immediately after the end of the intervention period and prior to the data processing that commenced as part of the health economics research project under the auspices of TeleCare Nord.

On the basis of this preliminary business case, the Government, Local Government Denmark and Danske Regioner reached an agreement (in connection with the 2016 financing agreements) on the nationwide rollout of telemedicine by the end of 2019.

In extension of the agreement that was reached on the nationwide rollout, PA Consulting Group carried out a recalculation of the preliminary business case during the period May-September 2016, based on the processed data from the health economic research project. Access to processed data has made it possible to qualify the preliminary business case, first and foremost through a stratification of the observed results on the basis of the participants' severity of COPD. The recalculated business case is intended to support the planning and implementation work in the five regional programmes for the rollout of telemedical

home monitoring for citizens with COPD. The results of this recalculation are presented in the present report.

The preparation of the business case has been anchored in a steering group consisting of Local Government Denmark, Danske Regioner as well as the Ministry of Health, Agency for Digitisation and the Central Denmark Region. The business case's results are reported to the common public portfolio steering group for the nationwide rollout of telemedical home monitoring for citizens with COPD.

Telemedical home monitoring, as defined in this business case, consists of the care and treatment between citizens and healthcare professionals, supported by communication and information technology that is used to record and report data from a distance.

The business case for providing telemedical home monitoring for citizens with COPD includes activities in hospitals (including admissions and outpatient visits), municipal care, practical assistance and nursing services as well as in general practices. The business case includes both financial gains (e.g. fewer hospital admissions among citizens suffering from COPD) and qualitative gains such as increased quality of life and patient empowerment.

## 1.2 The two large-scale projects

The business case is essentially based on data from the implementation of the two large-scale projects TeleCare Nord and NetKOL (under KIH). It was determined that the data from these projects, in a Danish context, represents the best experience base in relation to the expenditure of time, project costs and clinical efficacy as a basis for preparing a nationwide business case.

### 1.2.1 TeleCare Nord

The TeleCare Nord project has piloted home monitoring for citizens with COPD in the North Denmark Region. 1,225 citizens suffering from either severe or very severe COPD participated in the project, which has been implemented as a RCT study where the solution has been tested in full operation (587 in the intervention group and 647 in the control group). A number of PhD students were attached to the TeleCare Nord project with a view to ensuring scientific documentation of (among other things) the health economics effects and the qualitative, person-centred gains. Given the scope of the TeleCare Nord project - both in relation to the number of participants and the level of cross-sectorial involvement - the data from the project provides a unique basis for assessing the effects of telemedical home monitoring in a Danish context.

The telemedicine service includes monitoring of patients in their own homes via tablets and equipment for measuring health parameters (oxygen saturation, heart rate and weight), as well as asynchronous monitoring of data and follow-ups by health professionals. The project is a cross-sectorial collaboration between the 11 municipalities in northern Jutland, the North Denmark Region, general practitioners in northern Jutland as well as Aalborg University revolving around the development of a solution for telemedical home monitoring aimed at citizens living in northern Jutland who suffer from COPD (Chronic Obstructive Pulmonary Disease).

The goal of the project is for TeleCare Nord to become a telehealth service for all citizens living in northern Jutland with severe or very severe COPD (GOLD 3 and 4) who could benefit from the project's telemedical home monitoring solution irrespective of which municipality, hospital or general practitioner an individual with COPD is attached to. In practice, citizens with mild and moderate COPD (GOLD 1 and 2) were also included in the TeleCare Nord project.

In the project, telemedical home monitoring was defined as care and treatment between a person's home and healthcare professionals, supported by communication and information technology.

In addition to the project organisation itself<sup>1</sup>, the TeleCare Nord project has developed a collaboration concept for the actors involved and an associated support model for the solution.

<sup>1</sup> Read more on the project webpage: <http://www.rm.dk/Sundhed/Til-sundhedsfaellige-og-samarbejdspartnere/TeleCare-Nord>

The distribution of tasks and organisation from this collaboration concept has been employed in the business case's calculations, which is why it will be elaborated upon in the following.

The objective has been a collaboration concept which could be implemented in the involved organisations, along with a support model that defined the framework for the project's various support tasks. Collectively, the collaboration concept and support model make up key parts of the overall distribution of tasks and responsibilities in the TeleCare Nord project, including between public and private sector actors. Table 1 provides a comprehensive overview of key activities and tasks in the project as well as their associated responsible parties.

Table 1: Overall organisation of tasks and responsibilities in the TeleCare Nord project<sup>1</sup>.

Activity/Task	Responsibility
Identification of suitable citizens	General practitioner, hospital, municipality
Referral of citizens	General practitioner, hospital, municipality
Inclusion (administrative task)	Municipality
Inclusion (instruction of citizens)	Municipality
Weekly follow-ups on recorded health measurements	Municipality (and with a few exceptions, hospital)
System operation management	Consolidated IT North Denmark Region
System management of the IT solution	Project secretariat, Consolidated IT North Denmark
System management of joint collaboration	Project secretariat
Helpdesk/support (health professionals)	Project secretariat, Frederikshavn Municipality
Helpdesk/support (citizens)	Municipality
Application maintenance (IT-solution)	Private supplier (Silverbullet A/S)
Supplier management	Project secretariat
Logistics and maintenance	Private supplier (Atea)
Professional development	Project secretariat, health track

### 1.2.2 NetKOL

Clinically Integrated Home Monitoring (Klinisk Integreret Hjemmemonitorering, or KIH) is a cross-sectorial project based in the Central Denmark Region and the Capital Region. The project includes approximately 1,200 citizens with COPD, diabetes, inflammatory intestinal diseases and pregnant women with and without complications. The sub-project NetKOL includes two rounds of 124 citizens suffering from COPD who have been through the project, distributed into an intervention and control group (a total of 281 citizens suffering from COPD were included in the study). NetKOL is a cross-sectorial collaboration between the pulmonary/respiratory departments at four hospitals in the Capital Region as well as 10 municipalities.

The objective of the sub-project NetKOL has been to implement a telemedical initiative to achieve higher quality of treatment and a more tailored treatment for individual, as well as more efficient coordination and use of healthcare resources in the form of fewer hospital admissions and outpatient visits. The telemedicine initiative is aimed at citizens with severe or very severe COPD who are in outpatient treatment via hospitals. The telemedicine service includes monitoring of patients in their own homes via tablets and equipment that measures health parameters (lung function, oxygen saturation, heart rate and

weight), asynchronous monitoring of data and follow-ups by health professionals as well as video conversations between the patient in their home and the hospital.

Unlike TeleCare Nord, the organisational responsibility for monitoring the health of the citizens has been in the hands of the pulmonary outpatient clinics rather than the municipalities, and video conferences have been used in connection with the continuous monitoring.

The sub-project has also included municipal home care in a number of municipalities. The collaboration between hospital and home care is supported by a shared access to data and video conferencing. The municipal home care staff can assist the patients with measurements and video consultation as needed, and it is also possible for the municipality to have video conferences with the patient.

### 1.3 National prerequisite measures

This business case has been prepared taking into account key national initiatives in the telemedicine area that are already underway.

As part of the 2016 financing agreement on the rollout of telemedicine, a prerequisite project has been launched to ensure the maturation of Denmark's telemedical infrastructure. A total of DKK 21.3 million has been allocated to the three components of the maturation activities:

- Maturation of the KIH database and its integration with other application systems
- Maturation of services and standards in the National Health Platform (Nationale Sundhedsplatform)
- Maturation of governance in relation to OpenTele

Furthermore, the expenses associated with the establishment of a secretariat to coordinate the nationwide rollout, prerequisite measures regarding service and logistics as well as the preparation of the business case and healthcare guidelines have been factored in. Overall, the national prerequisite measures which have already been planned or implemented amount to DKK 47 million, which has been factored into this business case.

### 1.4 Structure of the report

This report presents the business case, including its main results and conclusions as well as key data points and methodological considerations.

The remainder of this report consists of the following chapters:

- Chapter 2: Results of the business case
- Chapter 3: Methodology and approach
- Chapter 4: Review of input parameters

## 2 RESULTS OF THE BUSINESS CASE

The result of the business case for a nationwide rollout of telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) is an accumulative net economic potential over five years amounting to DKK 483 million. The business case is modelled on the basis of a rollout of the organisation from the large-scale project TeleCare Nord in the North Denmark Region to the whole country. The calculations of the business case are characterised by a degree of uncertainty, meaning the results may prove to be either higher or lower than what has been estimated. The worst case scenario is assessed as resulting in DKK 388 million, while the best case scenario is assessed as resulting in DKK 578 million.

### 2.1 Results

The business case outlines the financial aspects in relation to a nationwide rollout of telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) in the five regional programmes over a period of five years from 2017-2021.

The business case is modelled on the technical and organisational setup used in TeleCare Nord (see the above description in section 1.2.1), and the assumption in the calculations of this business case is that a similar setup will be rolled out to the other Danish regions (adjustments have been made on a number of input parameters in relation to the experiences from TeleCare Nord, which is explicitly stated in the review of each input parameter in Chapter 4). The business case also takes into account different activity levels for hospital admissions and outpatient visits in the five regions.

The potential is achieved through the preventive effects of telemedicine for citizens suffering from COPD, particularly in the form of expenditure on hospital admissions as well as a decrease in costs for practical assistance and care in municipalities. The costs detailed in the business case relate particularly to procurement and ongoing replacement of the telemedical equipment (scales, oxygen meters, tablets) as well as systematic follow-ups on the measuring data.

The business case looks at a five-year period from 2017-2021. It is calculated on the basis of 2016 PL levels, and the results are generally listed in fixed 2016 prices.

#### 2.1.1 Total net potential over five years

The business case for a nationwide rollout of telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 & 4) results in an accumulative economic potential of DKK 483 million over a 5-year period.

The following figure and table provide an overview of the development in the business case's accumulative gross economic potential, costs and net economic potential over the 5-year period for citizens with severe



and very severe COPD (GOLD 3 and 4). The business case has a payback period of just over two years. The net economic potential is particularly a result of the average expenditure on hospital admissions for citizens with severe COPD (GOLD 3) falling significantly. There is some uncertainty associated with the estimate on hospital admissions, which is elaborated upon in section 2.1.2 as well as in Chapter 3.

Figure 1 Main effects of the business case (DKK million in fixed prices)

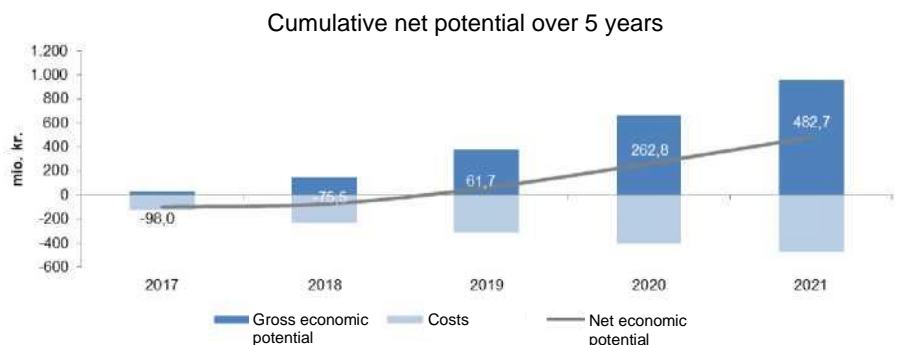


Table 2 Accumulative net economic potential over five years, development over the period (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021
Gross potential	27.1	151.2	376.4	663.5	956.3
Positive effects	28.2	157.6	392.4	691.6	996.9
Negative effects	-1.1	-6.4	-16.0	-28.2	-40.6
Costs - operation and investment	-125.1	-226.7	-314.7	-400.7	-473.6
<b>Net potential</b>	<b>-98.0</b>	<b>-75.5</b>	<b>61.7</b>	<b>262.8</b>	<b>482.7</b>

Concerning the total economic potential, it should be noted that the business case does not consider the consequences of the ongoing implementation of a new hospital system structure, which in the long term will lead to fewer, bigger hospitals with fewer beds. In this business case, the potential of a future implementation of telemedical home monitoring has therefore been calculated on the basis of the current capacity and geographical location of Denmark's hospitals.

The business case is premised on the following basic assumptions in relation to the realisation of economic potential and investment needs:

- Gross economic potential: The gross economic potential represents the difference between implementing telemedical home monitoring for citizens with COPD and the current care/treatment provided in this area, meaning that it can be both positive and negative effects associated with the implementation of the project.
- Positive effects: It is assumed that a nationwide rollout of telemedical home monitoring for citizens with COPD will start in 2017 and be fully phased in by 2019 for citizens with severe and very severe COPD (GOLD 3 and 4). The gross potential is calculated as reductions in activity levels and costs in connection with the treatment of patients through hospital admissions, practical help and care, outpatient visits, consultations with general practitioners and patient transportation.
- Negative effects: The negative effects are based on the same assumptions as the positive effects, but instead calculate any increases in activity levels and costs for municipal nursing interventions and changes in medicine consumption at the individual patient level.

- Costs - operation and investment: Covers two expenditure groups:
- The implementation costs consist of investments in decentralised equipment and the installation of technical infrastructure, as well as project costs for regional and municipal project management, training of nursing staff in how to use the technology in the telemedicine kit and national prerequisite measures<sup>2</sup>.
- Operating costs for the operation of the technical solutions, replacement and transport of equipment as well as extra work for health professionals as a consequence of the need for follow-ups on the measurement data in connection with telemedical home monitoring.

A further description of the costs and gross economic potential can be found in section 2.1.4.

**Table 3 Annual net economic potential, development over the period (DKK million in fixed prices)**

Type	2017	2018	2019	2020	2021	Total
Gross potential	27.1	124.2	225.2	287.1	292.8	956.3
<i>Positive effects</i>	28.2	129.4	234.7	299.3	305.3	996.9
<i>Negative effects</i>	-1.1	-5.3	-9.6	-12.2	-12.4	-40.6
Expenditure - operation and investment	-125.1	-101.7	-88.0	-86.0	-72.9	-473.6
<b>Net potential</b>	<b>-98.0</b>	<b>22.5</b>	<b>137.2</b>	<b>201.1</b>	<b>219.9</b>	<b>482.7</b>

## 2.1.2 Uncertainty and sensitivity calculations

In connection with the preparation of the business case, sensitivity calculations as well as calculations of uncertainty in the form of worst case and best case scenarios have been performed.

Sensitivity calculations show how sensitive the business case is to changes in the values of the input variables. Upon identifying the most sensitive variables, it has been assessed to which extent there is any uncertainty attached to their parameter values. In those areas assessed as being characterised by the greatest degree of uncertainty, an uncertainty spread was established to subsequently calculate the worst case and best case scenario using a Monte Carlo simulation (see Chapter 3 for a detailed description of the use of Monte Carlo).

### Sensitivity calculations

Sensitivity analyses have been performed on all input variables included in this business case. The sensitivity analysis has been performed in relation to the overall business case and thus not separately for citizens with severe and very severe COPD (GOLD 3 and 4), respectively, and also not for individual regional programmes. The sensitivity analysis shows which variables have important implications for the overall result of the business case, and accordingly, where there is a particular need to ensure a precise estimate for the value of the input variable.

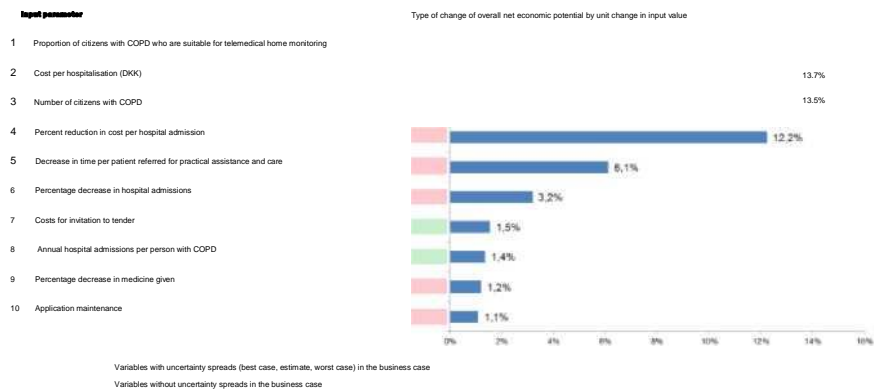
The sensitivity analysis does not in and of itself show which input variables in the business case are characterised by uncertainty in the setting of their values. For input variables showing high sensitivity and the values of which are also uncertain to some extent, the business case includes an uncertainty spread (worst case, estimate and best case). There are also a number of input parameters that are not among the most sensitive in the model, but nevertheless have an uncertainty spread to reflect that there is some uncertainty attached to the setting of the parameter value.

<sup>2</sup> All national prerequisite measures have been factored into the first year of the business case. Some expenditures have been made in 2016, while it is likely that others will be made after 2017. These expenditures have not been included in each separate regional programme's business case.

The sensitivity analysis has been carried out separately for each input variable. The sensitivity is calculated by increasing the individual input variable to a constant value of 10% over its estimated value in the business case and thereafter calculating the average change in the business case value by at the same time letting all other input variables vary in what is assumed would be a normally distributed spread between best case and worst case values in Monte Carlo simulations.

Figure 2 below shows the sensitivity of the input variables' influence on the overall business case.

Figure 2 Overview of the most sensitive input variables



The figure also shows the variables with a significant level of sensitivity and for which an uncertainty spread has consequently been included (marked in red).

The sensitivity analysis shows that the business case is primarily sensitive to estimates relating to the number of citizens suffering from COPD who are suitable for telemedical home monitoring, variables concerning costs per hospital admission as well as variables associated with the average time spent on providing practical assistance and care for citizens with COPD.

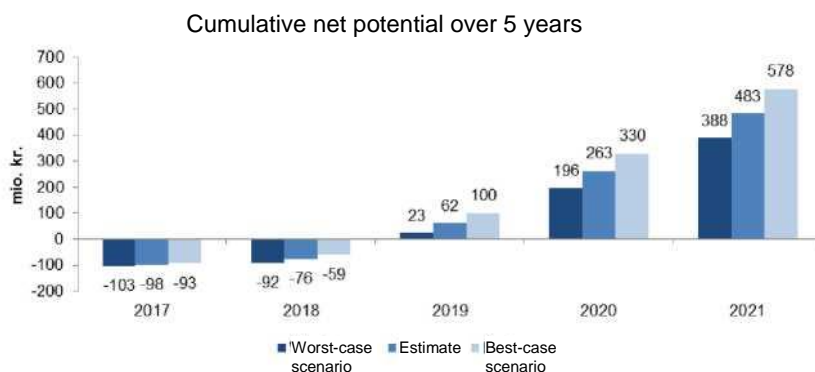
It is therefore primarily the parameters on the economic potential side, and not the ones on the cost side, which are the most sensitive. The estimates on the potential side are essentially based on actual measured data from the TeleCare Nord project, which as mentioned earlier in this report constitutes a unique basis for assessing the effects of telemedical home monitoring for citizens with COPD in a Danish context. However, the data is still characterised by a degree of statistical uncertainty, which is why uncertainty spreads have been included for these parameters in the business case.

