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STROKE PATIENT MANAGEMENT AT HIIUMAA HOSPITAL PRE- AND POST-IMPLEMENTATION OF GLOBAL BUDGET

Master's thesis

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INSULDI PATSIENDI KÄSITLUS HIIUMAA HAIGLAS ENNE JA PÄRAST EELARVEPÕHISE RAHASTUSE RAKENDAMIST

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Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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20.05.2020

Abstract

Background: In April 2018, Estonian Health Insurance Fund introduced a new payment method - budget-based financing model to ensure Hiiumaa hospitals' financial sustainability. Thus, the hospital became the first in Estonia where the new financing method is piloted. *Aim:* The aim of the thesis is to describe and evaluate the changes to stroke patient pathway and management at Hiiumaa hospital pre- and post-implementation of global budget. *Methods:* A retrospective registry-based study including Hiiumaa hospitals' stroke patients from 1st of January 2014 to 31st of March 2018 and 1st of April 2018 to 29th of February 2020 was conducted. Data from medical bills from Estonian Health Insurance Fund was used to identify and describe the patient pathway at Hiiumaa hospital. The purpose of the logistic regression analysis was to study if independent variables like patient sex and age, patient management and outcome can help to predict whether the patient was treated in pre- or post-implementation period. Qualitative semi-structured explorative expert telephone interview was conducted with doctor Elo Volmer, Hiiumaa hospitals' neurologist. *Results:* There were 48 and 50 patients in the post- and pre-implementation period, respectively. The patient pathways did not change after implementation of global budget but there were changes in length of hospital stay for patient groups. The results of regression analysis show that all variables are statistically not significant (p-value >0.05). Variable "referred to stroke unit" had strong negative or none correlations with other variables. *Conclusion:* The patient groups are the same for pre-and post-implementation of global budget. The results of logistic regression analysis show no statistically significant difference in stroke patient management. The antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department complies with the guideline developed by American Heart Association/American Stroke Association.

This thesis is written in English and is 60 pages long, including 6 chapters, 4 figures and 7 tables.

Annotatsioon

Insuldi patsiendi käsitlus hiiumaa haiglas enne ja pärast eelarvepõhise rahastuse rakendamist

Taust: Aprillis 2018 tutvustas Eesti Haigekassa uut rahastus süsteemi – eelarve põhine rahastus tagamaks Hiiumaa haigla finantsilise suutlikkuse. Seega on haigla esimene Eestis, kus uut rahastussüsteemi piloteeritakse. *Eesmärk:* Töö eesmärk on kirjeldada ja hinnata muutusi insuldi patsiendi teekonnas ja tervise tulemites Hiiumaa haiglas enne ja pärast eelarve põhise rahastuse rakendamist. *Metoodika:* Teostati retrospektiivne registripõhine uurimus, mis hõlmas Hiiumaa haigla insuldi patsiente 1.01.2014-31.03.2018 ja 1.04.2018-29.02.2020. Eesti Haigekassa raviarvete andmeid kasutati identifitseerimas ja kirjeldamaks insuldi patsiendi teekonda Hiiumaa haiglas. Logistilise regressioon analüüsi eesmärgiks oli uurida kas argumenttunnuste nagu patsiendi sugu või vanus või patsiendi käsitluse või patsiendi käsitluse tulemi abil saab prognoosida, kas insuldipatsienti käsitleti enne või pärast eelarve põhise rahastuse rakendamist perioodis. Kvalitatiivne uuriv ekspertintervjuu telefoni teel tehti doktor Elo Volmeriga, Hiiumaa haigla neuroloogiga. *Tulemused:* Patsientide arv enne ja pärast eelarve põhise rahastuse rakendumist oli 48 ja 50. Insuldi patsiendi teekond ei muutunud pärast eelarve põhise rahastuse rakendamist, kuid muutused oli haiglaravi pikkuses patsientide gruppides. Regressioon analüüsi tulemus näitab, et kõik argumenttunnused on statistiliselt mitteolulised (p-väärtus >0.05). Argumenttunnuse väärtuse muutmine ei prognoosi, millises ajaperioodis patsienti käsitleti. Muutujal „suunatud insuldi keskusesse“ oli tugev negatiivne või null korrelatsioon teiste muutujatega. *Järeldused:* Patsiendi grupid on samad nii enne kui pärast eelarve põhise rahastuse rakendamist. Logistilise regressioon analüüsi tulemused ei näidanud statistiliselt olulist erinevust insuldipatsiendi käsitluses. Ajuinfarkti trombolüütilise ravi juhend, mida kasutatakse Hiiumaa haigla erakorralises osakonnas vastab Ameerika Südame Assotsiatsiooni/Ameerika Insuldi Assotsiatsiooni poolt välja töötatud ravijuhendi soovitustele.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 60 leheküljel, 6 peatükki, 4 joonist, 7 tabelit.