#### Uncertainty calculated as worst case and best case scenarios

In the overall business case, the worst case and best case scenario calculations for the five-year period show a net economic potential between DKK 395 million to DKK 589 million. The spread between worst case and best case is determined by the calculated uncertainty of the business case's input variables. The calculation of the business case results for the worst case and best case scenarios are based on a Monte Carlo simulation (described in further detail in Chapter 3).

Figure 3 below provides an overview of the development of the worst case, estimate and best case scenarios for the business case's accumulative net potential over the five-year period.

Figure 3 Accumulative net economic potential over five years (DKK million in fixed prices)



The figure shows that the business case will have a payback period of just over two years and that the business case is expected to be positive. It also shows that there is a degree of uncertainty in the business case which is expected to be within a spread of approximately DKK 190 million over five years.

The uncertainties in the business case are linked to the estimate of the number of citizens with COPD as well as the input parameters estimating the business case's economic potential side, including in particular the effect of telemedicine in relation to the number of hospital admissions and the costs associated with them. The uncertainties regarding hospital admissions are caused by two factors in particular:

- A substantial portion of the observed economic potential is linked to relatively few observations. For citizens with severe COPD (GOLD 3), there are indications that a significant portion of the total economic potential is linked to a small number of very expensive hospitalisations that could - to some extent - be avoidable through the use of telemedical home monitoring.
- Lack of knowledge about the medium and long-term effects. The TeleCare Nord project has measured the effects of telemedical home monitoring during the first year after the citizens in the project intervention group received their telemedicine kits. The observed effects are factored in the business case for the overall five-year period. However, there may be medium and long-term effects associated with telemedical home monitoring that are unknown at the present time and which therefore have not been included in the business case.

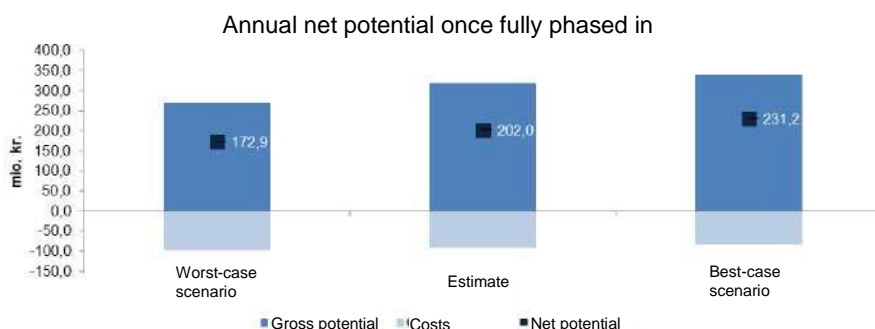
### 2.1.3 Annual net economic potential once fully phased in

The annual net economic potential of a full phasing-in of the business case amounts to DKK 202 million after 2021 (which is the calculated average of the annual result in a future operational situation)<sup>3</sup>. The worst case and best case scenarios range between DKK 173 and 231 million. The uncertainties in the analysis mean that the potential may prove to be either smaller or greater than estimated on the basis of current data and associated uncertainties for each input parameter (see section 2.1.2).

Figure 4 and the table below provide an overview of the estimates for the worst case and best case scenarios for gross economic potential, costs and net economic potential per year following a full phasing-in of the telemedical service at the national level.

<sup>3</sup> The costs of a full phasing-in only reflects the operating costs, as the investment and project costs have been incurred at an earlier point.

Figure 4 Annual net economic potential once fully phased in (DKK million in fixed prices)



## 2.1.4 Gross potential and costs

The business case divides the potential on an organisational level between regions, municipalities and general practices. It should be noted that the distribution of costs only looks at the municipal and regional level, as general practices and the regions - in this regard - are treated as a single actor<sup>4</sup>.

Four different drivers affect the gross economic potential:

- Development in the number of services performed per patient. For all organisational levels, a development in the number of services is seen in terms of the average number per patient following the implementation of telemedical home monitoring.
- Development of the cost per service performed. The costs for the individual services are based on the development of the average costs for the control and intervention groups recorded in the TeleCare Nord project.
- Development of time spent on performing services. For the municipal services, the potential is calculated in terms of the time spent by healthcare staff providing services for or visiting citizens with COPD<sup>5</sup> as well as the costs for staff wages.
- Development in transport. Transport costs for general practices and outpatient clinics are not significant in relation to the business case, as they collectively constitute a positive potential of about DKK 388,000 over the five years of the business case, corresponding to 0.04% of the total gross economic potential of the business case.

Overall, the most significant economic potential is linked to hospital admissions, which, in terms of organisation, fall under the regions but are also co-financed by municipalities (approximately 19% on average).

The potential distribution therefore does not completely reflect the overall economic potential of each organisational body. Figure 5 below shows the different developments of each economic potential parameter.

Figure 5 Development of selected economic potential parameters [Figure excluded]

<sup>4</sup> It will be challenging for the regions to realise the net potential of DKK 5.7 million in general practices over a five-year period as this will require a specific agreement with the Danish Medical Association.

<sup>5</sup> Data registration practices have not been completely uniform across municipalities. Some have recorded the amount of referred time allocated to citizens suffering from COPD, while others have recorded the actual time spent.

The figure shows that overall, it is hospital admissions of patients in both GOLD groups that drive the positive economic potential, while municipal nursing services for both groups are likely to have a negative potential.

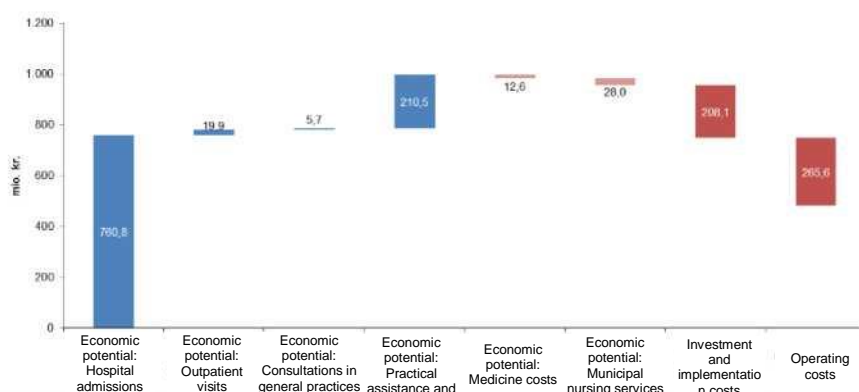
On the cost side, the business case operates with two main types of costs:

- Investment costs. There are costs associated with project management for the implementation as well as initial training of nurses in the telemedical equipment. In addition, there are costs associated with local maturation activities. Furthermore, there are investment costs associated with the procurement of the technical equipment which will be provided to citizens with COPD. Investments will also be required for the creation of interfaces between the telemedical solutions and the KIH database<sup>6</sup>. Also included are expenses for national prerequisite measures for telemedical home monitoring of citizens with COPD, part of which will be incurred prior to the start of the business case.
- Operating costs. The operating costs are primarily driven by health professionals' follow-ups on patients' measurement data as well as the ongoing replacement of telemedical equipment. In addition, there are costs associated with technical operation and maintenance as well as software licences.

Chapter 4 provides a detailed review of definitions, sources, etc. for each input variable in the business case.

Figure 6 below shows the distribution of the business case's overall five-year gross economic potential and costs broken down by the main types of potential and costs.

**Figure 6 Distribution of gross economic potential and costs over five years (DKK million in fixed prices)**



Each of the main types of economic potential and costs are elaborated upon in the two following sections.

#### **Gross economic potential broken down by type**

The business case shows that a nationwide rollout of telemedical home monitoring for citizens suffering from COPD will result in both positive and negative financial effects.

<sup>6</sup> The creation of concrete integrations between the KIH database and local systems (EOJ, EPR and LPS) as well as adjustments to these is assumed to be the responsibility of the individual actors and has therefore not been factored in in the business case.

### Positive economic effects

Figure 7 and the table below provide an overview of the development of the annual gross economic potential of the positive effects of the business case's five-year time span distributed across four services: Hospital admissions, outpatient visits, consultations with general practitioners as well as practical assistance and care.

Figure 7 Annual positive effects, five-year development distributed by types of economic potential (DKK million in fixed prices)

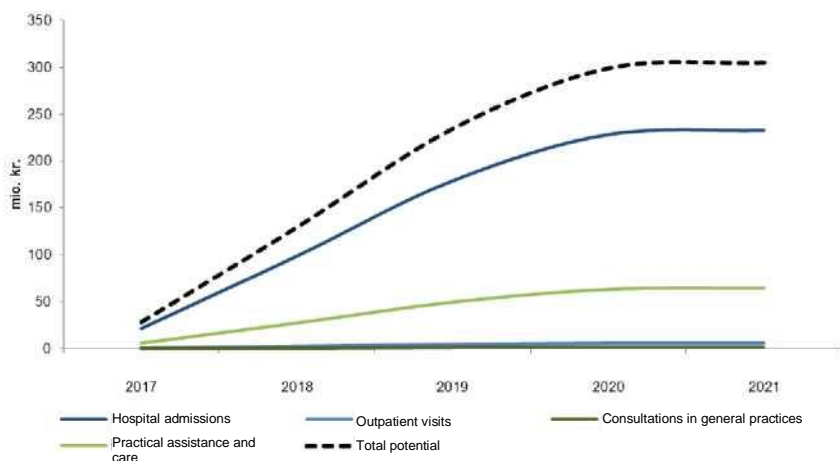


Table 4 Annual positive effects, five-year development distributed by types of economic potential (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Hospital admissions	21.5	98.8	179.1	228.4	233.0	760.8
Practical assistance and care	6.0	27.3	49.6	63.2	64.5	210.5
Outpatient visits	0.6	2.6	4.7	6.0	6.1	19.9
General practices	0.2	0.7	1.3	1.7	1.7	5.7
<b>Positive effects in total</b>	<b>28.2</b>	<b>129.4</b>	<b>234.7</b>	<b>299.3</b>	<b>305.3</b>	<b>996.9</b>

**Hospital admissions.** The above table shows that the gross economic potential is largely due to a decrease in costs related to hospital admissions (DKK 760.8 million over the business case's five-year time span, corresponding to about 75% of the overall positive effects). It is particularly a decline in the cost per hospital admission for citizens with severe COPD (GOLD 3) and to a lesser extent a decline in the number of hospital admissions for citizens with very severe COPD (GOLD 4) who drive this potential. In addition, the business case also projects a slight decline in the number of hospital admissions for citizens with severe COPD (GOLD 3).

**Practical assistance and care.** The number of citizens who are made eligible for practical assistance and care will increase, but the decrease in the cost per visit will decline to an extent where this will more than make up for the increase in the number of citizens receiving assistance and care. This results in a gross economic potential of DKK 210.5 million over the business case's 5-year time span, corresponding to about 20% of the overall positive effects.

**Outpatient consultations.** Outpatient consultations only affect the business case to a fairly limited extent, since only citizens with very severe COPD (GOLD 4) will experience a noticeable fall in outpatient

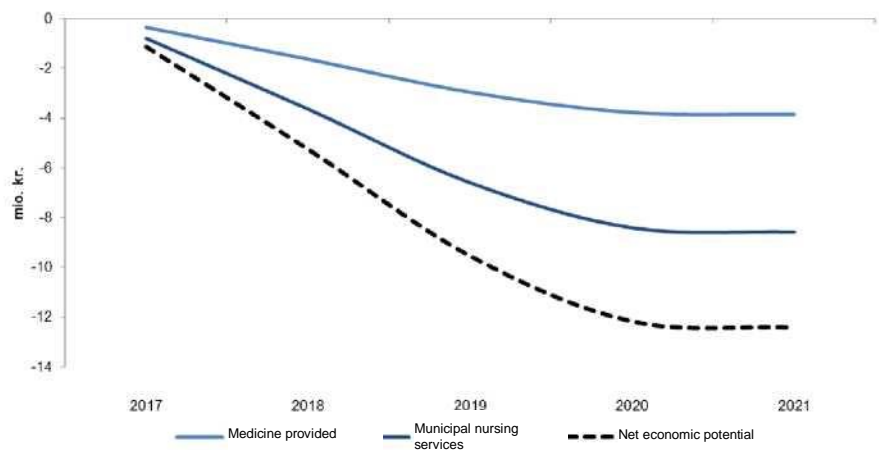
consultations, while all other parameters across the target groups will only be affected to a limited extent. This results in an economic potential of DKK 20 million over a five-year time span, of which only DKK 1 million is from transport costs.

**Consultations in general practices.** Consultations in general practices has virtually no effect on the business case. A slight decline in the cost per consultation for citizens with severe COPD (GOLD 3) will result in a positive economic potential of just under DKK 6 million over the business case's 5-year time span.

**Negative financial effects**

Figure 8 and Table 5 below provide an overview of the development of the negative effects over the business case's five-year time scale distributed across two services: dispensing of medicine and municipal nursing interventions.

**Figure 8 Annual negative effects, five-year development distributed by types of potential (DKK million in fixed prices)**



**Table 5 Annual negative effects, five-year development distributed by types of potential (DKK million in fixed prices)**

Type	2017	2018	2019	2020	2021	Total
Medicine consumption	-0.4	-1.6	-3.0	-3.8	-3.9	-12.6
Municipal nursing interventions	-0.8	-3.6	-6.6	-8.4	-8.6	-28.0
Negative effects in total	-1.1	-5.3	-9.6	-12.2	-12.4	-40.6

**Development in medicine consumption.** Medicine costs will rise 2% for citizens with severe COPD (GOLD 3), but fall 2% for citizens with very severe COPD (GOLD 4) who receive telemedical home monitoring. The number of citizens with severe COPD (GOLD 3) is higher than the number of citizens with very severe COPD (GOLD 4), which is why the gross economic potential becomes negative.

**Municipal nursing interventions.** Both the number of citizens referred to medical care and the costs for the municipal nursing services will rise for citizens with severe as well as very severe COPD (GOLD 3 and GOLD 4) as a result of the introduction of telemedical home monitoring. The negative effects of the increase in municipal nursing interventions is estimated to amount to DKK 28 million.



## Costs distributed by type

Table 6 and Figure 9 below provide an overview of the annual costs distributed by the two main types of costs: investment costs and operating costs.

Figure 9 Annual expenditure over five years (DKK million in fixed prices)

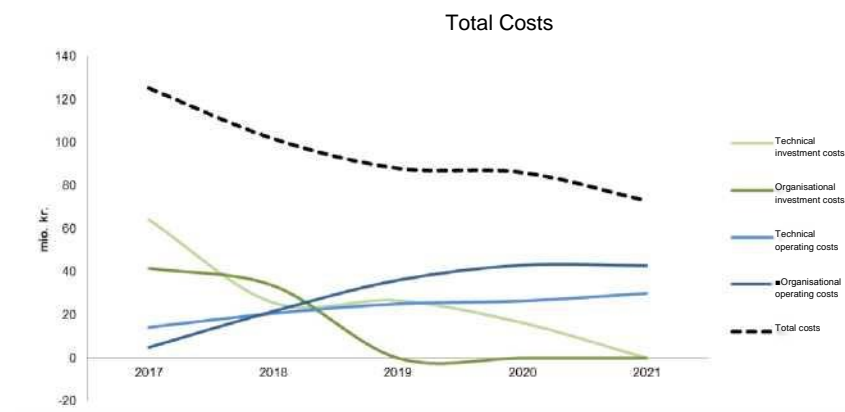


Table 6 Annual costs over five years (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Investment costs	105.8	59.2	26.7	16.4	0.0	208.1
Operating costs	19.3	42.4	61.3	69.6	-72.9	265.6
<b>Costs, total</b>	<b>125.1</b>	<b>101.7</b>	<b>88.0</b>	<b>86.0</b>	<b>72.9</b>	<b>473.6</b>

**Investment costs.** Primarily consists of investments in decentralised equipment used for measuring patient data as well as to a lesser extent local maturation activities and the establishment of interfaces for the KIH database. Added to this is the expenditure on project management and training of nursing staff, which, however, only makes up a relatively small portion of the overall business case. It is especially the investment of just over DKK 76 million in decentralised equipment that accounts for a large portion of the business case's costs at 16% of the total costs over the five-year period. In addition, expenditure on national prerequisite measures amounting to DKK 47 million has been factored into the first year of the business case and is also a major item among the expenditures.

**Operating costs.** The organisational operating costs consist of training citizens with COPD, management of the programmes and follow-ups on measuring data from citizens with COPD. The technical operating costs consist of operation and maintenance of decentralised equipment, technical support to citizens and healthcare staff, operation and maintenance of infrastructure and applications, subscriptions and licences as well as ongoing purchases to replace decentralised equipment. 52% of the operating costs consist of

the time spent on the routine follow-ups on measuring data from citizens with COPD, which corresponds to 29% of the total costs in the business case's five-year perspective<sup>7</sup>.

2.1.5 The business case in net current value

The financial figures in the business case are converted to net present value based on an assumption of a general price and wage increase of 1.5% over the business case's five-year period from 2017-2021. Over the same period, we have calculated a discount interest rate of 4%, which is used to discount back the business case's results.

Figure 10 Main effects of the business case (DKK million in NPV)

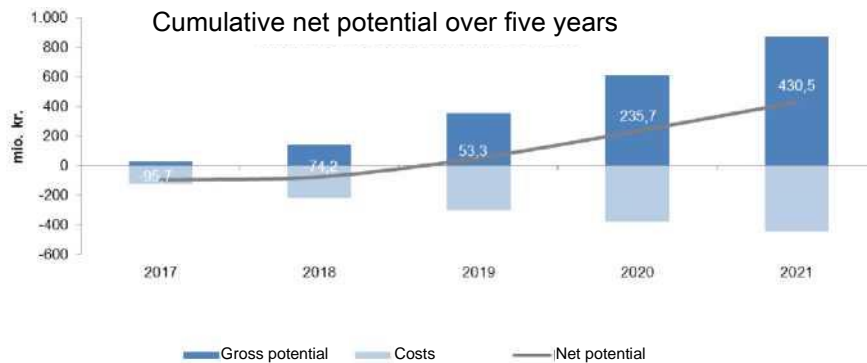


Table 7 Accumulative net potential over five years, development over the period (DKK million in NPV)

Type	2017	2018	2019	2020	2021
Gross economic potential	26.4	144.7	354.0	614.4	873.7
Expenditure - operation and investment	-122.1	-218.9	-300.7	-378.7	-443.3
Net potential	-95.7	-74.2	53.3	235.7	430.5

Calculated in net present value, the business case's accumulative net economic potential over five years is DKK 430 million.

2.1.6 Cost distribution between municipalities and regions

A nationwide rollout of telemedical home monitoring as described above will require substantial expenditures on investments and operating costs. In connection with the preparation of this business case, a model was prepared to determine how these costs can be distributed between the involved parties, i.e. municipalities and regions<sup>8</sup>. The national prerequisite measures have not been included in this calculation, as these costs have been or will be incurred in another context.

The model for distribution of costs for telemedical home monitoring consists of two main principles (read more about assumptions and the model for distribution in section 4.6):

- Costs that are borne by one actor alone are charged to that actor.

<sup>7</sup> It is not possible to determine whether the costs for the telemedical solution should be budgeted as capital or operating budgets, as this depends on local purchasing decisions in the regional programmes, including issues such as whether to lease or buy hardware, for example.

<sup>8</sup> The business case does not include proposals on how to practically distribute the costs in connection with a nationwide rollout of telemedical home monitoring.

- Shared costs are distributed based on the calculated distribution of the gross economic potential between the involved actors. Any negative effects are offset at the actor level, thereby resulting in a percentage distribution to calculate each actor's share of the shared costs.

The table below shows the business case's accumulative gross economic potential over five years distributed across municipalities and regions. The percentage-based distribution between municipalities and regions has been used as the basis for the following calculation of the distribution of shared costs between municipalities and regions.

**Table 8 Distribution of the five-year gross economic potential between municipalities and regions (fixed prices)<sup>9</sup>**

Actor	DKK	Percent
Regions	639 million	65%
Municipalities	359 million	35%

The following table provides an overview of the calculated distribution of costs between municipalities and regions. The figure also makes clear the division between actor-specific costs and shared costs in relation to the investment and operating costs.

**Table 9 Distribution of total costs over a five-year period (DKK million in fixed prices)**

Type	Operating costs	Investment costs	Total costs
Municipalities	189.2	85.9	275.0
Actor-specific	148.9	55.2	204.0
Shared	40.3	30.7	71.0
Regions	76.4	75.2	151.6
Actor-specific	0.0	17.0	17.0
Shared	76.4	58.2	134.6
<b>Total costs</b>	<b>265.6</b>	<b>161.1</b>	<b>426.6</b>

*The table indicates the potential for the GOLD 3 and GOLD 4 groups. In section 2.3, "Perspective calculations for the new target group", a cost overview can be found for citizens categorised as belonging to the GOLD D group.*

Municipalities have more actor-specific costs than the regions do, which is primarily because the business case assumes that the monitoring of telemedical data will be handled by municipal nurses, making it an actor-specific cost. The creation of interfaces for regional IT systems as well as regional project management are the only costs borne specifically by the regions.

The accumulative five-year net economic potential for the municipalities is DKK 55 million. For the regions, the five-year net economic potential is DKK 474 million. Added to this is an additional expenditure of DKK 47 million for national prerequisite measures, which this business case assumes fall under a separate context than the regional and municipal budgets.

The table below shows the respective shares of the municipalities' and regions' potential and costs over the business case's five-year period.<sup>9</sup>

**Table 10 Annual net economic potential for the municipalities, development over the five-year period (DKK million in fixed prices)**

Type	2017	2018	2019	2020	2021	Total
Gross economic potential	9.3	42.9	77.8	99.2	101.1	330.3

<sup>9</sup> Positive and negative effects in relation to general practices has been included under the regions.

Operating costs	9.9	28.9	44.8	52.3	53.3	189.2
Investment costs	35.4	35.6	9.2	5.7	0.0	85.9
<b>Net economic potential</b>	<b>-36.0</b>	<b>-21.6</b>	<b>23.7</b>	<b>41.2</b>	<b>47.9</b>	<b>55.3</b>

The municipalities have a total economic potential of approximately DKK 55 million over the business case period. For the municipalities, the business case has a payback period of four years.

**Table 11 Annual net economic potential for the regions, development over the five-year period (DKK million in fixed prices)**

Type	2017	2018	2019	2020	2021	Total
Gross potential	17.7	81.3	147.4	187.9	191.7	626.0
Operating costs	9.3	13.6	16.5	17.3	19.7	76.4
Investment costs	23.4	23.6	17.5	10.7	0.0	75.2
<b>Net economic potential</b>	<b>-15.1</b>	<b>44.1</b>	<b>113.5</b>	<b>159.9</b>	<b>172.0</b>	<b>474.4</b>

The regions have a total net economic potential of approximately DKK 474 million over the business case period. The business case has a payback period of two years for the regions.

### 2.1.7 Economic potential distributed by GOLD groups

The business calculates an economic potential both for citizens with severe COPD (GOLD 3) and very severe COPD (GOLD 4). A portion of the citizens with severe COPD (GOLD 3) will experience a worsening in their condition over the period covered in this business case to such an extent that they will transition over to the group of citizens with very severe COPD (GOLD 4). Part of the phasing-in process for this group will thus occur naturally, while the phasing-in for the remaining portion of citizens with very severe COPD (GOLD 4) will occur in parallel to the phasing-in for citizens with severe COPD (GOLD 3).

Table 12 shows how the business case is distributed between the GOLD groups.

**Table 12 Annual net economic potential, development over the period distributed by GOLD groups (DKK million in fixed prices)<sup>10</sup>**

Type	2017	2018	2019	2020	2021	Total
Citizens with severe COPD (GOLD 3)	-45.4	13.0	116.2	171.5	187.9	443.1
Gross economic potential	23.3	107.0	194.1	247.5	252.4	824.4
Investment costs	51.6	56.5	23.9	14.6	0.0	146.5
Operating costs	17.1	37.5	54.1	61.4	64.6	234.7
Citizens with very severe COPD (GOLD 4)	-5.7	9.5	21.0	29.6	32.1	86.5
Gross economic potential	3.7	17.1	31.1	39.6	40.4	131.9
Investment costs	7.3	2.7	2.8	1.7	0.0	14.6
Operating costs	2.1	4.9	7.2	8.3	8.3	30.9
<b>Total net economic potential</b>	<b>-51.0</b>	<b>22.5</b>	<b>137.2</b>	<b>201.1</b>	<b>219.9</b>	<b>529.7</b>

<sup>10</sup> In this table, the net potential excludes the costs associated with the national prerequisite measures, as these expenses will not fall under the regional programmes.

In this business case, all organisational implementation costs (e.g. project management and training of staff) are linked to the rollout of telemedical home monitoring for citizens with severe COPD (GOLD 3) as it is assumed that the implementation will focus on this group of citizens with COPD. Operating costs that are independent of the number of citizens have been distributed equally between the two target groups (GOLD 3 and 4). Additionally, there is an expenditure of DKK 47 million for national prerequisite measures that has not been included for any of the groups in this overview.

The potential in relation to citizens with severe COPD (GOLD 3) represents by far the largest part of the business case's total potential.

## 2.2 Qualitative gains

In the two large-scale projects TeleCare Nord and NetKOL (KIH), researchers have not only looked into the financial gains but also the extent to which the rollout of telemedical home monitoring for citizens with COPD results in gains of a non-financial nature. These qualitative gains have not been ascribed financial value in this business case.

Specifically, the two large-scale projects have identified a number of qualitative gains for citizens with COPD resulting from a rollout of telemedical home monitoring. The identified qualitative gains for patients are closely related and partially overlapping, but are presented in the following under three overarching categories<sup>11</sup>:

- Increased knowledge and competences for self-care
- Influence on their own condition
- Increased quality of life, patient confidence and satisfaction.

### 2.2.1 Increased knowledge and competences for self-care

The results from NetKOL under the large-scale project KIH show that telemedical home monitoring can help citizens with COPD better understand when to contact the hospital. While 52% of the participants in NetKOL indicated in the pre-intervention survey that they were "often" or "sometimes" in doubt about when to contact the hospital, only 24% of the participants in the intervention group indicated the same in the post-intervention survey.<sup>12</sup>

These findings are backed by other results from NetKOL that show a positive intervention effect from telemedical home monitoring for citizens with COPD through the Health Education Impact Questionnaire sub-scale "Self monitoring and insight" (see Table 13). The post-intervention survey scores of the intervention group are significantly better than the pre-intervention scores. The sub-scale covers issues relating to *"increased insight into personal health, increased self-care and ability and confidence to act."*<sup>13</sup>

<sup>11</sup> See project goals 1 and 2 in the memo "Forskningsdesign i TeleCare Nord". The results presented in this section are based on the final evaluation of KIH as well as the research findings from TeleCare Nord which were published before the completion of this report.

<sup>12</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond from the National Board of Health and Welfare, Jan Petersen and Kirsten Ravn from MedCom, "Klinisk Integreret Hjemmemonitorering (KIH): Slutrapportering til Fonden for Velfærdsteknologi", p. 91.

<sup>13</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond from the National Board of Health and Welfare, Jan Petersen and Kirsten Ravn from MedCom, "Klinisk Integreret Hjemmemonitorering (KIH): Slutrapportering til Fonden for Velfærdsteknologi", p. 91.

**Table 13 Self-monitoring and insight (intervention and control effects in NetKOL. On a scale of 1-4, where 1 = most negative and 4 = most positive)<sup>14</sup>**

	Before	After	Difference
Intervention group (n = 122)	3.22	3.32	+0.1*
Control group (n = 122)	3.08	3.13	+0.05

\*) alpha level significance p = 0,05

In extension thereof, the results from the large-scale project TeleCare Nord show that the citizens who received telemedical home monitoring reported feeling safer (72%), freer (27%), more in control (62%) and that they had achieved a better understanding of their symptoms (50%) through use of the telemonitoring kit.<sup>15</sup> The study on health literacy shows that this increased feeling of safety, freedom, control as well as a better understanding of symptoms that the telemonitoring kit provides is not dependent on the citizens' prior technological know-how nor their general health literacy. The last one is particularly interesting because the study showed inadequate or marginal health literacy among a little under half of the participants.<sup>16</sup>

The results from the two large-scale projects show that a nationwide rollout of telemedical home monitoring for relevant citizens with COPD would help raise the level of the participants' knowledge about COPD and their self-care competences. The results also show that a prior understanding of technology and one's own condition is not an essential prerequisite to success for patients using telemedical home monitoring.

### 2.2.2 Influence on their own condition

The experiences from NetKOL show that telemedical home monitoring for citizens with COPD leads to improvements in the participants' perception of their own ability to navigate through the healthcare system, including, in particular, increased confidence in working together with health professionals and the feeling of having their needs covered through existing health services.<sup>17</sup>

Results from NetKOL are shown in the table below, demonstrating a positive intervention effect from telemedical home monitoring for citizens with COPD in terms of the Health Education Impact Questionnaire sub-scale "Health service navigation". The post-intervention survey of the intervention group shows significantly improved results compared to the pre-intervention survey. The sub-scale covers issues

<sup>14</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond from the National Board of Health and Welfare, Jan Petersen and Kirsten Ravn from MedCom, "Klinisk Integreret Hjemmemonitorering (KIH): Slutrapportering til Fonden for Velfærdsteknologi", p. 97.

<sup>15</sup> Lilholt, Pernille Heyckendorff et al.; Specific technological communication skills and functional health literacy have no influence on self-reported benefits from enrollment in the TeleCare North trial; International Journal of Medical Informatics, Volume 91, p. 60-66

<sup>16</sup> Lilholt, Pernille Heyckendorff et al.; Specific technological communication skills and functional health literacy have no influence on self-reported benefits from enrollment in the TeleCare North trial; International Journal of Medical Informatics, Volume 91, p. 60-66

<sup>17</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond from the National Board of Health and Welfare, Jan Petersen and Kirsten Ravn from MedCom, "Klinisk Integreret Hjemmemonitorering (KIH): Slutrapportering til Fonden for Velfærdsteknologi", p. 93.

concerning “increased confidence in interactions with health professionals, more information and an increased feeling of getting one’s needs covered through existing health services”.<sup>18</sup>

**Table 14 Health service navigation (intervention and control effects in NetKOL. On a scale of 1-4, where 1 = most negative and 4 = most positive)<sup>19</sup>**

	Before	After	Difference
Intervention group (n = 122)	3.37	3.46	+0.09*
Control group (n = 122)	3.33	3.28	-0.05

\*) alpha level significance p = 0,05

As mentioned above, the results from the large-scale project TeleCare Nord show that the citizens who received telemedical home monitoring reported feeling safer (72%), freer (27%) and more in control (62%).<sup>20</sup>

The results from the two large-scale projects show that citizens with COPD who are offered telemedical home monitoring become more active and involved in their own treatment process.

### 2.2.3 Increased quality of life, patient safety and satisfaction

In connection with the TeleCare Nord project, the participants’ physical and mental quality of life was investigated through a survey where the clinically validated form for measuring quality of life, SF-36, was sent out to 1,225 citizens prior to and after the intervention. The results showed that quality of life declined for both the intervention and control groups, but that the decline was bigger in the control group. In other words, the citizens who received telemedical home monitoring did not experience the same loss of quality of life as those citizens who did not receive telemedical home monitoring. Further analysis on a sub-group level indicated that, particularly for citizens with severe COPD (GOLD 3), there is a positive development in the perceived quality of life in connection with the use of telemedical home monitoring.<sup>21</sup>

In extension thereof, the results from the NetKOL project show that telemedical home monitoring has a positive effect on citizens’ confidence as well as their self-assessed condition. Specifically, NetKOL’s post-intervention survey shows that a significantly higher proportion (5%) of citizens in the intervention group have a predominately positive view of their health in comparison to the pre-intervention survey.

The same positive effect of telemedical home monitoring was revealed through the question on how confident citizens in the intervention group generally felt about their COPD treatment. Furthermore,

<sup>18</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark’s Centre for Applied Health Services Research (CAST), Tina Hosbond

<sup>19</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark’s Centre for Applied Health Services Research (CAST), Tina Hosbond

<sup>20</sup> Liholt, Pernille Heyckendorff et al.; Specific technological communication skills and functional health literacy have no

<sup>21</sup> Liholt , Pernille Heyckendorff “Hvad er de patientnære effekter af telemedicin”,

the NetKOL project also shows a significant reduction in the incidence of negative emotions such as anger, anxiety and depression among the citizens in the intervention group compared to the control group.<sup>22</sup>

Results from NetKOL are shown in the table below, demonstrating a positive intervention effect from telemedical home monitoring for citizens with COPD in terms of the Health Education Impact Questionnaire sub-scale "Emotional well-being". The post-intervention survey of the intervention group shows significantly improved results compared to the pre-intervention survey. The sub-scale covers issues concerning *"negative feelings and attitudes towards life, anxiety, stress, anger and depression"*.<sup>23</sup>

**Table 15 Emotional well-being (intervention and control effects in NetKOL. On a scale of 1-4, where 1 = most positive and 4 = most negative)<sup>24</sup>**

	Before	After	Difference
Intervention group (n = 122)	2.50	2.34	-0.16*
Control group (n = 122)	2.61	2.54	-0.07

\*) alpha level significance p = 0,05

The results from the two large-scale projects show that a nationwide rollout of telemedical home monitoring for citizens with COPD is very likely to have a potential to improve quality of life, particularly for citizens with severe COPD (GOLD 3). At the same time, the studies show a positive development in the level of patient confidence and self-assessed health as a consequence of home monitoring.

### 2.3 Perspective calculation for the new target group

The results of the business case are based on data from the TeleCare Nord project, which stratifies citizens based on the old GOLD criteria (GOLD 1-4), which are solely based on spirometric measurements. While the TeleCare Nord project has been underway, however, new GOLD criteria have been developed that take into account the patient's symptoms (GOLD A-D).

The new clinical guidelines recommend that the target group for telemedical home monitoring should be citizens in the GOLD D group due to the medical assessment that this group will have the most to gain from the service.

The amended guidelines make it relevant to estimate their impact on the business case, since it is a different, smaller target group which differs in terms of symptoms and treatment. However, it is not possible to use the data available from TeleCare Nord to perform a precise calculation of this, which is why the business case has not been adjusted to reflect the changes in the guidelines. Instead, the business case contains a perspective calculation which can provide an indication of the financial consequences.

<sup>22</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond

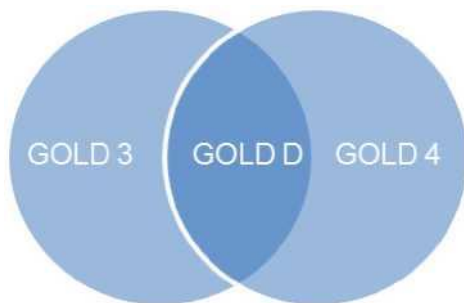
<sup>23</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond

<sup>24</sup> Anne Lee and Marianne Sandvei from the University of Southern Denmark's Centre for Applied Health Services Research (CAST), Tina Hosbond



If a person is classified as belonging to the GOLD D group (according to the new criteria), he or she would either fall under the GOLD 3 or GOLD 4 group under the old criteria. Conversely, a number of citizens (about half) classified with GOLD 3 or GOLD 4 will not fall under the GOLD D group, as illustrated in the figure below.

Figure 11 Overlaps within the GOLD groups



About 50% of citizens who fall under the COPD GOLD 3 or GOLD 4 groups are classified as COPD GOLD D. The perspective business case is thus calculated on a base of 10,000 citizens who are suitable for telemedical home monitoring rather than the 20,000 citizens upon which the calculations of the business case are based. The effect of this in terms of the costs calculated in the business case can be fairly accurately estimated because it is clear what the cost is per person who is referred to telemedical home monitoring. If we halve the number of citizens who are in the target group for receiving telemedical home monitoring, the costs would therefore fall by just under 30%.

The effect in terms of the business case's potential, however, becomes very uncertain, as the available data from TeleCare Nord does not tell us anything about what the effects of telemedical home monitoring are for citizens belonging to the GOLD D group. It is extremely likely that citizens with COPD GOLD D have a different potential profile than citizens with COPD GOLD 3 and GOLD 4, but there is no accurate data on the differences.

In connection with the establishment of the clinical guidelines, it was determined that citizens with COPD GOLD D have the most to gain from telemedical home monitoring. There are two basic scenarios that together outline the possible consequences of the adjustment of the target group:

Scenario 1: The effect per citizen with COPD GOLD D is at least the same as for citizens with COPD GOLD 3 and 4. The total gross economic potential therefore falls proportionally based on the size of the reduced target group.