List of abbreviations and terms

AF	Atrial fibrillation
AHA/ASA	American Heart Association/American Stroke Association
AIS	Acute ischemic stroke
(ECG)-Gated CT	Electrocardiography (ECG)-Gated Computed Tomography
ECG	Electrocardiography
EHIF	Estonian Health Insurance Fund
ICH	Intracerebral haemorrhage
ICU	Intensive care unit
IVT	Intravenous thrombolysis
MT	Mechanical thrombectomy
NICE	The National Institute for Health and Care Excellence
SAH	Subarachnoid haemorrhage
r-tPA	Recombinant tissue-type plasminogen activator

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1 Introduction

According to the "State of Health in the EU Estonia Country Health Profile 2017" cardiovascular diseases causes most deaths in both sexes. In 2014, 6% of all deaths in Estonia were caused by stroke. [1] The results of Estonian Health Insurance Fund (EHIF) quality indicators' report 2018 showed there were 3519 stroke patients, 20 of them at Hiiumaa hospital, with acute ischemic and intracerebral haemorrhage in Estonia in 2018. The largest number of patients were in age group 75-84. The 30-day mortality rate in 2018 was 17% and at Hiiumaa hospital 25% (N=5). [2]

In April 2018, EHIF introduced a new payment method - budget-based financing model to ensure Hiiumaa hospitals' financial sustainability. With the new financing model specialities and healthcare services that Hiiumaa hospital continues to provide and total sum that EHIF will reimburse to serve all the patients were agreed upon. [3] Hiiumaa hospital is the first hospital in Estonia piloting the new financing method. Nevertheless, pros and cons of global budgets are assessed by EHIF to balance financial sustainability of hospitals overall spending on hospital care [4]. In 2019, EHIF started a project to improve stroke patients' pathway in Tartu University Hospital, North-Estonian Hospital, West-Tallinn hospital and East-Viru hospital [5]. Therefore, it is important to assess if implementation of global budget as a payment mechanism at Hiiumaa Hospital has brought any changes in stroke patient pathway and management.

The aim of the thesis is to describe and evaluate the changes to stroke patient pathway and management at Hiiumaa hospital pre- and post-implementation of global budget. To achieve the aim three research objectives are established:

1. To identify and describe stroke patient pathways at Hiiumaa hospital pre- and post-implementation of global budget.
2. To compare the changes in stroke patient management pre- and post-implementation of global budget.
3. To assess the adherence of antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department to the Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018

Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association recommendations.

The thesis consists of six chapters, including introduction. Second chapter gives an overview of Hiiumaa hospital and global budget as a financing method. Also, overview of stroke as a disease and the guideline used in Estonia for managing stroke patient is given. Methodology and methods are described in third chapter and results in fourth. The fifth chapter discusses the results of the study. The final chapter six presents the conclusions of the study.

2 Background

This chapter will provide an overview of Hiiumaa hospital and global budget as a financing system. It will also give an overview of stroke as disease and provide overview of the guideline used for managing stroke patient in Estonia.

2.1 General information about Hiiumaa hospital

In April 2018 by Estonian Governments regulation (RT I, 04.04.2018, 5) "Hospital network development plan" entered into force. The regulation covers different types of hospitals in Estonia – regional hospitals, central hospitals and general hospitals. According to the regulation Hiiumaa hospital categorizes as a general hospital. [6]

Hiiumaa hospital is situated on the second largest island of Estonia and provides healthcare services to population of 9387 [7]. The hospital has challenges to tackle for example limited access and variable travel time. This results in challenges for service provision and financial sustainability. In July 2017, Hiiumaa hospital concluded the Treaty of Accession with North-Estonian hospital meaning that from that moment the North-Estonian hospital has been responsible for organizing the specialized medical care and accompanying services. According to the analysis conducted by Hiiumaa hospital and North-Estonian hospital showed this should have ensured access to quality healthcare and Hiiumaa hospitals' financial sustainability [8].

2.2 Global budget

Under a global budget, the provider is given a fixed amount of money for fixed period of time to cover expenditures to enable provision of health care services agreed upon in contract. The main aim is to keep the costs under control [4, 9]. The main payment method for hospitals in Estonia are based on the volume of service provided [4]. Budgets are generally set though historical, capitated and normative approaches or combination of the three [9]. The main financial objective of a hospital is to contain operating costs within