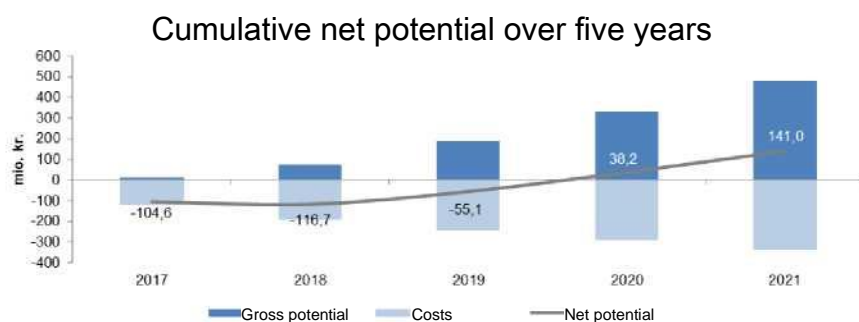
Scenario 2: People with COPD GOLD D are the ones who achieve all the beneficial effects observed in TeleCare Nord and thereby drive the entire economic potential described in the business case. The total gross economic potential is therefore unchanged compared to the present business case even though the number of citizens in the target group is cut in half.

The two scenarios have been outlined below as economic worst case and best case scenarios.

### 2.3.1 Scenario 1: Same effect of telemedicine for citizens classified as GOLD 3 or 4 as GOLD D

If we assume that telemedical home monitoring will have the same effect on citizens falling under the GOLD D group as on citizens falling under the GOLD 3 and 4 groups, the gross economic potential will drop to half, i.e. DKK 956 million to DKK 478 million. The costs will fall by roughly 29%, from DKK 474 million to DKK 337 million. The overall business case will have a net economic potential of DKK 141 million over the five-year period, as outlined in the figure below, with an annual net potential of DKK 94 million once it has been fully phased in.

Figure 12 Main effects of scenario 1 (DKK million in fixed prices)

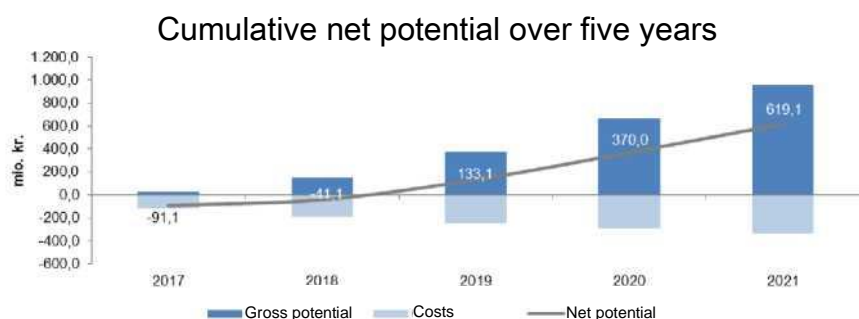


### 2.3.2 Scenario 2: The full effect of telemedicine for citizens classified as GOLD 3 or GOLD 4 also applies to citizens classified as GOLD D

If we assume that the effect of the telemedicine on patients in the groups GOLD 3 and GOLD 4 as documented by TeleCare Nord are exclusively achieved by telemedical home monitoring for citizens classified as GOLD D, the gross economic potential will remain unchanged at DKK 956 million.

As in the other scenario, the cost levels will drop by approximately 29%, as the number of citizens in the target group is halved in this calculation. The overall business case will have a net economic potential of DKK 619 million over five years, as detailed in the figure below, with an annual net economic potential of DKK 240 million once fully phased in.

Figure 13 Main effects of scenario 2 (DKK million in fixed prices)



The costs are similar in both scenarios, and thus there is also a similar distribution of costs between municipalities and regions as shown in the table below.

**Table 16 Distribution of total costs over a five-year period for citizens with GOLD D (DKK million in fixed prices)**

Type	Operating costs	Investment costs	Total costs
Municipalities	106.4	72.8	179.2
<i>Actor-specific</i>	74.4	55.2	129.6
<i>Shared</i>	32.0	17.6	49.6
Regions	0.6	50.4	111.0
<i>Actor-specific</i>	0.0	17.0	17.0
<i>Shared</i>	0.6	33.3	94.0
<b>Total costs</b>	<b>167.0</b>	<b>123.2</b>	<b>290.2</b>

## 3 RESULTS DISTRIBUTED BY REGION

This chapter reviews the business case's results broken down by each of the five regional programmes. This distribution takes into account differences in the incidence of citizens with COPD as well as differences in treatment activity levels for each region.

### 3.1 Approach

The business case calculates what economic potential can be expected from each of the regional programmes with the rollout of telemedicine for citizens with COPD. Certain input parameters vary by regional programme:

- The number of citizens suffering from COPD. This number has been estimated at the national level on the basis of the prevalence studies of the total Danish population. Data from the national health profile was subsequently used to assess incidence of citizens with COPD in the individual regions.
- The average number of hospital admissions per person and the average number of outpatient visits per person. These parameters are based on estimates from the North Denmark Region using data from TeleCare Nord. The figures were then adjusted to the average activity levels in the regions based on figures from the Danish National Patient Registry<sup>25</sup>.
- The number of nurses requiring training has been estimated on the basis of the average need identified in the municipalities in the North Denmark Region and subsequently extrapolated to the other regions. This parameter has very limited significance to the business case.

The table below shows the estimated distribution of citizens with COPD in Denmark's five regions.

**Table 17 Number of citizens with COPD distributed by region**

Region	Severe COPD (GOLD 3)	Very severe COPD (GOLD 4)	Total
Capital Region	10,050	1,200	11,250
Region Zealand	5,650	650	6,300
Region of Southern Denmark	8,300	1,000	8,300
Central Denmark Region	7,700	900	8,600
North Denmark Region	4,050	500	4,050
<b>Entire country</b>	<b>35,750</b>	<b>4,250</b>	<b>40,000</b>

<sup>25</sup> The data is from 2015 and was retrieved from the Danish Register for Chronic Obstructive Pulmonary Disease's annual report.

Implementation costs that are not linked to the number of citizens are distributed evenly across the five regional programmes. The operating costs associated with the operation and maintenance of applications and infrastructure are distributed among the regional programmes based in part on the number of citizens suffering from COPD in those regions.<sup>26</sup>

The calculations of the economic potential for each of the five regional programmes do not include the national prerequisite measures. The total net economic potential for municipalities and regions will accordingly appear as DKK 47 million more than the net economic potential of the nationwide business case.

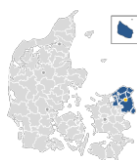
Table 18 below shows the distribution of the net economic potential across the five regional programmes.

**Table 18 Net economic potential for the five regional programmes (DKK in fixed prices)**

Regional programme	Five-year economic potential	Year 1 (2017)	Annual economic potential once fully phased in
Capital Region	166.0	-12.2	61.4
Region Zealand	121.0	-8.5	44.1
Region of Southern Denmark	89.8	-11.8	36.3
Central Denmark Region	98.7	-10.5	38.2
North Denmark Region	54.2	-8.1	22.1
<b>Entire country</b>	<b>529.7</b>	<b>-51.0</b>	<b>202.0</b>

The Capital Region programme has the greatest net economic potential, while the North Denmark Region programme has the least. The Region Zealand programme has the second highest net economic potential in spite of the fact that the region is home to fewer citizens suffering from COPD than in the Central Denmark Region and the Region of Southern Denmark. The reason for this is that on average, Region Zealand has more hospital admissions per COPD patient than the other regions and therefore also a larger baseline for the calculation of the economic potential.

## 3.2 The Capital Region programme



The Capital Region programme has the highest net economic potential of the five regional programmes. The business case estimates that 10,050 citizens with severe COPD (GOLD 3) and 1,200 citizens with very severe COPD (GOLD 4) the Capital Region. The Capital Region is accordingly also the region with the highest number of citizens with COPD, equal to just under 30% of all COPD patients in Denmark with severe or very severe COPD (GOLD 3 and 4).

### The business case's calculation of the overall effects of the Capital Region programme

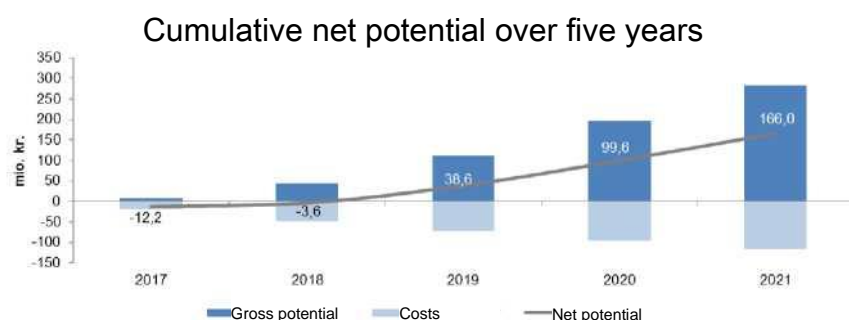
The business case shows an accumulative economic potential of DKK 166 million for telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) in the Capital Region programme.

The following figure and table provides an overview of the development in the business case's gross potential, costs and net potential accumulating over the 5-year period for citizens with severe and very severe COPD (GOLD 3 and 4).

<sup>26</sup> 30% of the costs will be divided equally between the regions, while 70% of the costs will be distributed based on the estimated proportion of citizens with COPD living in each region.

The net potential is in particular a result of the average cost of hospital admissions for citizens with severe COPD (GOLD 3) falling significantly. There is some uncertainty associated with the estimate on hospital admissions, which is elaborated upon in section 2.1.2 as well as in Chapter 3.

Figure 14 The primary effects of the business case, Capital Region programme (DKK million in fixed prices)



The table below shows the economic potential and costs of the five-year period.

Table 19 Net economic potential for the Capital Region programme (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Gross economic potential	8.0	36.7	66.5	84.7	86.4	282.3
Investment costs	-15.1	-16.5	-7.5	-4.6	0.0	-43.7
Operating costs	-5.1	-11.6	-16.8	-19.1	-20.0	-72.6
<b>Net economic potential</b>	<b>-12.2</b>	<b>8.6</b>	<b>42.2</b>	<b>61.0</b>	<b>66.4</b>	<b>166.0</b>

People with severe COPD (GOLD 3) account for approximately DKK 138 million of the net economic potential over the five-year period, while citizens with very severe COPD (GOLD 4) are estimated to account for a net economic potential of approximately DKK 28 million.

### 3.3 The Region Zealand programme



The Region Zealand programme has the second-highest net economic potential of the five regional programmes. The business case estimates that 5,650 citizens with severe COPD (GOLD 3) and 650 citizens with very severe COPD (GOLD 4) reside in Region Zealand. The potential is driven by the fact that Region Zealand has the highest number of hospital admissions per COPD patient among the five regions.

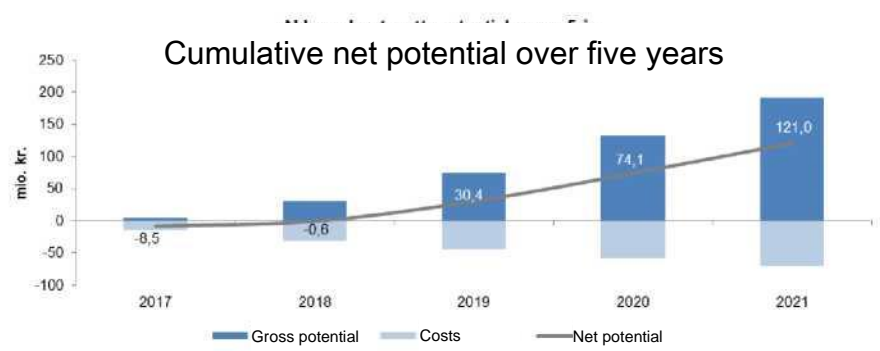
#### The business case's calculation of the overall effects of the Region Zealand programme

The business case shows an accumulative economic potential of DKK 121 million for telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) in the Region Zealand programme.

The following figure and table provides an overview of the development in the business case's gross economic potential, costs and net economic potential accumulating over the 5-year period for citizens with severe and very severe COPD (GOLD 3 and 4).

The net potential in particular a result of the average cost of hospital admissions for citizens with severe COPD (GOLD 3) falling significantly. There is some uncertainty associated with the estimate on hospital admissions, which is elaborated upon in section 2.1.2 as well as in Chapter 3.

Figure 15 The primary effects of the business case, Region Zealand programme (DKK million in fixed prices)



The table below shows the economic potential and costs of the five-year period.

Table 20 Net economic potential for the Region Zealand programme (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Gross economic potential	5.4	24.9	45.1	57.5	58.6	191.4
Investment costs	-10.7	-10.0	-4.2	-2.6	0.0	27.5
Operating costs	-3.2	-6.9	-9.9	-11.2	-11.7	-42.9
<b>Net economic potential</b>	<b>-8.5</b>	<b>7.9</b>	<b>31.0</b>	<b>43.7</b>	<b>46.9</b>	<b>121.0</b>

People with severe COPD (GOLD 3) account for approximately DKK 104 million of the net economic potential over the five-year period, while citizens with very severe COPD (GOLD 4) are estimated to account for a net economic potential of approximately DKK 17 million.

### 3.4 The Region of Southern Denmark programme



The Region of Southern Denmark programme has the second-lowest net economic potential of the five regional programmes. The business case estimates that 8,300 citizens with severe COPD (GOLD 3) and 1,000 citizens with very severe COPD (GOLD 4) reside in the Region of Southern Denmark. The Region of Southern Denmark has the lowest number of hospital admissions per COPD patient among the five regions.

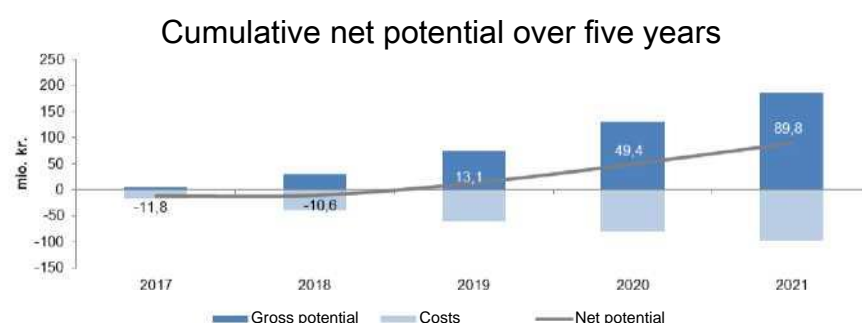
#### The business case's calculation of the overall effects of the Region of Southern Denmark programme

The business case shows an accumulative economic potential of DKK 90 million for telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) in the Region of Southern Denmark programme.

The following figure and table provides an overview of the development in the business case's gross economic potential, costs and net economic potential accumulating over the 5-year period for citizens with severe and very severe COPD (GOLD 3 and 4).

The net potential in particular a result of the average cost of hospital admissions for citizens with severe COPD (GOLD 3) falling significantly. There is some uncertainty associated with the estimate on hospital admissions, which is elaborated upon in section 2.1.2 as well as in Chapter 3.

Figure 16 The primary effects of the business case, Region of Southern Denmark programme (DKK million in fixed prices)



The table below shows the economic potential and costs of the five-year period.

Table 21 Net economic potential for the Region of Southern Denmark programme (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Gross economic potential	5.3	24.3	44.0	56.1	57.2	186.8
Investment costs	-12.7	-13.3	-6.2	-3.8	0.0	-36.0
Operating costs	-4.4	-9.7	-14.1	-16.0	-16.8	-60.9
<b>Net economic potential</b>	<b>-11.8</b>	<b>1.2</b>	<b>23.7</b>	<b>36.3</b>	<b>40.4</b>	<b>89.8</b>

People with severe COPD (GOLD 3) account for approximately DKK 73 million of the net economic potential over the five-year period, while citizens with very severe COPD (GOLD 4) are estimated to account for a net economic potential of approximately DKK 16 million.

### 3.5 The Central Denmark Region programme



The Central Denmark Region programme has the third-highest net economic potential of the five regional programmes. The business case estimates that 7,700 citizens with severe COPD (GOLD 3) and 900 citizens with very severe COPD (GOLD 4) reside in the Central Denmark Region. The Central Denmark Region has the second-lowest number of hospital admissions per COPD patient among the five regions.

#### The business case's calculation of the overall effects of the Central Denmark Region programme

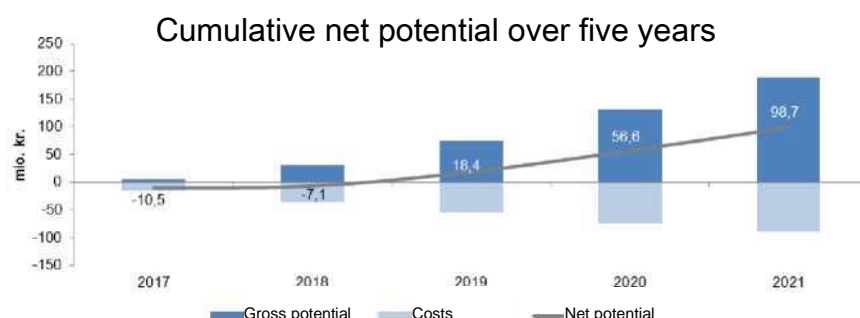
The business case shows an accumulative economic potential of DKK 99 million for telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) in the Central Denmark Region programme.

The following figure and table provides an overview of the development in the business case's gross economic potential, costs and net economic potential accumulating over the 5-year period for citizens with severe and very severe COPD (GOLD 3 and 4).



The net potential is in particular a result of the average cost of hospital admissions for citizens with severe COPD (GOLD 3) falling significantly. There is some uncertainty associated with the estimate on hospital admissions, which is elaborated upon in section 2.1.2 as well as in Chapter 3.

Figure 17 The primary effects of the business case, Central Denmark Region programme (DKK million in fixed prices)



The table below shows the economic potential and costs of the five-year period.

Table 22 Net economic potential for the Central Denmark Region programme (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Gross economic potential	5.3	24.5	44.4	56.6	57.7	188.4
Investment costs	-11.7	-12.1	-5.7	-3.5	0.0	-33.0
Operating costs	-4.1	-9.1	-13.1	-14.9	-15.6	-56.7
<b>Net economic potential</b>	<b>-10.5</b>	<b>3.3</b>	<b>25.5</b>	<b>38.2</b>	<b>42.1</b>	<b>98.7</b>

People with severe COPD (GOLD 3) account for approximately DKK 82 million of the net economic potential over the five-year period, while citizens with very severe COPD (GOLD 4) are estimated to account for a net economic potential of approximately DKK 17 million.

### 3.6 The North Denmark Region programme



The North Denmark Region programme has the smallest net economic potential of the five regional programmes. The business case estimates that 4,050 citizens with severe COPD (GOLD 3) and 500 citizens with very severe COPD (GOLD 4) reside in the North Denmark Region. The North Denmark Region has the lowest number of hospital admissions per COPD patient among the five regions.

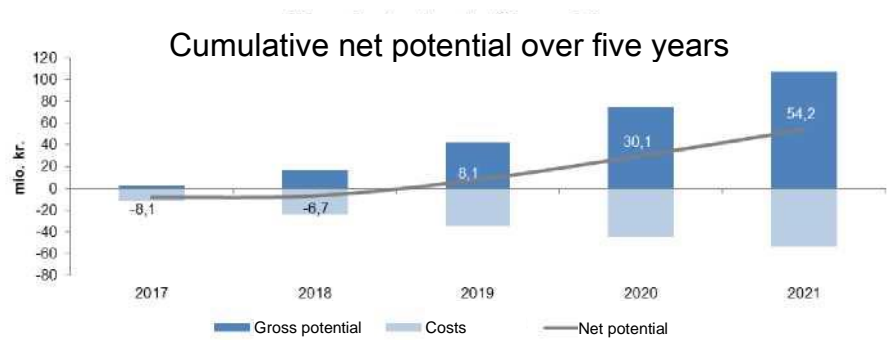
#### The business case's calculation of the overall effects of the North Denmark Region programme

The business case shows an accumulative economic potential of DKK 54 million for telemedical home monitoring for citizens with severe and very severe COPD (GOLD 3 and 4) in the North Denmark Region

The following figure and table provides an overview of the development in the business case's gross economic potential, costs and net economic potential accumulating over the 5-year period for citizens with severe and very severe COPD (GOLD 3 and 4).

The net potential is in particular a result of the average cost of hospital admissions for citizens with severe COPD (GOLD 3) falling significantly. There is some uncertainty associated with the estimate on hospital admissions, which is elaborated upon in section 2.1.2 as well as in Chapter 3.

Figure 18 The primary effects of the business case, North Denmark Region programme (DKK million in fixed prices)



The table below shows the economic potential and costs of the five-year period this business case deals with.

Table 23 Net economic potential for the North Denmark Region programme (DKK million in fixed prices)

Type	2017	2018	2019	2020	2021	Total
Gross economic potential	3.0	13.9	25.3	32.2	32.9	107.4
Investment costs	-8.7	-7.3	-3.0	-1.9	0.0	-20.8
Operating costs	-2.5	-5.2	-7.4	-8.4	-8.8	-32.4
Net economic potential	-8.1	1.4	14.8	22.0	24.1	54.2

People with severe COPD (GOLD 3) account for approximately DKK 46 million of the net economic potential over the five-year period, while citizens with very severe COPD (GOLD 4) are estimated to account for a net economic potential of approximately DKK 9 million.

## 4 METHOD AND APPROACH

This chapter provides an overview of how the business case was prepared, the methods and data used as well as uncertainties and sensitivity calculations.

### 4.1 The Danish state's business case model

The business case is based on the basic principles and guidelines from the Danish state's business case model. In addition to this report on the business case, the supporting documents for the business case include a spreadsheet that contains the calculations of the business case, including input data, sheets with calculations and a number of summary sheets with estimates and best case and worst case scenarios.

#### **Methodological adjustments to the business case model**

The state's business case model is designed for government IT projects subject to governmental budget and accounting requirements. The business case for the nationwide rollout of telemedical home monitoring for citizens with COPD encompasses different parts of the public sector, laying out the economic potential as well as costs at both the regional and municipal level. Some minor adjustments have therefore been necessary in relation to the use of some of the model's core concepts.

Specifically, adjustments have been made to the following two areas:

- Current operation
- Future operation

#### **Current operation**

The state's business case model starts with the total current operating costs for the area concerned. These are determined on the basis of accounting figures. A comprehensive calculation of the current operating costs associated with treatment and care across regions, municipalities and general practices would be very comprehensive. At the same time, with some of the collected accounting information it would not be possible to precisely distribute the costs for various individual activities and thereby focus on those activities that are relevant to the business case. It would therefore necessitate making a large number of estimates and assumptions about cost distributions in the affected areas in relation to activities.

Instead of identifying and quantifying the total operating costs for treatment and care as a whole, the business case's calculations deal with direct costs (DRGs and associated staff time linked directly to the COPD patients who have participated in the large-scale project TeleCare Nord). The business case therefore does not include a detailed overall picture of the finances of the affected areas in municipalities, regions and general practices.

### **Future operation**

The state's business model operates on a so-called 1-scenario, which is meant to determine project expenses and future operating costs associated with the implementation of the proposed project, and a 0-scenario, which is meant to determine the cheapest alternative to solving the same problem.

Designing a 0-scenario would be a time-consuming endeavour and associated with substantial uncertainty, and was also assessed as being beyond the scope of this task.

Instead of drafting a 0-scenario, the gross economic potential in the business case for a nationwide rollout of telemedical home monitoring for citizens with COPD has been calculated as the difference between the current operation (as-is) and future operation of a nationwide implementation of telemedical home monitoring (to-be).

The extrapolations over the period that affect that business case, e.g. the growth in the number of citizens with COPD as well as the growth in the number of suitable participants, are included in both the as-is and to-be calculations.

Project expenses, i.e. expenses for the development and implementation of telemedical home monitoring, are included in the calculation in accordance with the model so that a net gain is also calculated.

## **4.2 Structure of the model**

The overall business case has been calculated for citizens with severe or very severe COPD (GOLD 3 and GOLD 4) for each of the five regional programmes,<sup>27</sup> resulting in 10 segmentations, all of which contain different input data.

The economic potential of the model is structured on the basis of an assumption that the use of telemedical home monitoring for citizens with COPD can contribute to reducing the number and costs of hospital admissions, outpatient visits, consultations in general practices, municipal nursing services, practical assistance and care as well as medicine consumption through a generally improved follow-up of the patients' state of health.

The model is structured in such a way that as many parameters as possible are included to estimate the costs and potential gains arising from the treatment of individual COPD patients. Some parameters on the cost side are not dependent on the number of COPD patients participating in the solution (e.g. application development) and have therefore been estimated on the basis of functionality rather than the number of COPD patients.

The following provides an overview of how the models are constructed and which variables are important to the calculation of the business case's gross economic potential. This is followed by a review of how the development of the variables that constitute the economic potential have been calculated. Chapter 4 contains an overview of all input parameters used in the model.

### **4.2.1 Modelling of the economic potential side**

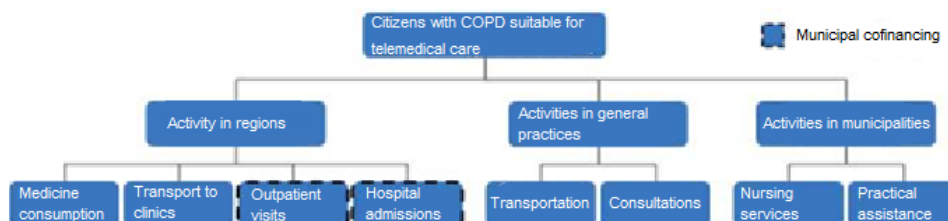
There are eight cost-incurring activities for citizens with COPD which affect the gross economic potential from the as-is scenario to the to-be scenario. These are depicted in Figure 11 below. This model is similar across the 10 segmentations included in the model.

The cost activities are broadly divided into three overarching activity areas: regions, general practices and municipalities. These categorisations are used to distribute costs between the different

<sup>27</sup> There is international consensus on the diagnostic criteria for COPD, prepared by the Global initiative for chronic Obstructive Lung Disease (GOLD). Assessment of the severity of the disease attaches importance to symptoms (primarily shortness of breath), lung function levels (based on spirometry) and the risk of future exacerbations (based on the number of exacerbations over the past year), and citizens with COPD are divided into the clinical GOLD A, B, C or D groups, where citizens with the fewest symptoms and lowest risk of exacerbations are placed in Group A and citizens with the highest number of symptoms and most at risk of exacerbations are placed in Group D.

organisational units, with the one exception being certain regional activities, specifically hospital admissions and outpatient visits, which are co-financed by the municipalities.

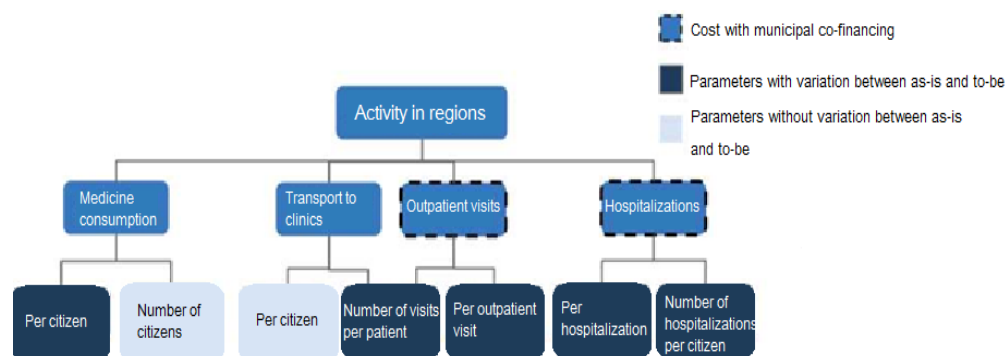
Figure 11 Overview of cost-incurring activities affected by the business case's economic potential calculation



The difference between as-is and to-be is only calculated on the basis of the proportion of citizens with COPD who are assessed as suitable for telemedical home monitoring. The assumption is that other COPD patients will require the same amount of healthcare resources as would be the case if telemedical home monitoring were not to be implemented, as their treatment remains unchanged. The proportion of non-suitable citizens is defined as citizens who either do not wish to or are unable to use the telemedical equipment, e.g. due to a lack of motivation, lifestyle, state of health, etc.

For each general activity area below, it has been specified which parameters affect each cost-incurring activity from the as-is to the to-be scenarios. The parameters reflect any preventive effects or increase in activity levels arising from the introduction of telemedical home monitoring. The model does not deal with the causes and influences of these effects, but only notes the development of each parameter, which means that the parameters do not influence one another. This means that in this model, a greater preventive effect will therefore not affect the number of consultations in general practice, as no data exists to demonstrate such an influence.

Figure 20 Overview of cost-incurring activities in the regions

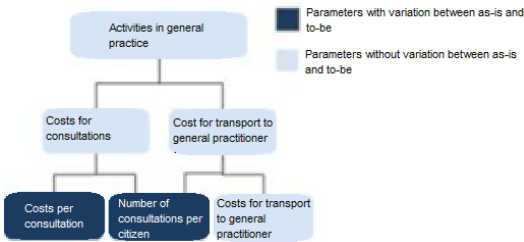


The figure shows which parameters are used to calculate each cost-incurring activity in the regions. The dark blue boxes show which parameters vary between the as-is and to-be scenarios. For regional activities, the number of citizens suitable for telemedical home monitoring and the costs of transportation to and from outpatient clinics are the only parameters that do not vary. The others either experience a rise or fall from as-is to to-be, depending on what the available data can tell us.

The model is therefore based on an assumption that the use of telemedical home monitoring can affect the costs associated with medicine consumption, the number of outpatient visits, the costs of outpatient visits, the number of hospitalisations and the cost of

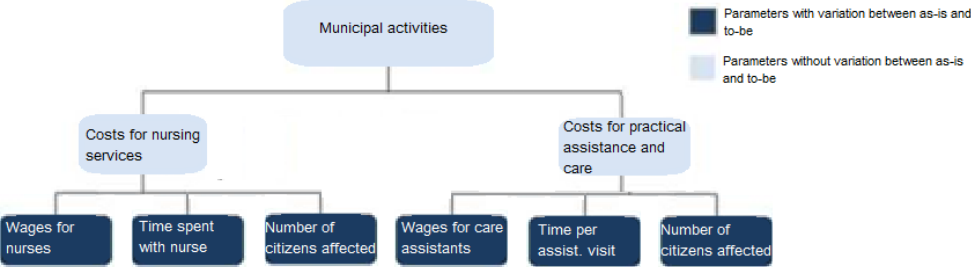
hospital admissions, all of which affect the total costs for regional activities relating to the treatment of citizens with COPD.

Figure 21 Overview of cost-incurring activities in general practice



The figure above shows the model for calculating the economic potential in relation to general practitioners. It shows that only the development in the number of consultations and the development of the cost per consultation determine the economic potential for general practice.

Figure 22 Overview of cost-incurring activities in the municipalities



The above figure shows the model for economic potential in municipal activities. The costs for nursing and costs for practical assistance and care are calculated using the same method. The model calculates how many visits telemedical home monitoring can make redundant for nursing and practical assistance and care, as well as how much time per visit can be saved on average for each service. The savings are accordingly calculated as a general development in time spent multiplied by wage costs for nursing staff as well as care assistants.

This leaves us with 11 parameters across the three general activity areas that are expected to vary and thus result in a savings potential with the introduction of telemedical home monitoring for citizens suffering from COPD.

#### 4.2.2 Calculation of the development of input parameters on the economic potential side

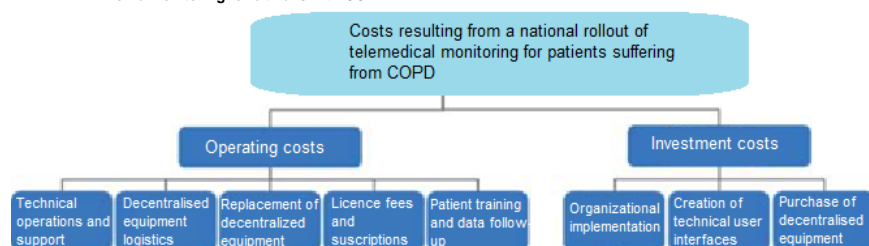
The calculation of the development of the 11 input parameters has been carried out on the basis of data from the health economic research project carried out in connection with TeleCare Nord.

The estimated effect of telemedicine has been calculated as the difference in the development between the intervention group and the control group before and after the telemedical intervention. The relative development in the control group's activity and resource demands is assumed to be the development that the intervention group would have experienced if they, too, had received telemedical treatment.

#### 4.2.3 Modelling of the cost side

The secondary costs of a nationwide rollout of telemedical home monitoring are divided into investment costs and operating costs. The figure below shows what components the operating and implementation costs are comprised of.

Figure 12 Overview of secondary costs of a nationwide rollout of telemedical home monitoring for citizens with COPD.

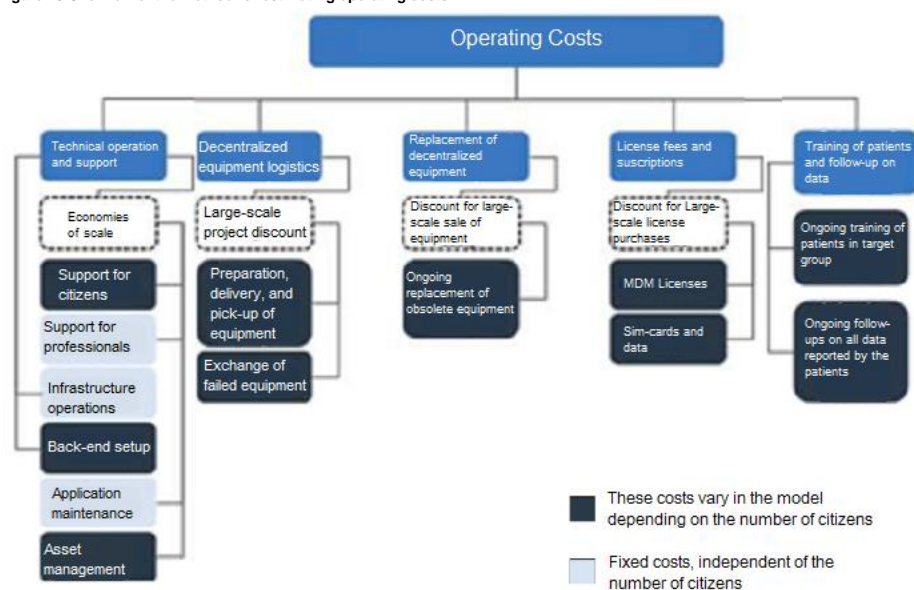


The operating costs are incurred annually as telemedical home monitoring is rolled out to the whole country, while the investment costs are incurred once in connection with the phasing-in of the project.

The costs are estimates based on significantly more sources and experiences than is the case for the economic potential calculations. That is why it is not possible to describe the general method for how the costs have been calculated as a whole. In Chapter 4, the various parameters on the cost side are elaborated upon with reference to sources.

The figure below shows the model used to estimate operating costs.

Figure 13 Overview of the method for estimating operating costs



The parameters in Figure 24 (above) marked in light blue are not directly dependent on the number of citizens receiving telemedical home monitoring. For example, in the estimate for support for health practitioners, application maintenance and operation of infrastructure, the number of COPD patients is taken into account, but the estimates are not directly derived from the number of citizens included in the programmes.

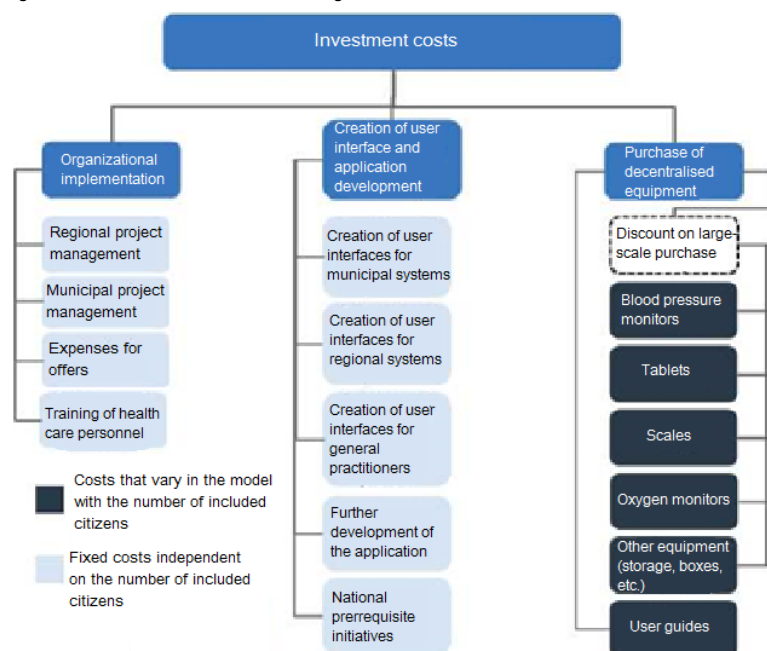
The parameters marked with dark blue, on the other hand, are directly affected by the number of citizens with COPD who receive telemedical home monitoring.