the allocated global budget. Global budgets are managed often by some form of contract that may incorporate elements on financing, outliers, volume, quality standards and outcome. [10] The contract between purchaser and provider gives the financial budget, specifies the amount of services that must be delivered and has list of indicators to measure quality [9, 10]. In the health care financing agreement between EHIF and Hiiumaa hospital, nine indicators were listed to assess the outpatient, inpatient and ambulance service quality. The indicators listed in the contract are following: 1. Percentage of Hiiumaa islands inhabitants treated at Hiiumaa hospital; 2. Availability of services described in the contract clause 1 and 2 compared to previous years; 3. Change in the number of patients referred to other healthcare provider; 4. Change in the number of ambulance calls and general practitioner visits; 5. Change in numbers of in-patients in specialist care and nursing compared to previous years; 6. Change in length of hospital stay in department of follow-up care and nursing compared to previous years and general hospitals mean; 7. Percentage of in-patient and day care cases compared to previous years and general hospitals mean; 8. Change in number of out-patient compared to previous years; 9. Number of out-patient visits per patient compared to previous years and general hospitals mean. [11]

Lagarde *et al.* pointed out that if hospitals are allowed to keep any remaining excess at the end of the period or cover any shortage, they have financial autonomy. That might encourage the hospitals to conserve health services to make sure that their costs remain within their budget, and/or refer to other health care providers. [12] Berenson *et al.* argues with global budget the hospitals have strong stimulus to admit patients with real need for inpatient care [9].

2.3 Stroke

This chapter gives an overview of stroke as a disease and presents data on the incidence of stroke at Hiiumaa.

2.3.1 Stroke subtypes

Stroke can be divided into subtypes – ischemic stroke, intracerebral haemorrhagic and subarachnoid haemorrhage [13, 14]. Ischemic stroke or acute ischemic stroke (AIS) is a condition when a sudden loss of blood supply to brain tissues occur [14]. Intracerebral haemorrhage (ICH) is rupture of blood vessels in the brain [15]. A subarachnoid

haemorrhage (SAH) is a condition that is caused by bleeding on the surface of the brain [16].

2.3.2 Symptoms and signs

The most universal symptoms of AIS is waking up with weakness of one side and speech disturbance or having acute onset of those symptoms. Other main symptoms and signs are facial weakness, headache, arm paresis and hemiparetic/ataxic gait. [13]

Symptoms of ICH predominantly occur when the patient is awake. Main symptoms are sudden weakness, paralysis or numbness in any part of the body, inability to speak and control eye movements correctly and vomiting. [17]

Main symptom of SAH is sudden severe headache, something that patients have never experienced before or describe it as the worst headache of their life. Other symptoms like vomiting, stiff neck, photophobia, blurred or double vision and loss of consciousness can occur with the headache. [13, 15]

2.3.3 Diagnostic tests

Patients with stroke symptoms should have immediate non-contrast **computed tomography** (CT) or **magnet resonance imaging** (MRI) to distinguish between AIS and ICH. Diffusion-weighted MRI images have a greater sensitivity for detecting ischemic stroke. Although MRI has better resolution the CT is faster, more available and less expensive. [13] If ICH is diagnosed a cerebral angiography is needed to diagnose secondary cause [15].
For diagnosing SAH non-contrast CTA has 100% accuracy for the first 72 hours at the same time magnet resonance imaging remains highly sensitive up to 30 days [13].

Computed tomography angiography (CTA) is a medical test that combines a computed tomography with contrast agent to produce pictures of blood vessels and tissues in a part of body [18].

Clinical audit „Justification and quality of stroke care (I63) in Estonian hospitals“ showed that in 2012 none of Hiiumaa hospitals' stroke patients received CT. Although a CT-scanner is available. [19]

2.3.4 Treatment

Treatment of acute stroke is usually carried out in hospital, preferably in department of neurology, followed by rehabilitation in the corresponding department, nursing hospital or in patients home according to his/her functional and social capabilities [20].

2.3.4.1 Intravenous thrombolysis

Intravenous thrombolysis (IVT) is a procedure where the thrombus is cleaved and blood flow to brain artery is restored. This will stop the so-called neuronal damage ischemic cascade to prevent nerve cells irreversible damage. [21]

Administration of intravenous recombinant tissue-type plasminogen activator (r-tPA) to appropriate patients is still the main treatment of acute ischemic stroke. Research shows that intravenous thrombolysis for eligible patients improves functional incomes at 3 to 6 months when administered within 4.5 hours from AIS onset. [22]

2.3.4.2 Mechanical thrombectomy

Mechanical thrombectomy (MT) is a procedure where a blood clot is removed from the artery through a catheter [23]. Referral to perform thrombectomy should be done in 4,5 hours of stoke onset and the arterial puncture should be done within 6 hours. For some carefully selected patients' even up to 16-24 hours. [24]

2.3.4.3 Anticoagulant treatment in patients with atrial fibrillation

Direct anti-coagulants like apixaban, dabigatran, edoxaban and rivaroxaban are four direct oral-anticoagulants that are approved to use in patients with atrial fibrillation [25]. Estonian "Atrial fibrillation guideline" recommends that patients with atrial fibrillation should take warfarin or DOACS like apixaban, dabigatran or rivaroxaban [26]. In 2017 there were eight patients diagnosed with stroke who had concurrent diagnose of AF and three of those patients had a prescription of anticoagulants 30 days after discharge according to EHIF quality report [2]. According to 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS recommend to start the anticoagulant treatment in AF patients between one and 12 days after AIS, depending on the severity of stroke. For AF patients who have suffered from ICH the recommendation is to make a multidisciplinary decision input from stroke physicians/neurologists, cardiologists, neurologists and neurosurgeons. [27]

2.3.5 Stroke incidence in Hiiumaa

The incidence of stroke in Europe at the beginning of the 21st century ranged from 95 to 290/100,000 per year [28]. According to "The Burden of Stroke in Estonia" the stroke incidence in 2017 was 2735 and 115.7 stroke per 100 000 inhabitants annually. Estimated increase of stroke incidence in 2015-2035 is 21%. [29] At Hiiumaa there were 22 patients diagnosed with stroke in 2017, that is 261.95 stroke per 100 000 inhabitants. The number of stroke patients and stroke per 100 000 inhabitants in 2014-2019 in Hiiumaa can be seen in a figure below (Figure 1).

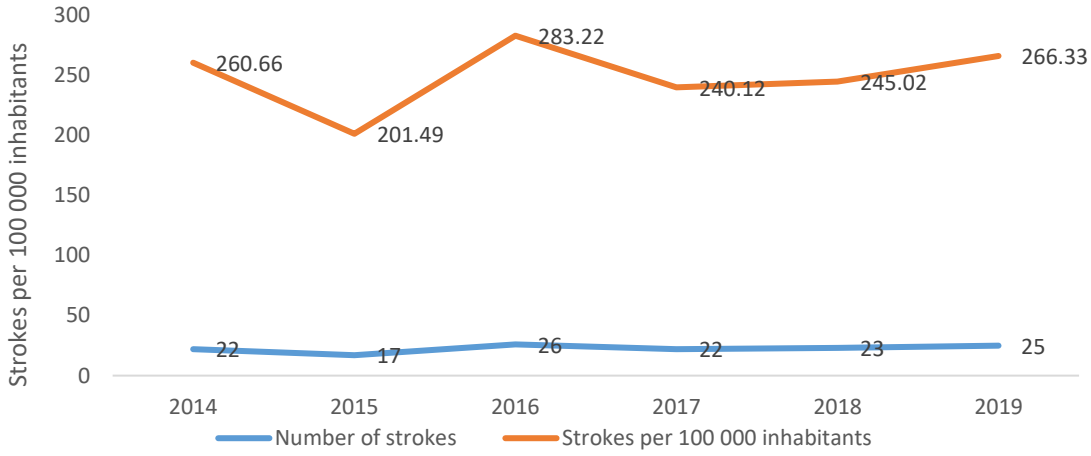

Figure 1. Number of stroke patients and stroke incidence per 100,000 inhabitants in Hiiumaa.

The figure shows approximately 10% increase of strokes per 100 000 inhabitants from 2017 to 2019. This could be explained by the fact that the percentage of elderly people at Hiiumaa is increasing.

2.4 Stroke guidelines

In 2004 Estonian Stroke treatment guide was developed and no renewed version of the guideline is published online. [20] To modernize the stroke treatment management in Estonia the Ludvig Puusepp Society of Neurologists and Neurosurgeons has developed a new stroke management guideline in collaboration with all level hospitals, rehabilitation centres, ambulance service providers and EHIF in 2019 [30]. European Stroke Organisation compiles stroke guidelines for physicians, allied health professionals, stroke patients and lay persons. The latest consensus statements and recommendations for stroke management were renewed in 2018. [31] American Heart Association/American Stroke

Association published an AIS Guideline in 2013, an update was published in 2018. A new update of the guideline was published in 2019, Guideline on Early Management of Acute Ischemic Stroke. The update provides comprehensive set of recommendations for physicians caring for adult patients with AIS. These recommendations cover the field of prehospital care, emergency evaluation and treatment, general supportive care and emergency treatment, in-hospital management of AIS: general supportive care and treatment of acute complications and in-hospital institution of secondary stroke prevention. The main recommendations from AHA/ASA Guideline for the Early Management of Patients with AIS are listed below. [32] Neurologists in Estonia use the AHA/ASA guidelines for stroke treatment since it is renewed more frequently than European guidelines [33]. Earlier guideline was released in 2013 and update to the 2013 guideline was released in 2018. An update to the 2018 guideline was released in 2019. At Hiiumaa hospital doctors on-call in emergency department who are not neurologist's use the antithrombotic treatment of AIS introduction conducted by North-Estonian hospital. The antithrombotic treatment of AIS instructions clearly stipulate which analysis and procedures are relevant for performing the procedure, how to administer the intravenous recombinant tissue-type plasminogen activator (r-tPA), how to monitor the patients during and after the procedure and what are the contraindications for thrombolysis. The procedure is performed using telemedicine when neurologist is not on call. Therefore, the adherence to Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke recommendations listed in paragraph 1.6 Telemedicine, 2.2.2. IV Alteplase Eligibility, 3.5 IV Alteplase and 3.5.6. Post-alteplase treatment based on antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department are compared [32]. The recommendations assessed are listed in a table below (table 1).