The boxes with dotted lines show which parameters in the business case are likely to achieve a volume discount on, either through procurement contracts or economies of scale.

The figure shows that the vast majority of operating costs depend on the number of citizens receiving telemedical home monitoring and only to a lesser extent rely on system costs and ongoing development activities of the technical solutions.

The figure below shows which parameters are used to estimate the investment costs.

**Figure 14 Overview of the method for estimating investment costs**



The figure shows that the parameters that constitute the investment costs are, to a greater extent than the parameters that constitute the operational costs, fixed expenses that are independent of the number of COPD patients who are receiving telemedical home monitoring. However, the largest share of the operating costs lies in investments in the purchase of decentralised equipment, which is directly proportional to the number of citizens receiving telemedical home monitoring.

The secondary costs are thus made up of a number of parameters, most of which are directly affected by the number of citizens receiving telemedical home monitoring. In that way, the business case is also approximated as a business case for individual COPD patients to the extent that is possible.

### 4.3 Data used

This section provides a general description of the data that was used for this business case. Chapter 4 provides an overview of all input parameters used in the model.

Common to all the data relating to regional and municipal effects of telemedical home monitoring is that in the TeleCare Nord project, the data was recorded on an individual level for both the intervention group and control group. Given the scope of the TeleCare Nord project - both in relation to the number of participants and the cross-sectoral involvement - the data from the project provides a unique basis for assessing the effects of telemedical home monitoring in a Danish context.

The preparation of this business case has entailed working with data on an aggregated sum level for the selected sub-groups (GOLD 3 and 4), as on ethical research grounds, PA Consulting Group has not had



access to the full data set from the TeleCare Nord project at an individual level. This restriction to data access adds some degree of uncertainty to the business case, as has been elaborated upon in the section below on uncertainties and sensitivity in the business case as well as in the review of each input parameter in Chapter 4.

The data used for this business case primarily stems from the large-scale project TeleCare Nord for the purpose of estimating the business case's economic potential as well as most of the parameters relating to the business case's cost side. The data received from the TeleCare Nord project comes in the form of average values and standard deviations for the relevant parameters broken down by GOLD groups in the control group and intervention group both before and after the intervention.

The data set contains data pulled from regional systems as well as data from municipalities. Regarding the municipal data, a substantial portion of the citizens in the intervention group in five of the eight participating municipalities have been registered as receiving telemedicine as part of their overall treatment. There is accordingly a significant risk that citizens who do not receive services from municipal nursing services are in fact registered as having as having received such services. Given the summary data forwarded to us in connection with the recalculation, it has not been possible to make an adjustment that compensates for this skewed data.

Instead, for the input parameter 'development in the number of citizens referred to municipal healthcare' the same method and same data was used as in the preliminary business case from May 2015. This data has to a greater extent allowed for adjustments in the observed skewness, as this data set is broken down by municipalities in such a way that it is to a greater extent possible to separate registration of telemedical home monitoring from the registration of other nursing activities.

#### 4.4 Sensitivity calculations and uncertainty

The business case includes sensitivity calculations as well as calculations of uncertainty in the form of worst case and best case scenarios.

##### Sensitivity calculations

Sensitivity analyses have been performed on all input variables included in this business case using the same method. The sensitivity analysis shows which variables have important implications for the overall result of the business case's overall result.

The sensitivity is calculated by increasing the value of the input variable by 10% in a positive direction for the business case, keeping this value as a constant and thereafter calculating the average change in the business case value over the five-year period by simultaneously having all other input variables vary between the best case and worst case values in 300 Monte Carlo simulations.

The sensitivity analysis does not in and of itself show which input variables in the business case are characterised by uncertainty in the determination of their values. For input variables showing high sensitivity and the values of which also carry some degree of uncertainty, the business case includes an uncertainty spread (worst case, estimate and best case). There are also a number of input parameters that are not among the most sensitive in the model, but nevertheless have an uncertainty spread to reflect that there is uncertainty attached to the determination of the parameter values for those variables.

As shown in the table below, the most sensitive input variables are linked to the estimates concerning the number of citizens with COPD.

Table 24 Sensitivity calculation

Input variable	Input value		Change in total net economic potential after a 10% change in input value
	GOLD 3	GOLD 4	
Share of citizens with COPD suitable for telemedicine	50%	50%	14.2%

<b>Costs per hospital admission</b>			<b>13.7%</b>
Number of citizens with COPD	35,750	4,250	13.5%
Reduction in costs per hospital admission			12.5%
Reduction in time per			6.1%

#### Uncertainty calculated as best case and worst case

In the overall business case, the spread between worst case and best case for the accumulative five-year net economic potential lies between DKK 388 million and DKK 578 million.

The spread between the best case and worst case scenario is determined by the calculated uncertainty of the business case's most uncertain and most significant input variables. For each of these input variables, a value has been determined for the worst case scenario, estimate and best case scenario. These values have been determined on the assumption that the probability of the input variable lying somewhere between the best case and worst case scenario is 95% and is normally distributed.

In order to calculate the overall business case value, 2,000 simulations are carried out<sup>28</sup> where the input values for each simulation has been selected at random from the above distribution. These 2,000 simulations were used to calculate (1) the average business case value (estimate) and (2) the interval covering 95% of the business case values (best case and worst case).

The worst case and best case values have been calculated on the basis of the standard deviation of the overall value of the business case in the form of the gross economic potential and the costs for each year of the period covered in this business case.

The uncertainties in the business case are linked to the estimate of the number of citizens with COPD as well as the input parameters estimating the business case's economic potential side, including especially the number and development of hospital admissions. The uncertainties regarding hospital admissions are due to two factors in particular:

- For citizens with severe COPD (GOLD 3), there are indications that a significant portion of the total potential is linked to a small number of very expensive hospitalisations that could - to some extent - be avoidable through the use of telemedical home monitoring.
- The TeleCare Nord project has measured the effects of telemedical home monitoring in the first year after the participants in the project's intervention group received their telemedical kit. The observed effects have been included in the business case for the overall five-year period. Thus, there can be positive or negative long-term effects in connection with the use of telemedical home monitoring which are unknown at present and therefore have not been included in the business case.

For citizens with severe COPD (GOLD 3), an uncertainty spread has been incorporated into the estimate for the costs associated with a hospital admission corresponding to the difference between the intervention group and control group prior to the intervention. Additionally, a relatively large uncertainty spread of +/- 10% has been added to the development of costs for a hospital admission as a result of the telemedical intervention.

For citizens with very severe COPD (GOLD 4), a corresponding uncertainty spread has been calculated solely for the number of admissions per COPD patient, since it is this variable that is the most sensitive for the group of citizens with very severe COPD (GOLD 4).

## 4.5 Activity adjustment across regions

The economic potential for hospitalisations and outpatient visits has been adjusted in relation to the individual regions' 2015 activity levels. The data used to calculate the economic potential primarily stems from the TeleCare Nord project, which was restricted to the North Denmark Region. Calculations concerning outpatient and

<sup>28</sup> 300 simulations have been carried out for the sensitivity calculations and 2,000 simulations have been carried out for the uncertainty calculations.

hospitalisation activity levels have therefore been adjusted to avoid any bias due to differences in activity levels between regions.

For both activities, an adjustment factor has been calculated for each region. The adjustment factor is multiplied by the number of hospitalisations or outpatient visits per person with COPD as a way of adjusting for activity levels in individual regions. This is calculated by comparing the actual and projected level of activity in each region with the actual and projected level of activity in the North Denmark Region, resulting in an estimate on the difference we can expect in activity levels by utilising data from TeleCare Nord and the individual regional programmes.

The table below shows hospital admission activities for the regions based on data from the Danish National Patient Registry as published in the Danish Register for Chronic Obstructive Pulmonary Disease's 2016 annual report. The figures from the North Denmark Region are used as reference, as these are the figures that are extrapolated to the other regions.

**Table 25 Activity level adjustments for the number of hospitalisations in the Capital Region programme**

	Capital Region	Region Zealand	Region of Southern Denmark	Central Denmark Region	North Denmark Region
<i>Number of hospital admissions</i>	10,367	7,252	6,402	6,662	3,881
<i>Projected number of hospital admissions based on the region's share of citizens with COPD</i>	9,720	5,455	8,011	7,455	3,921
<i>Adjustment factor</i>	1.08	1.34	0.81	0.90	-
<i>Projected number of hospital admissions per person with severe COPD (GOLD 3)</i>	0.33	0.42	0.25	0.28	0.31
<i>Projected number of hospital admissions per person with very severe COPD (GOLD 4)</i>	0.59	0.74	0.44	0.50	0.55

The number of hospital admissions covers the total number of admissions falling under the diagnostic code DJ44 (chronic obstructive pulmonary disease) as the discharge diagnosis, DJ44 as the additional diagnosis for discharge diagnoses with the code DJ96 (respiratory failure) or the diagnostic codes DJ13-18 (various forms of pneumonia)<sup>29</sup>.

The table below shows activity levels for outpatient visits for all regions. The figures from the North Denmark Region are used as reference, as these are the figures that are extrapolated to the other regions.

**Table 26 Activity level adjustments for the number of outpatient visits in the Capital Region programme**

	Capital Region	Region Zealand	Region of Southern Denmark	Central Denmark Region	North Denmark Region
<i>Average number of outpatient visits per person with COPD undergoing treatment in a COPD outpatient clinic.</i>	2.71	2.45	2.48	2.44	1.70

<sup>29</sup> The diagnostic codes DJ13-18 concern the following diagnoses: DJ13 (pneumococcal pneumonia), DJ14 (haemophilus influenzae), DJ15 (bacterial pneumonia, other), DJ16 (pneumonia due to other infectious agent, unclassified), DJ17 (pneumonia arising from a disease classified elsewhere) and DJ18 (pneumonia, agent not specified)

<i>Expected average number of outpatient visits per person undergoing treatment in a COPD outpatient clinic based on the region's share of citizens with</i>	2.46	2.46	2.46	2.46	2.46
<i>Adjustment factor</i>	1.60	1.44	1.46	1.44	-
<i>Calculated number of outpatient visits per person with severe COPD (GOLD 3)</i>	1.28	1.15	1.17	1.15	0.80
<i>Calculated number of outpatient visits per person with very severe COPD (GOLD 4)</i>	2.14	1.93	1.95	1.92	1.34

As shown in the table above, the figures from the Danish Register for Chronic Obstructive Pulmonary Disease's annual report (the two top rows of the table) differ from the figures used in the business case calculation (the two bottom rows of the table).

The figures from the annual report reflect what the average level of activity is in relation to citizens undergoing treatment at outpatient clinics, while the figures used in the business case reflect the average level of activity for all citizens suffering from COPD in the relevant target group, including those who are not undergoing regular treatment. The activity level adjustment is therefore based on the assumption that all other things being equal, it is the same share of the target groups undergoing regular treatment in the outpatient clinics. This results in a small degree of uncertainty in the estimates, which is not deemed to be significant to the overall business case

## 4.6 Funding allocation between municipalities and regions

This section outlines the assumptions and model for how costs in relation to a nationwide rollout of telemedical home monitoring for citizens with COPD will be computationally distributed between municipalities and regions in this business case.

The assumptions and model presented in this section are based on the principles for the distribution of costs used in the TeleCare Nord project. The assumptions and model have been adjusted in connection with the preparation of the business case. The assumptions and model for the distribution of costs should solely be seen as a calculation and distribution principle used for the business case. The business case does not consider the actual distribution principles that will be decided on. This will be negotiated in the individual regional programmes.

The total costs are broken down into two overarching dimensions: a time dimension (investment vs. operation) and an actor dimension (municipality vs. region vs. general practice).

Added to that is a further breakdown of costs based on whether an individual cost should be borne by just one actor or jointly funded by several actors.

The model for distribution of expenditure for telemedical home monitoring consists of two main principles:

- Costs that are borne by one actor alone are charged to that actor.
- Shared costs are distributed according to a basis of distribution that is anchored in the calculated distribution of gross potential between the involved actors. Any negative effects are offset on the actor level, thereby resulting in a percentage distribution to calculate each actor's share of the shared costs.

The distribution of the shared costs for the two overarching cost groups is therefore determined on the basis of the distribution established between municipalities and regions, where the basis of distribution is calculated on the basis of the total gross economic potential of the period covered by the business case, offset by any negative effects.

The distribution of the shared costs for both the investment costs and operating costs is determined using the same model. If the gross economic potential offset by any negative effects for any given actor is negative, the share of the shared costs for this actor will be DKK 0.

Figure 26 provides a summary overview of assumptions and the associated model for distribution as well as an overview of the associated defined cost groups.

**Figure 26: Summary overview of assumptions and model for distribution of cost groups**



Table 27 below shows how the economic potential parameters and cost parameters have been calculated as either municipal, regional or shared.

Specifically, the gross potential in the business case is divided in terms of 35% for the municipalities and 65% for the regions. This means that the shared costs are distributed between municipalities and regions using the same basis of distribution.

The municipal share of the gross economic potential is comprised of two main components - an economic potential linked to practical assistance and care in the municipalities and an economic potential linked to the municipal co-financing of the regional costs for hospital admissions and outpatient visits.<sup>30</sup>

The calculation of the size of the municipal co-financing is based on the total population in the TeleCare Nord project, i.e. citizens with COPD GOLD 1-4. It is not possible to stratify data regarding municipal co-financing in a way that the municipal co-financing can be determined solely on the basis of data regarding citizens with COPD GOLD 3-4.

The stratified data used in the recalculated business case shows that the greatest share of the total economic potential is linked to a decrease in costs per hospitalisation. The data indicates that the economic potential is linked to a smaller number of costly hospital admissions, which can have an impact on how large a share of the economic potential the municipalities will benefit from, as part of this economic potential could lie above the limit for municipal co-financing. It is not possible on the basis of the data made available for this business case to make any conclusions about the exact cost profile distributed across individual hospitalisations.

<sup>30</sup> The realisation of the economic potential in relation to the municipal co-financing (MCF) relies on making local agreements in the regional programmes, and also assumes a reduction of capacity in the regions. Furthermore, the municipal gains from municipal co-financing cannot be transferred to municipal operations. Computationally, the level of MCF will correspondingly be reduced after two years, and accordingly any gains will impact the level for re-adjustment of MCF. This will still result in socioeconomic gains.

The stratified data used in the recalculated business case also shows that in TeleCare Nord, there have been a number of activities associated with citizens with COPD GOLD 3-4, such as fall in the number of hospitalisations and a fall in the number of outpatient visits, where the economic potential lies below the limit for municipal co-financing and where the economic potential is consequently reflected in the municipal co-financing.

In this business case, the municipal co-financing has been set to 19%, which is the most precise estimate that can be made on the basis of the available data from TeleCare Nord.

**Table 27 Summary overview of the distribution of costs between municipalities and regions**

Parameter	Cost/economic potential borne by:
<b>Positive effects of telemedicine</b>	
Economic potential in relation to hospital admissions	Region - municipal co-financing
Economic potential in relation to practical assistance and care	Municipality
Economic potential in relation to outpatient visits	Region - municipal co-financing
Economic potential in relation to transport costs of outpatient visits	Region
Economic potential in terms of consultations with general practitioners	Region
Economic potential in terms of transport costs of consultations with general practitioners	Municipality
<b>Negative effects of telemedicine</b>	
Economic potential of medicine	Region
Economic potential of municipal nursing	Municipality
<b>Costs</b>	
<b>Operating costs</b>	
Total cost of ongoing training of COPD patients (DKK)	Municipality
Total cost of following up of measurement data from citizens with COPD (DKK)	Municipality
Costs of registering patients in backend/system (DKK)	Shared
Costs of subscriptions and video-conferencing solution	Shared
Broadband subscriptions for patients with video-conferencing solutions	Shared
Costs of asset management	Shared
Setup, delivery, installation and retrieval of equipment	Shared
Costs of swapping defective equipment at patients' homes	Shared
Technical support for health practitioners	Shared
Technical support for citizens	Shared
Costs of application maintenance	Shared
Costs of infrastructure operation	Shared
Costs of SIM cards and data plans	Shared
Costs of MDM licences	Shared
Ongoing purchases to replace decentralised equipment	Shared
<b>Project and implementation costs</b>	
Total price for training	Municipality
Total price for temporary staff	Municipality
Regional project management	Region
Municipal project managers	Municipality
Costs for invitations to tender	Shared
Local maturation activities	Shared
<b>Investment costs</b>	
Procurement of sphygmomanometers	
Procurement of tablets	Shared
Procurement of scales	Shared
Procurement of oxygen meters	Shared
	Shared
Procurement of other equipment	Shared
Costs of user guides	Shared
Creation of interfaces for KIH	Shared
Creation of interfaces for GPs	
Creation of interfaces for municipal nursing and care systems	
Creation of interface for Regional Electronic Patient Records (EPR)	

# 5 REVIEW OF INPUT PARAMETERS

This chapter describes the input variables included in the business case, including the values and sources of these variables. The chapter also describes the relationship between the various input parameters in the business case.

## 5.1 General assumptions

This business case is based on a number of general assumptions in order to estimate the business case's baseline and assess the wage costs in connection with various services. The combination of the total number of people with COPD in the target group, growth in this number as well as the proportion of people suffering from COPD who are suitable for telemedical treatment make up the overall baseline for the number of people with COPD who are expected to receive telemedical treatment.