Table 1. Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke recommendations on using telemedicine and IV alteplase eligibility. [32]

Telemedicine	**COR**	**LOE**
1. For sites without in-house imaging interpretation expertise, teleradiology systems approved by the US Food and Drug Administration are recommended for timely review of brain imaging in patients with suspected acute stroke.	**Strong (Class I)**	**A**

2. When implemented within a telestroke network, teleradiology systems approved by the US Food and Drug Administration are effective in supporting rapid imaging interpretation in time for IV alteplase administration decision making.	**Strong (Class I)**	**A**
3. The use of telemedicine/telestroke resources and systems should be supported by healthcare institutions, governments, payers, and vendors as one method to ensure adequate 24/7 coverage and care of acute stroke patients in a variety of settings.	**Strong (Class I)**	**C-EO**
4. Telestroke/teleradiology evaluations of AIS patients can be effective for correct IV alteplase eligibility decision making.	**Moderate (Class IIa)**	**B-R**
5. Administration of IV alteplase guided by telestroke consultation for patients with AIS can be beneficial.	**Moderate (Class IIa)**	**B-NR**
6. Telestroke networks may be reasonable for triaging patients with AIS who may be eligible for interfacility transfer in order to be considered for emergency mechanical thrombectomy.	**Weak (Class IIb)**	**B-NR**
7. Providing alteplase decision-making support via telephone consultation to community physicians is feasible and safe and may be considered when a hospital has access to neither an in-person stroke team nor a telestroke system.	**Weak (Class IIb)**	**C-LD**
IV Alteplase Eligibility	**COR**	**LOE**
1. Administration of IV alteplase in eligible patients without first obtaining MRI to exclude cerebral microbleeds (CMBs) is recommended.	**Strong (Class I)**	**B-NR**
2. In patients eligible for IV alteplase, because benefit of therapy is time dependent, treatment should be initiated as quickly as possible and not delayed for additional multimodal neuroimaging, such as CT and MRI perfusion imaging.	**Strong (Class I)**	**B-NR**
3. In patients with AIS who awake with stroke symptoms or have unclear time of onset > 4.5 hours from last known well or at baseline state, MRI to identify diffusion-positive FLAIR-negative lesions can be useful for selecting those who can benefit from IV alteplase administration within 4.5 hours of stroke symptom recognition.	**Moderate (Class IIa)**	**B-R**
IV Alteplase **General principles**		
1. In patients eligible for IV alteplase, benefit of therapy is time dependent, and treatment should be initiated as quickly as possible.	**Strong (Class I)**	**A**

General principles (continued)		
2. In patients undergoing fibrinolytic therapy, physicians should be prepared to treat potential emergent adverse effects, including bleeding complications and angioedema that may cause partial airway obstruction.	**Strong (Class I)**	**B-NR**
3. The potential risks should be discussed during IV alteplase eligibility deliberation and weighed against the anticipated benefits during decision-making.	**Strong (Class I)**	**C-EO**
4. Treating clinicians should be aware that hypoglycemia and hyperglycemia may mimic acute stroke presentations and determine blood glucose levels before IV alteplase initiation. IV alteplase is not indicated for nonvascular conditions.	**III: No Benefit**	**B-NR**
5. Because time from onset of symptoms to treatment has such a powerful impact on outcomes, treatment with IV alteplase should not be delayed to monitor for further improvement	**III: Harm**	**C-EO**
Time Windows	**COR**	**LOE**
1. IV alteplase (0.9 mg/kg, maximum dose 90 mg over 60 minutes with initial 10% of dose given as bolus over 1 minute) is recommended for selected patients who can be treated within 3 hours of ischemic stroke symptom onset or patient last known well or at baseline state. Physicians should review the criteria outlined in Table 8 to determine patient eligibility.	**Strong (Class I)**	**A**
2. IV alteplase (0.9 mg/kg, maximum dose 90 mg over 60 minutes with initial 10% of dose given as bolus over 1 minute) is also recommended for selected patients who can be treated within 3 and 4.5 hours of ischemic stroke symptom onset or patient last known well or at baseline state. Physicians should review the criteria outlined in Table 8 to determine patient eligibility.	**Strong (Class I)**	**B-R**
3. IV alteplase (0.9 mg/kg, maximum dose 90 mg over 60 minutes with initial 10% of dose given as bolus over 1 minute) administered within 4.5 hours of stroke symptom recognition can be beneficial in patients with AIS who awake with stroke symptoms or have unclear time of onset >4.5 hours from last known well or at baseline state and who have a DW-MRI lesion smaller than one-third of the MCA territory and no visible signal change on FLAIR.	**Moderate (Class IIa)**	**B-R**
Mild Stroke	**COR**	**LOE**

1. For otherwise eligible patients with mild but disabling stroke symptoms, IV alteplase is recommended for patients who can be treated within 3 hours of ischemic stroke symptom onset or patient last known well or at baseline state.	**Strong (Class I)**	**B-R**
2. For otherwise eligible patients with mild disabling stroke symptoms, IV alteplase may be reasonable for patients who can be treated within 3 and 4.5 hours of ischemic stroke symptom onset or patient last known well or at baseline state.	**Weak (Class IIb)**	**B-NR**
3. For otherwise eligible patients with mild nondisabling stroke symptoms (NIHSS score 0–5), IV alteplase is not recommended for patients who could be treated within 3 hours of ischemic stroke symptom onset or patient last known well or at baseline state.	**III: No Benefit**	**B-R**
4. For otherwise eligible patients with mild non-disabling stroke symptoms (NIHSS 0–5), IV alteplase is not recommended for patients who could be treated within 3 and 4.5 hours of ischemic stroke symptom onset or patient last known well or at baseline state.	**III: No Benefit**	**C-LD**
Post-alteplase Treatment	**COR**	**LOE**
1. BP should be maintained at <180/105 mmHg for at least the first 24 hours after IV alteplase treatment.	**Strong (Class I)**	**B-R**
2. The risk of antithrombotic therapy (other than IV aspirin) within the first 24 hours after treatment with IV alteplase (with or without mechanical thrombectomy) is uncertain. Use might be considered in the presence of concomitant conditions for which such treatment given in the absence of IV alteplase is known to provide substantial benefit or withholding such treatment is known to cause substantial risk.	**Weak (Class IIb)**	**B-NR**

COR- Class (strength) of recommendations
LOE – Level (quality) of evidence
Level A – high level evidence
Level B-R – moderate-quality evidence from 1 or more RCTs
Level B-NR – moderate-quality evidence from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
Level C-LD – randomized or nonrandomized observational or registry studies with limitations of design or execution
Level C-EO – consensus of expert opinion based on clinical experience

3 Methodology and methods

3.1 Overview of study design

A retrospective registry-based study including patients with stroke was conducted. Data about Hiiumaa hospitals' stroke patients from 1st of January 2014 to 31st of March 2018 and 1st of April 2018 to 29th of February 2020 was extracted from the EHIF registries. From 2014 North-Estonian hospital has been providing emergency care services in Hiiumaa hospital (see paragraph 2.2) thus the first period was chosen to describe the stroke patient pathway and management pre-implementation of global budget. The results are compared to post-implementation period to see if the new financing model has had any impact.

The demographic features of the patients are presented using summary statistics. Categorization of the patients' data is done based on gender, age, diagnosis and death. To achieve the first objective of this thesis study subjects are divided into four groups according to the pathways identified based on EHIF medical bills. Patients who had a medical bill from Hiiumaa hospital with main diagnose of stroke ICD-10 I60 or sub-groups, ICD-10 I61 or subgroups or ICD-10 I63 or subgroups and no previous or following medical bill from stroke unit are grouped to group A - diagnosed and treated at Hiiumaa hospital. Patients with Hiiumaa hospital medical bill with main diagnose of stroke ICD-10 I60 or sub-groups, ICD-10 I61 or subgroups or ICD-10 I63 or subgroups and with the marking of "Teine RA piirkondlik haigla statsionaar" or "Teine RA keskhaigla statsionaarne" are grouped to group B - diagnosed at Hiiumaa hospital and referred to stroke unit. Patients with the marking of "Teine RA piirkondlik haigla statsionaar" or "Teine RA keskhaigla statsionaarne" on Hiiumaa hospital medical bill with the main diagnos of stroke ICD-10 I60 or sub-groups, ICD-10 I61 or subgroups or ICD-10 I63 or subgroups and with the marking of "Teine RA üldhaigla statsionaarne" or "Teine RA muu haigla statsionaar" on the stroke unit medical bill and "Suunatud keskhaiglast" or "Suunatud piirkondlikust haiglast" on the following Hiiumaa hospital medical bill are grouped to group C - diagnosed at Hiiumaa hospital, referred to stroke unit and referred to Hiiumaa hospital for follow up care. Patients who have "Suunatud keskhaiglast" or "Suunatud piirkondlikust haiglast" on Hiiumaa hospital bill with main diagnose of stroke ICD-10 I60 or sub-groups, ICD-10 I61 or subgroups or ICD-10 I63 or

subgroups and have a previous medical bill from stroke unit are grouped to group D - diagnosed and admitted to stroke unit and referred to Hiiumaa hospital for follow-up care. Based on the identified groups patient pathways and health care services provided in pre- and post-implementation of global budget are described. Pathways are shown in Appendices 1 and 2.