**Table 28 General assumptions**

Input variable	Value			Description
	Worst case	Estimate	Best case	
Number of people with severe COPD (GOLD 3)	31,900	35,750	39,600	<p>The estimate of the number of people with severe COPD is based on three scientific articles: one from the North Denmark Region and two from the Capital Region. The articles attempt to estimate the prevalence of COPD. The studies indicate that approximately 40,000 people in Denmark suffer from COPD to a severe or very severe degree and that the number is expected to increase in the coming years.</p> <p>The distribution of people with severe and very severe COPD is based on one of the three studies (Løkke <i>et al.</i>), which is the only study that has calculated this distribution. The study indicates that approximately 11% in this group suffer from very severe COPD (GOLD 4), while approximately 89% suffer from severe COPD (GOLD 3).</p> <p>Sources:</p> <p>Lange <i>et al.</i> (2012), "Substantial need for early diagnosis, rehabilitation and treatment of chronic obstructive pulmonary disease"</p> <p>Løkke <i>et al.</i> (2007), "<i>Forekomst af kronisk obstruktiv lungesygdom i København. Resultater fra Østerbrounderøgelsen</i>"</p> <p>Hansen <i>et al.</i> (2008), "<i>The prevalence of Chronic Obstructive Pulmonary Disease among Danes aged 45-84 Years: population based study</i>"</p>
Number of people with very severe COPD (GOLD 4)	3,525	4,250	4,975	Estimates are based on the same as above.
Growth in number of people with COPD	1.5%	2.0%	2.5%	<p>According to Statistics Denmark, the number of people who annually have outpatient visits to hospitals has risen by an average of 2.0% a year. Efforts were made to validate this estimate through discussions with a number of clinicians at the respiratory medicinal field in connection with the preparation of the preliminary business case in 2015.</p> <p>Sources:</p> <p>Statistics Denmark</p> <p>Interviews with clinicians</p>



Share of people with COPD suitable for telemedical treatment	40%	50%	60%	<p>This estimate has been established on the basis of the experiences from the two large-scale projects, KIH and TeleCare Nord, including interviews with physicians attached to the two projects. It reflects how large a share of people with COPD are suitable for telemedical home monitoring and are willing to accept this form of treatment.</p> <p>Sources: KIH &amp; TeleCare Nord</p>
Number of new people with COPD in the target group per year	3,600			<p>The estimate reflects how many new people each year will become part of the target group for telemedical treatment of people with COPD. The estimate is used here to estimate the volume of operational services, such as ongoing training of new COPD patients. The estimate is based on the number of deaths registered as having COPD as the primary cause (B-066). It is also assumed that some deaths in the target group will be registered under other causes such as pneumonia. All other things being equal, it is assumed that the exit of people from the target group will be the same as the entry of people to the target group when - as we have done in this estimate – one disregards the growth in the number of people suffering from COPD.</p> <p>Source: The Danish Register of Causes of Death</p>
Phasing-in, years 1-5	GOLD 3		GOLD 4	<p>The speed of the phasing-in process is based on the assumption that a rollout of telemedical home monitoring will commence in mid-2017 and be fully implemented in relation to the portion of the target group that is suitable by the end of 2019. The speed of the phasing-in process is assumed to be linear.</p> <p>The phase-in percentage reflects the average progress of the overall phasing-in during that year. For example, it is assumed that by 2019, telemedical home monitoring for people with COPD will be 60% phased in by the start of the year and 100% phased in by the end of that year at a linear rate, whereby the average for the year is 80%.</p> <p>The phasing-in is assumed to take place in parallel for both people with severe COPD (GOLD 3) and people with very severe COPD (GOLD 4). The assumptions relating to the phasing-in are based on the regional programmes' preliminary implementation plans.</p>
	2017	10%	2017	10%
	2018	45%	2018	45%
	2019	80%	2019	80%
	2020	100%	2020	100%
	2021	100%	2021	100%

The wage costs are estimated primarily on the basis of data from the Joint Municipal Wage Data Office (Det Fælleskommunale Løndatakontor). The wage costs in the business case are used partly to estimate the potential of the municipal services, which have been calculated in terms of time spent, and partly to estimate the cost of individual projects relating to implementation and operation.

**Table 29 Input variables for wages costs**

Input variable	Value			Description
	Worst case	Estimate	Best case	
FTE project manager	-	DKK 545,000	-	<p>The average gross annual salary in 2015 for graduates and lawyers/economists working in regions and municipalities. The figure has been projected to 2016 prices using the municipal price and salary adjustment rate.</p> <p>Sources:</p> <p>The Joint Municipal Wage Data Office (Det Fælleskommunale Løndatakontor)</p> <p>Local Government Denmark - municipal price and salary development</p>
FTE nurse	-	DKK 445,000	-	<p>The average gross salary in 2015 for municipal nurses in non-managerial positions within the fields of nursing and care for the elderly and disabled as well as preventive interventions for the elderly and the disabled. The figure has been projected to 2016 prices using the municipal price and salary adjustment rate.</p> <p>Sources:</p> <p>The Joint Municipal Wage Data Office (Det Fælleskommunale Løndatakontor)</p> <p>Local Government Denmark - municipal price and salary development</p>
FTE care assistant	-	DKK 384,700	-	<p>The average gross salary in 2015 for municipal care assistants and helpers in non-managerial positions within the fields of nursing and care for the elderly and disabled as well as preventive interventions for the elderly and the disabled. The figure has been projected to 2016 prices using the municipal price and salary adjustment rate.</p> <p>Sources:</p> <p>The Joint Municipal Wage Data Office (Det Fælleskommunale Løndatakontor)</p> <p>Local Government Denmark - municipal price and salary development</p>
FTE technical support	-	DKK 373,600	-	<p>The average gross salary in 2015 for municipal IT workers. The figure has been projected to 2016 prices using the municipal price and salary adjustment rate.</p>

				Sources:
				The Joint Municipal Wage Data Office (Det Fælleskommunale Løndatakontor)
				Local Government Denmark - municipal price and salary development
Actual FTE in hours		1,450 hours		The FTE standard of 1924 hours with adjustment for vacations, public holidays, etc. Source: "Analyse af øget brug af videotolkning og videomøder", 2014
Overheard	-	25%	-	Overhead is added to wages costs in order to take into account the indirect costs of the work performed.  Sources: Activity-based costing studies show overhead costs in eye care clinics amounting to 14-20%. (Omkostningseffektive afdelinger. Analyse af øjenområdet, PWC 2011) A KORA analysis on courses of treatment determined a variation in indirect costs between hospitals and clinics of 7-88%. An analysis of eight specific courses of treatment found that the percentage varies between 25-40%. (PASS-patientforløb i speciallægepraksis og på sygehus, KORA, November 2012) US studies have found indirect costs at hospitals amounting to 24-25%. (Den "forbandede" overhead; hvem skal egentligt betale for forskningen? Olaf Svenningsen, University of Southern Denmark, March 2010)

## 5.2 The economic potential side's input parameters

The business case has a potential for economic gains in regions, municipalities and general practices.

The potential manifests itself through a reduction of activities and costs in municipalities and regions

as a result of the nationwide rollout of telemedical home monitoring for people with COPD.

### 5.2.1 Regional services

The potential in the regions include activities covering hospital admissions, consultations in outpatient clinics as well as medicine consumption among people with COPD.

The estimate of the reduction in activities and costs is based on data from the TeleCare Nord project and reflects the difference in development between the control group and intervention group. A negative development reflects a fall in activity levels or costs from the intervention group to the control group, while a positive development reflects an increase in activity levels and costs.

The data used stems from participants in the TeleCare Nord project who have been hospitalised with the

diagnostic code DJ44 (chronic obstructive pulmonary disease) as the discharge diagnosis or as an

additional diagnosis for hospitalisations with the discharge diagnoses DJ96 (respiratory failure) or

DJ13-DJ18 (pneumonia).

**Table 30 Input variables used for estimates relating to hospitalisations**

Input variable	Value			Description
	Worst case	Estimate	Best case	
Annual number of hospital admissions per person with COPD in the North Denmark Region	GOLD 3 GOLD 4			Reflects the average number of hospitalisations per COPD patient. The estimate is based on data from the TeleCare Nord project. Uncertainty spreads have been added to the estimates.  Source: TeleCare Nord.
Annual number of hospital admissions per person with COPD in the Capital Region	GOLD 3 GOLD 4			The data is based on the same as the above. Adjustments have been made to reflect the general hospital admission activity level per person with COPD. The estimate has therefore been multiplied by a factor of 1.08 in relation to the North Denmark Region.  Source: DrKOL 2016 annual report The data is based on the same as the above. Adjustments have been made to reflect the general hospital admission activity level per person with COPD. The estimate has therefore been multiplied by a factor of 1.34 in relation to the North Denmark Region.
Annual number of hospital admissions per person with COPD in Region Zealand	GOLD 3 GOLD 4			Source: DrKOL 2016 annual report The data is based on the same as the above. Adjustments have been made to reflect the general hospital admission activity level per person with COPD. The estimate has therefore been multiplied by a factor of 0.81 in relation to the North Denmark Region.
Annual number of hospital admissions per person with COPD in the Region of Southern Denmark	GOLD 3 GOLD 4			Source: DrKOL 2016 annual report The data is based on the same as the above. Adjustments have been made to reflect the general hospital admission activity level per person with COPD. The estimate has therefore been multiplied by a factor of 0.90 in relation to the North Denmark Region.
Annual number of hospital admissions per person with COPD in the Central Denmark Region	GOLD 3 GOLD 4			Source: DrKOL 2016 annual report The estimate is based on data from TeleCare Nord and reflects the average cost of a hospitalisation of a person with COPD.
Cost per hospitalisation of people with COPD	GOLD 3 GOLD 4			Source: TeleCare Nord Development in the intervention group's number of admissions from 2013 to 2014 subtracted from the development in the control group during the same period in the TeleCare Nord project. The estimate is derived from data from the TeleCare Nord project research group.
Development in the number of hospital admissions	GOLD 3 GOLD 4			Source: TeleCare Nord The estimate is derived from regional data from the TeleCare Nord project. The diagnostic codes for the costs are the same as above.  Source: TeleCare Nord
Development in the cost per hospital admission	GOLD 3 GOLD 4			

Outpatient visits do not have any noteworthy effect on the business case. Outpatient visits have been estimated on

the basis of data from TeleCare Nord and includes people involved in outpatient visits with the discharge code

DJ44 – Chronic Obstructive Pulmonary Disease or as an additional diagnosis for hospitalisations with the discharge

diagnoses DJ96 (respiratory failure). The parameters are described in the table below.

**Table 31 Input variables used to estimate outpatient visits**

Input variable	Value			Description
	Worst case	Estimate	Best case	
Annual number of outpatient visits with medicinal clinics per person with COPD – North Denmark Region	GOLD 3 GOLD 4			Reflects the average number of outpatient visits per COPD patient at medical clinics in 2013. The estimate is based on data from the TeleCare Nord project.
Annual number of outpatient visits with medicinal clinics per person with COPD – Capital Region	GOLD 3 GOLD 4			The data is based on the same as the above. Adjustments have been made to reflect the general activity levels at COPD clinics for people with COPD. The estimate has therefore been multiplied by a factor of 1.60 in relation to the North Denmark Region.

Annual number of outpatient visits with medicinal clinics per person with COPD – Region Zealand	GOLD 3 GOLD 4	<p>Source: DrKOL 2016 annual report</p> <p>The data is based on the same as the above. Adjustments have been made to reflect the general activity levels at COPD clinics for people with COPD. The estimate has therefore been multiplied by a factor of 1.44 in relation to the North Denmark Region.</p>
Annual number of outpatient visits with medicinal clinics per person with COPD – Region of Southern Denmark	GOLD 3 GOLD 4	<p>Source: DrKOL 2016 annual report</p> <p>The data is based on the same as the above. Adjustments have been made to reflect the general activity levels at COPD clinics for people with COPD. The estimate has therefore been multiplied by a factor of 1.46 in relation to the North Denmark Region.</p>
Annual number of outpatient visits with medicinal clinics per person with COPD – Central Denmark Region	GOLD 3 GOLD 4	<p>Source: DrKOL 2016 annual report</p> <p>The data is based on the same as the above. Adjustments have been made to reflect the general activity levels at COPD clinics for people with COPD. The estimate has therefore been multiplied by a factor of 1.44 in relation to the North Denmark Region.</p>
Cost per outpatient visit	GOLD 3 GOLD 4	<p>Source: DrKOL 2016 annual report</p> <p>The estimate is based on regional data from the TeleCare Nord and reflects the average cost per outpatient visit per COPD patient in the respective target groups.</p>
Transport to and from outpatient clinic	GOLD 3 GOLD 4	<p>Source: TeleCare Nord</p> <p>Transport has been calculated on the basis of a number of input parameters: the share of people with COPD who are pensioners, costs for direct and reimbursable patient transport as well as the share of outpatient visits with respectively direct and reimbursable patient transport for both pensioners and non-pensioners. The cost savings on patient transport depend on the development in the number of outpatient visits. The regions cover the costs for patient transport to and from clinics.</p> <p>Sources: Statistics Denmark Deloitte analysis "Kortlægning og analyse af befordringsordninger" for the Ministry of Finance (2012) Own calculations</p>
Development in the number of outpatient visits	GOLD 3 GOLD 4	<p>The development in the intervention group's number of outpatient visits at clinics from 2013 to 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.</p>
Development in the cost per outpatient visit	GOLD 3 GOLD 4	<p>Source: TeleCare Nord</p> <p>The development in the intervention group's costs per outpatient visit from 2013 to 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.</p> <p>Source: TeleCare Nord</p>

The development in costs for medicine is shown below.

**Table 32 Input variables used to estimate medicine costs**

Input variable		Value			Description
		Worst case	Estimate	Best case	
Annual cost of medicine per patient	GOLD 3 GOLD 4				Reflects the average cost of medicine per patient in 2013 for the intervention and control group in the TeleCare Nord project.  Source: TeleCare Nord
Annual number of outpatient visits with medicinal clinics per person with COPD – Capital Region	GOLD 3 GOLD 4				The development in the intervention group's cost of medicine per patient from 2013 to 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project.  Source: TeleCare Nord

## 5.2.2 General practices

The economic potential in general practices encompasses the development of the number of consultations and

the costs thereof as well as transport to and from general practices. The estimates are based on figures from

the TeleCare Nord project, where the number of consultations includes all consultations and not just

COPD-related consultations. We have tried to take this into account in our estimate for transport costs.

**Table 33 Input variables used to estimate costs for general practices**

Input variable		Value			Description
		Worst case	Estimate	Best case	
Annual number of consultations in general practices per patient	GOLD 3 GOLD 4				Reflects the average number of consultations per COPD patient in general practices in 2013. The figure reflects all consultations, including telephone consultations, e-mail consultations and non-COPD-related consultations.  Source: TeleCare Nord
Cost per consultation in general practices	GOLD 3 GOLD 4				The estimate is derived from regional data from the TeleCare Nord project. The amount has been calculated as the average cost per consultation in general practices per person with COPD in the respective target groups.  Source: TeleCare Nord
Transport to and from general practices	GOLD 3 GOLD 4				Transport has been calculated on the basis of a number of input parameters: the share of people with COPD who are pensioners, costs for direct and reimbursable patient transport as well as the share of outpatient visits with respectively direct and reimbursable patient transport for both pensioners and non-pensioners. The cost savings on patient transport depend on the development in the number of consultations in general practices. The regions cover the costs for patient transport to and from general practices.  Sources: Statistics Denmark

Deloitte analysis "Kortlægning og analyse af befordringsordninger" for the Ministry of Finance (2012)  
Own calculations

Development in the number of consultations in general practices	GOLD 3 GOLD 4	The development in the intervention group's number of consultations with general practitioners from 2013 and 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.
Development in the cost per consultation in general practices	GOLD 3 GOLD 4	Source: TeleCare Nord The development in the intervention group's costs per consultation in general practices from 2013 to 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.  Source: TeleCare Nord

### 5.2.3 Municipal services

The economic potential in relation to municipal services consists of the development in practical assistance and care as well as nursing interventions. The data is derived from reports from 8 municipalities involved in the TeleCare Nord project. The data has been recorded differently in the municipalities, which has necessitated additional processing of the data. The data concerning nursing interventions is particularly uncertain as our assessment is that three out of eight municipalities have not recorded the nurses' time spent on telemedicine-related work in the same way as the other five municipalities. These issues are elaborated upon in Chapter 4.

**Table 34 Input variables used to estimate costs of practical assistance and care**

Input variable		Value			Description
		Worst case	Estimate	Best case	
Number of hours referred/spent on practical assistance and care per referred citizen	GOLD 3 GOLD 4				Reflects the average number of hours spent on practical assistance and care per citizen in 2013 across 8 out of the 10 municipalities that were involved in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.  Source: TeleCare Nord
Share of citizens with COPD referred to practical assistance and care	GOLD 3 GOLD 4				Reflects the average share of citizens with severe or very severe COPD who in 2013 were referred to practical assistance across the intervention and control group. Uncertainty spreads have been added to the estimates.  Source: TeleCare Nord
Development in the number of citizens with COPD referred to practical assistance and care	GOLD 3 GOLD 4				The development in the number of citizens referred to practical assistance and care in the intervention group from 2013 to 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.  Source: TeleCare Nord
Development in the recorded amount of time spent on practical assistance and care per citizen with COPD	GOLD 3 GOLD 4				The development in the recorded number of hours spent on practical assistance and care per referred patient in the intervention group from 2013 to 2014 subtracted from the development in the intervention group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.  Source: TeleCare Nord

**Table 35 Input variables used to estimate costs of nursing interventions**

Input variable		Value			Description
		Worst case	Estimate	Best case	
Number of hours referred/spent on municipal	GOLD 3 GOLD 4				Reflects the average number of hours spent on nursing

nursing interventions per referred citizen		interventions per citizen in 2013 across 8 out of the 10 municipalities that were involved in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.
		Source: TeleCare Nord
Share of citizens with COPD referred to municipal nursing interventions	GOLD 3 GOLD 4	Reflects the average share of citizens with severe or very severe COPD who in 2013 were referred to nursing interventions across the intervention and control group. Uncertainty spreads have been added to the estimates.
		Source: TeleCare Nord
Development in the number of citizens with COPD referred to municipal nursing interventions	GOLD 3 GOLD 4	The development in the number of citizens referred to nursing interventions in the intervention group from 2013 to 2014 subtracted from the development in the control group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.
		Source: TeleCare Nord
Development in the recorded amount of time spent on municipal nursing interventions per citizen with COPD	GOLD 3 GOLD 4	The development in the recorded number of hours spent on nursing interventions per referred patient in the intervention group from 2013 to 2014 subtracted from the development in the intervention group over the same period in the TeleCare Nord project. Uncertainty spreads have been added to the estimates.
		Source: TeleCare Nord

### 5.3 Technology-related input parameters

The following section uses the term “own calculation” for selected input parameters in relation to the source provided. The term includes input parameters where the given value is comprised of – and therefore calculated on the basis of – several individual input sources for the selected input parameter.

For example, the input parameter “SIM cards and data plan per unit per year” is comprised of information retrieved from the TeleCare Nord project as well as supplementary information concerning possible cost savings, similar projects with corresponding needs (such as IT systems relating to the field of digitally supported rehabilitation therapy), comparable prices from government procurement agreements and related public calls for tenders.

Certain input parameters have anonymised input sources, and the source of these are accordingly not described in further detail. Furthermore, certain input parameters include an uncertainty spread to reflect both an uncertainty concerning the estimate as well as the fact that the selected input sources are anonymised.

The table below provides an overview of the parameters for the technology-related operating costs.