The purpose of the logistic regression analysis is to study if independent variables like patient sex and age, patient management and outcome can help to predict whether the patient was treated in pre- or post-implementation period. If above-mentioned independent variable is statistically significant (p-value <= 0.05) then it can be said that the variable predicts in which period the patient was treated. For the purpose of this thesis stroke patient management is defined as health care services and interventions provided during the hospital stay. Patient management variables included in the analysis are based on the quality indicators developed by the Ludvig Puusepp Society of Neurologists and Neurosurgeons and calculated by EHIF and published in quality report. [2]

Atrial fibrillation patient risk of having stroke is five times higher than a person with healthy heart [34]. ESC 2016 guideline recommends to start anticoagulant treatment in one to 12 days after AIS and for AF patients suffered from ICH it is recommended to make a multidisciplinary decision to start anticoagulant treatment [27]. Therefore, it is important to measure if AF patients who suffered from stroke have prescription of anticoagulant 30 days after discharge to continue the treatment.

One of the indicators listed in the health care financing agreement between EHIF and Hiiumaa hospital is change in length of hospital stay in department of follow-up care and nursing compared to previous years and general hospitals mean [11]. For this reason, it is important to look at the length of stay in different departments for all patient groups.

General practitioner performs the monitoring of the stroke patient, controls lifestyle related health risks and treats conditions like high blood pressure and high cholesterol, assesses the patient health status and if needed refers patient to rehabilitation or consults with neurologist or other specialists after discharge [20]. Hence the mean and median days from hospital discharge to general practitioners (GP) first visit are calculated. The first visit to GP is considered to be the first medical bill with the main or concurrent diagnose of subarachnoid haemorrhage (ICD-10 I60), intracerebral haemorrhage (ICD-10 I61) or cerebral infarction (ICD-10 I63) after discharge. In case of medical bills

without main or concurrent diagnose of stroke the first medical bill after discharge is considered to be first visit after discharge.
To compare the changes in stroke patient management the pre-implementation period is shortened to 23 months, 1st of May 2016 to 31st of March 2018, as is the second period.

The third objective is achieved by assessing the adherence of antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department to the Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association recommendations on telemedicine, IV alteplase eligibility and IV alteplase. Due to the nationally set regulations from 13 March 2020 prohibiting hospital visits and face-to-face meetings due to global pandemic crises doctor Elo Volmer sent the pictures of the instructions.

Qualitative semi-structured explorative expert telephone interview was conducted with doctor Elo Volmer, Hiiumaa hospital neurologist. Telephone interview was chosen the crises mentioned in a section above. The aim of the interview was to get answers to questions and topics raised during the analysis of medical bill. Explorative interviews give comprehensive information about specific profession or industry [35]. Expert-interviews are used when researcher is not interested in persons resume, but in the expert special knowledge and experience he/she has from working within institution [36].

3.2 Description of data

Patients' diagnoses in EHIF database were given in ICD-10 code and therefore the diagnosis data was described by ICD-10 codes. Patients' medical bills suitable for this study had to have main diagnose of sub-arachnoid haemorrhage (ICD-10 I60), intracerebral haemorrhage (ICD-10 I61) or cerebral infarction/ischemic stroke (ICD-10 I63) and their sub-codes in the period of 1st of January 2014 to 31st of March 2018 (pre-implementation period) and 1st of April 2018 to 29th of February 2020 (post-implementation period).

The inclusion criteria included: diagnose codes based on ICD-10 I60 with sub codes, I61 with sub codes or I63 with sub codes at Hiiumaa hospital in the period of 1st of January 2014 to 31st of March 2018 and 1st of April 2018 to 29th of February 2020. Following stroke unit bills with main diagnose code I60 with sub codes, I61 with sub codes or I63 with sub codes. Data about prescriptions. All medical bills that fit the inclusion criteria and GP's medical bills with any kind of diagnose and healthcare services in the above-mentioned period. The description of data process is described in paragraph 3.2.1.

The exclusion criteria included: patients' medical bills with no clear index hospitalization with stroke.