**Table 36 Input variables used to estimate technology-related operating costs**

Input variable	Value			Description
	Worst case	Estimate	Best case	
Application maintenance, annual cost	DKK 6.7 million	DKK 4.6 million	DKK 2.5 million	<p>The cost covers maintenance of the telemedical solutions in the regions, including the development and deployment of software patches, necessary and forced upgrades and general technical security activities.<sup>1</sup></p> <p>The estimate is based on market research of two commercial solutions as well as an open source solution. The</p>

<sup>1</sup> It is not possible to determine whether the costs for the telemedical solution should be allocated under implementation or operating budgets, as this depends on local purchasing decisions in the regional programmes, such as whether to lease or purchase hardware.



estimate reflects an average calculation of the investigated solutions, as it is expected that at the solutions will be purchased in different ways (smaller or bigger purchasing groups) and at different prices at the local level.

The market research showed that the costs depend to a great extent on how many citizens will be covered by the solution, but that some fixed operating expenses must also be expected regardless of the number of citizens using the solution. The composition of fixed and variable costs varies across the investigated solutions. The estimate reflects an average of the obtained prices.

The prices are distributed between each region on a basis of distribution where 30% of the costs are fixed and uniform across the regions and 70% vary depending on the number of citizens with severe or very severe COPD (GOLD 3 and GOLD 4) in each region.

The worst case and best case scenarios have been estimated based on the price range identified in the market research.

Source: Own market research

Infrastructure and application service, annual cost	DKK 15.7 million	DKK 10.7 million	DKK 5.7 million	<p>The costs cover database support, development and service environments, incident and error management, capacity and release management, technical service desk as well as backup and licences related to the telemedical solutions in the regions.<sup>2</sup></p> <p>The estimate is based on market research of two commercial solutions as well as an open source solution. The estimate reflects an average calculation of the investigated solutions, as it is expected that the solutions will be purchased in different ways (smaller or bigger purchasing groups) and at different prices at the local level.</p> <p>The market research showed that the costs depend to a great extent on how many citizens will be covered by the solution, but that some fixed operating expenses must also be expected regardless of the number of citizens using the solution. The composition of fixed and variable costs varies across the investigated solutions. The estimate reflects an average of the obtained prices.</p> <p>The prices are distributed between each region on a basis of distribution where 30% of the costs are fixed and uniform across the regions and 70% vary</p>
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<sup>2</sup> It is not possible to determine whether the costs for the telemedical solution should be allocated under implementation or operating budgets, as this depends on local purchasing decisions in the regional programmes such as whether to lease or purchase hardware.

				<p>depending on the number of citizens with severe or very severe COPD (GOLD 3 and GOLD 4) in each region.</p> <p>The worst case and best case scenarios have been estimated based on the price range identified in the market research.</p> <p>Source: Own market research</p>
Replacement frequency	-	4 years	-	<p>Reflects how long IT equipment (i.e. measuring devices and data recording units) will be in operation before requiring replacement.</p> <p>The standard depreciation rate for 'other IT equipment' has been set as 3-5 years by the Danish state (office administrative equipment bought 'in bulk' has a linear depreciation over three years). The equipment in this business case will not undergo the same amount of wear as office administrative IT equipment, as it will only be used a limited number of times a week, which is why it is assumed that it will be able to last a year longer before requiring replacement.</p> <p>Source: Agency for Modernisation (Ministry of Finance)</p>
Asset management per unit per year	-	DKK 100	-	<p>Reflects an initial registration and ongoing monitoring of the decentralised equipment (location and status), including the operation of a shared asset database (per local regional installation or use).</p> <p>The estimate is derived from the costs in the TeleCare Nord project as well as similar market prices for corresponding services on the market, including corresponding projects in KIH.</p> <p>Source: TeleCare Nord and own calculation</p>
MDM licence per unit per year		DKK 300		<p>Reflects the cost of a licence for the MDM (Mobile Device Management) system, which handles the initial setup as well as ongoing management and control of the decentralised units (for the OpenTele recording tablet). The expense includes essential costs for the necessary back-end application and cost per administrated unit.</p> <p>The estimate is based on the costs recorded in the TeleCare Nord project as well as similar products on the market.</p> <p>Source: TeleCare Nord and own calculation</p>
SIM card and data plan per unit per year	-	DKK 150	-	<p>Reflects the costs of data plans for the regular transfer of data from the patient to the health professionals and vice versa for sending questionnaires and exchanging messages.</p> <p>The estimate is based on data from TeleCare Nord, but has been adjusted downwards. The reasoning behind this adjustment is that the volume of data that will be transferred in connection with the reporting of measurement data is relatively limited (this does not include video conferencing support).</p> <p>The estimate is also based on</p>

				<p>supplementary information from similar projects with corresponding needs (such as IT systems relating to the field of digitally supported rehabilitation therapy), comparable prices from government procurement agreements and related public calls for tenders.</p> <p>Source: TeleCare Nord and own calculation</p>
Quantity discount in connection with purchasing licences, subscriptions, etc.	25%	30%	35%	<p>The business case assumes that a significant discount can be achieved in connection with large-scale orders through procurement contracts or major bids. In the business case, the cost savings are deducted from the overall price of the total number of licences and subscriptions/plans.</p> <p>The estimates are derived from known cost savings in relevant state procurement agreements and related public invitations to tender.</p> <p>Source: Own calculation</p>
Economies of scale in connection with operation and maintenance of decentralised units	15%	20%	25%	<p>The business case assumes that economies of scale can be achieved in connection with a full phasing-in of a nationwide rollout, both in relation to regional operations and shared multi-region operations. In the business case, the cost savings are deducted from the overall price for operation and maintenance of decentralised units as well as associated server systems and the management of these.</p> <p>The estimates are derived from known cost savings in relevant state procurement agreements and related public invitations to tender.</p> <p>Source: Own calculation</p>
Economies of scale in connection with operation and maintenance of applications and infrastructure	15%	20%	25%	<p>The business case assumes that economies of scale can be achieved in connection with a nationwide rollout. In the business case, the cost savings are deducted from the input parameters "application maintenance" as well as "infrastructure and application service".</p> <p>The estimates are derived from market research carried out by PA Consulting among several suppliers as well as from known cost savings in relevant state procurement agreements and related public invitations to tender.</p> <p>Source: Own calculation and market research</p>

A number of investments in technology will be made in connection with a nationwide rollout of telemedical home monitoring. These costs are shown in the table below.

**Table 37 Input variables used to estimate technology-related investment costs**

Input variable	Value		Description
	Worst case	Best case	
Blood pressure meter, price per unit	-	-	<p>The price for blood pressure meters has been set to DKK 0.00 in the business case as a result of the decision not to include blood pressure meters in the telekit (which the TeleCare Nord project did).</p> <p>Sources:</p>

				Own calculation TeleCare Nord
Tablets, price per unit	DKK 1,650	DKK 1,500	DKK 1,350	<p>The price has been adjusted downwards in relation to the average price for tablets in the TeleCare Nord project, partly because the price dropped from the first to the second round of purchases in TeleCare Nord and partly because the project was forced to choose a more expensive tablet model to ensure compatibility with security requirements in the project's chosen MDM (Mobile Device Management) system.<sup>3</sup></p> <p>Our assessment is that compatibility can be ensured with cheaper tablet models and another/updated MDM platform. No discount has been factored into the price.</p> <p>Sources: Own calculation TeleCare Nord</p>
Scales, price per unit	DKK 1,200	DKK 1,100	DKK 1,000	<p>In the TeleCare Nord project, there was a requirement that the scale lived up to the Continua Health Alliance certification standard as well as the associated data format and exchange standards. No discount has been factored into the price.</p>
Oxygen meters, price per unit	DKK 2,350	DKK 2,150	DKK 1,950	<p>The price has been adjusted upwards in relation to the purchase price in the TeleCare Nord project. This is because the oxygen meter used in the TeleCare Nord project has not been of a satisfactory standard, which is why a better model is needed. No discount has been factored into the price.</p> <p>Sources: Own calculation TeleCare Nord</p>
Other equipment (transport box, etc.), price per unit	DKK 335			<p>This estimate includes prices from similar projects and equipment packages such as digitally supported rehabilitation therapy systems. It also includes expenses obtained from the TeleCare Nord project. The price is equivalent to the purchase price in the TeleCare Nord project. The equipment includes a transport box, tablet cover, tablet pens, etc. No discount has been factored into the price.</p> <p>Sources: Own calculation TeleCare Nord</p>

<sup>3</sup> It is not possible to determine whether the costs for the telemedical solution should be allocated under implementation or operating budgets, as this depends on local purchasing decisions in the regional programmes such as whether to lease or purchase hardware.

User guides, electronic and paper, price per unit	-	DKK 15	-	<p>The TeleCare Nord project has prepared the first version of the user guide which can be used as the starting point in connection with a nationwide rollout. This estimate also includes a possible cost saving by using digital versions of the guide, but experiences from TeleCare Nord show that digital guides do not replace printed guides, but only complement them.</p> <p>Source: TeleCare Nord</p>
Local maturation activities leading up to the nationwide rollout	-	DKK 5 million	-	<p>The business case assumes a one-time cost for local maturation activities leading up to the nationwide rollout. The maturation activities are meant to ensure that local technical and organisational setups are prepared to ensure stable operation of the telemedical home monitoring service and data flow.</p> <p>Source: Own calculation</p>
Creation of interfaces for KIH	-	DKK 5 million	-	<p>In order to ensure a free flow of data between the various sectors of the healthcare sector, an interface between the telemedical solutions and the KIH database must be created, from which interfaces to regional, municipal and general practice systems can be established (EPJ, EOJ and LPS, respectively). Based on Medcom's review of the KIH database as well as market knowledge about the cost of creating such integrations, it has been assessed that the cost of creating an interface between 2-3 telemedical solutions and the KIH database amounts to DKK 5 million.</p> <p>Source: Own calculation Medcom</p>
Creation of interfaces for the most common systems used by general practices	-	-	-	<p>The costs of creating an interface that makes it possible to pull data from the KIH database so that it can be used in systems employed by general practitioners falls under the budget for the national prerequisite measures. It is assumed that specific integrations and adjustments in healthcare systems and the cost thereof will be the responsibility of each actor, which is why a price for this has not been set in this business case.</p> <p>Source: Forståelsespapir; the Danish government; Local Government Denmark; Danske Regioner</p>
Creation of interfaces for municipal EOJ systems	-	-	-	<p>The costs of creating an interface that makes it possible to pull data from the KIH database so that it can be used in EOJ systems falls under the budget for the national prerequisite measures. It is assumed that specific integrations and adjustments in healthcare systems and the cost thereof will be the responsibility of each actor, which is why a price</p>

				for this has not been set in this business case. Source: Forståelsespapir; the Danish government; Local Government Denmark; Danske Regioner
Creation of interfaces for regional EPJ systems				The costs of creating an interface that makes it possible to pull data from the KIH database so that it can be used in EPJ systems falls under the budget for the national prerequisite measures. It is assumed that specific integrations and adjustments in healthcare systems and the cost thereof will be the responsibility of each actor, which is why a price for this has not been set in this business case. Source: Forståelsespapir; the Danish government; Local Government Denmark; Danske Regioner
Costs for national prerequisite measures	-	DKK 47 million	-	In connection with the nationwide rollout of telemedical home monitoring, a number of national prerequisite measures have been planned. These initiatives include the preparation of business cases, service and logistics, maturation of infrastructure, preparation of healthcare guidelines as well as the creation of a joint public portfolio secretariat. In the business case, this expense has been recorded for 2017, even though certain expenses will take place in 2016 and others in 2018 (presumably). Source: Forståelsespapir; the Danish government; Local Government Denmark; Danske Regioner

## 5.4 Input parameters relating to technological organisation

As in the previous section, some of the calculations in this section have been carried out by PA Consulting itself.

The technological organisation encompasses the organisational setup that is necessary to keep all decentralised equipment in service, including any associated logistics. In addition, some of the costs are tied to the rollout of the technology in the project. The parameters relating to the technical service are shown below.

**Table 38 Input variables used to estimate costs relating to the organisation of technology services**

Input variable	Value			Description
	Worst case	Estimate	Best case	
Time required to set up citizens with COPD in backend systems	-	6 minutes	-	Reflects the time needed by staff to set up new citizens with COPD starting telemedical treatment.  The estimate is based on experiences from TeleCare Nord.  Source: TeleCare Nord
Technical support for health practitioners, per year	-	DKK 2.75 million	-	The total annual cost of providing technical support to health practitioners who use telemedical equipment in their daily work. This support therefore also covers citizens making queries via the healthcare practitioners.

				<p>The estimate is based on actual costs recorded in TeleCare Nord. The expenses are calculated per patient and extrapolated to a national level based on the number of citizens with COPD in the other regions.</p> <p>Sources: Own calculation and TeleCare Nord</p>
Technical support per citizen per year	-	10 minutes	-	<p>Annual amount of time spent by technical support workers providing technical support to citizens with COPD participating in telemedical treatment (besides the initial training and continuous dialogue and follow-up on measurement data). The estimate is based on experiences from TeleCare Nord.</p> <p>Source: TeleCare Nord</p>
Delivery, setup and collection of equipment per citizen with COPD	-	DKK 1,000	-	<p>Reflects the logistical costs related to initialising and concluding a telemedical treatment process.</p> <p>The amount stated is based on several input sources, including prices from similar projects with corresponding logistical needs (such as delivery and collection of equipment used in projects relating to digitally supported rehabilitation therapy systems). The cost also includes current expenses from supplier contracts in the TeleCare Nord project, although in this business case, the costs for delivery and collection have been merged into a single parameter).</p> <p>Source: Own calculation</p>
Delivery and setup of equipment		DKK 570		<p>Reflects the logistical costs related exclusively to delivering new equipment, meaning no collection.</p> <p>The amount stated is based on several input sources, including prices from similar projects with corresponding logistical needs (such as delivery and collection of equipment used in projects relating to digitally supported rehabilitation therapy systems). The cost also includes current expenses from supplier contracts in the TeleCare Nord project, although in this business case, the costs for delivery and collection have been merged into a single parameter).</p> <p>Source: Own calculation</p>
Exchange of equipment	-	DKK 625	-	<p>Reflects the logistical costs related to exchanging defective equipment from the homes of patients who are actively involved in telemedical treatment. This parameter does not consider the general replacement frequency and depreciation rate. It solely concerns equipment that often simply needs repair or reconfiguration before it can be put back to use.</p> <p>The amount stated is based on several input sources, including</p>

				prices from similar projects with corresponding logistical needs (such as delivery and collection of equipment used in projects relating to digitally supported rehabilitation therapy systems). The cost also includes current expenses from supplier contracts in the TeleCare Nord project.  Sources: Own calculation and TeleCare Nord
Amount of equipment requiring exchange per year	-	5%	-	Reflects the share of equipment put into use that will require exchanging each year, and where such an exchange is associated with an expense (see separate input parameter). The estimate is based on experiences from supplier contracts from the TeleCare Nord project. The business case assumes a lower volume of exchanges than experienced in the TeleCare Nord project, as a portion of these exchanges were related to implementation issues. Sources: Own calculation and TeleCare Nord
Quantity discount in connection with logistics and setup of equipment	25%	30%	35%	The business case assumes that significant cost savings can be achieved in supplier agreements through procurement agreements or major invitations to tender. In the business case, the cost savings are deducted from the total cost for logistics and setup of equipment. The estimates are derived from known cost savings from relevant government procurement agreements and related public sector tender framework agreements. Source: Own calculation

## 5.5 Input parameters relating to healthcare organisation

This section provides an overview of the parameters relating to the organisation of healthcare services. It includes follow-ups by health practitioners on measurement data from telemedical home monitoring provided by citizens with COPD, as well as project and implementation costs associated with the organisation of a nationwide rollout. The table below shows the parameters relating to the organisation and implementation of these aspects.

**Table 38 Input variables used to estimate costs relating to the organisation of technology services**

Input variable	Value			Description
	Worst case	Estimate	Best case	
Training time per nurse	-	7 hours	-	Number of hours spent on each training for each nurse in order for him/her to be able to use the telemedical equipment. This has been calculated as a one-off cost, as it is assumed that for new staff, this training will be part of their general training process.  The estimate is based on experiences from the TeleCare Nord project.
Number of nurses requiring training	1,078	980	882	The number of nurses who it is assumed will be working with



				<p>telemedical equipment and who will therefore require training.</p> <p>The estimate is based on the number of nurses who were trained in the TeleCare Nord project (approximately 10 per municipality). The uncertainty spread covers +/- 1 nurse in each municipality.</p> <p>Source: TeleCare Nord</p>
Price per hour of training	-	DKK 250	-	<p>The price for one hour of training per nurse. The figure is based on the assumption that the training will be delivered in groups rather than individually. Experiences from TeleCare Nord show that nurses can be trained in groups of up to 10. The estimate is also based on prices for further training.</p> <p>Source: TeleCare Nord</p>
FTEs for regional project management and rollout, year 1	-	15	-	<p>It is assumed that each region will require three FTEs for project management relating to the rollout of telemedical home monitoring during the first year and 2 FTEs during the second year.</p> <p>The estimate is based on an assessment on the basis of experiences from the projects.</p>
FTEs for regional project management and rollout, year 2		10		See above.
FTEs for municipal project management and rollout, year 1	49.0	39.2	29.4	<p>It is assumed that the municipalities will be required to spend some resources on project management in connection with the rollout of telemedical home monitoring. It is assumed that the overall project coordination will occur at the regional level, which is why the municipalities' needs primarily relate to supporting its practical implementation.</p> <p>It is assumed that for each year, each municipality will on average require 0.4 FTEs for project management. These FTEs can be distributed evenly over a 2-year period or compressed into a more intensive process. The uncertainty spread covers a +/- 0.1 FTE in each municipality.</p>
FTEs for municipal project management and rollout, year 2	49.0	39.2	29.4	See above.
Costs relating to calls for tenders	DKK 3.5 million	DKK 3 million	DKK 2.5 million	<p>The costs associated with calls for tenders for selecting suppliers to carry out maturation activities relating to the telemedical recording system OpenTele, management of logistics and maintenance tasks (including support and operation if relevant). The total amount stated covers (potentially) several different calls for tender. The costs are a one-off expense and distributed equally across the five regions.</p> <p>The estimate is based on a similar call for tenders of a similar character and complexity.</p>
Time to train citizens with COPD, per patient	-	90 minutes	-	<p>The time spent on training individual citizens with COPD in how to use the telemedical equipment. The figure is based on data from 8 out of 10 municipalities that participated in the TeleCare Nord project. The training is carried out by nurses working for the municipality.</p>

				The estimate is based on data provided by municipalities participating in the TeleCare Nord project.
Time spent following up on data per citizen with COPD per year	-	5 hours	-	<p>The time spent on following up on measurement data from citizens with COPD. The follow-up is done by municipal staff.</p> <p>The estimate is based on data from nurses from 8 out of 10 municipalities participating in the TeleCare Nord project.</p>

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