The inclusion criteria and added time period resulted in 97 for the first time period and 51 for the second time period patients who are eligible for this study. In the pre-implementation period one patient was excluded because the index hospitalization with stroke was unclear. In the post-implementation period one patient was excluded because there was a referral to stroke unit but no medical bill from stroke unit.

3.2.1 Data variables and units

EHIF data variables and units are:

- Hiiumaa hospital demographic variables
    - Anonymous patient identification code (random numeric code).
    - Age.
    - Sex.
- Hiiumaa hospital medical bills
    - Anonymous patient identification code (random numeric code).
    - Bill number.
    - Bill starting date.
    - Bill ending date.
    - Bill ending reason.
    - Diagnosis code (ICD-10 code).
    - Diagnosis order.
- Hiiumaa hospital data connected with healthcare services
    - Bill number.
    - Healthcare service code (EHIF specific codes).

    - Data of service.
- Hiiumaa hospital data with concurrent diagnoses
    - Bill number.
    - Diagnosis code (ICD-10 code).
    - Diagnosis order.
- Next level hospitals' demographic variables
    - Anonymous patient identification code (random numeric code).
- Next level hospitals' medical bills
    - Bill number.
    - Bill starting date.
    - Bill ending date.
    - Bill ending reason.
    - Diagnosis code (ICD-10 code).
- Next level hospitals' data connected with healthcare services
    - Bill number.
    - Healthcare service code (EHIF specific codes).
    - Data of service.
- Next level hospitals' data with concurrent diagnoses
    - Bill number.
    - Diagnosis code (ICD-10 code).
    - Diagnosis order.
- General practitioner data
    - Bill number.
    - Healthcare service code (EHIF specific codes).
    - Data of service.
    - Diagnosis code (ICD-10 code).
    - Diagnosis order.
- Prescription data
    - Anonymous patient identification code (random numeric code).
    - Date of prescribing.
    - Status of prescription.
    - Prescription count (1 or 3).
    - Active ingredient/ATC Classification System code.

One patient gets one identification code and it is same in every data table. Patient codes are anonymous assigned by EHIF to protect patients' identities.

3.3 Data analysis

Descriptive analysis of collected data about stroke patients includes calculating mean and median. Other researchers have used regression analysis, multivariable regression fixed-effect regression model adjusted for clustering of patients within clinics, for adjustment of differences in health outcome. Logistic regression has been performed for dichotomous outcomes and linear regression for continuous data. [37] Logistic regression analysis is used where dependent variable is time period and independent variables are patient age and sex, treated at Hiiumaa hospital, performing thrombolysis and in-hospital death. Correlation is calculated with Pearson correlation coefficient and testing is done to see if correlation differs from zero. Data management is performed with program MS Excel and statistical analysis is performed with statistical computing and graphics software R.

3.4 Method's ethical aspects and limitations

3.4.1 Ethical consideration

This is a retrospective study based on anonymized data from EHIF database, therefore informed consent was not necessary. Linking of data of different activities for patient pathways was done by EHIF analyst and data subjects were coded.

3.4.2 Limitations

The Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association consists of over hundreds of recommendations in the field of prehospital care, emergency evaluation and treatment, general supportive care and emergency treatment, in-hospital management of AIS: general supportive care and treatment of acute complications and in-hospital institution of secondary stroke prevention. Adherence of many of the listed recommendations cannot be assessed on the antithrombotic treatment of AIS instructions used at Hiiumaa hospital because it is

concentrated on one aspect of stroke patient treatment, thrombolysis. To assess the adherence of other recommendations the patient medical records have to be looked through.

4 Results

4.1 Descriptive results

4.1.1 Demographics of pre-implementation period

In the period of 1st of January 2014 to 31th of March 2018 there were 96 patients with stroke treated at Hiiumaa hospital. The basic demographic and clinical features of the patients can be seen in the table below (Table 2).

Table 2. Demographic and clinical feature of the patients in pre-implementation period.

	Patients
N	96
Sex	
Female	54
Male	42
Diagnosis	
I60	2
I61	8 (8.33%)
I63	86 (89.58%)
In-hospital death	13 (13.54%)

Out of these 96 patients, the biggest age group at the time of diagnosis was 80-89 that was followed by 70-79, 60-69. The estimated mean age at the time of diagnosis was 73.4 and the estimated median age 77. The estimated mean age had difference between genders, being 76.75 for females and 68.22 for males, respectively.

Most of the patients (89.58%) had diagnosis of AIS, eight patients had diagnosis of ICH and two patients had diagnosis of SAH.

4.1.1.1 Distribution of patients in sub-groups in pre-implementation period

The patients were divided into 4 sub-groups according to their pathways: group A, diagnosed and treated at Hiiumaa hospital; group B, diagnosed at Hiiumaa hospital and referred to stroke unit; group C, diagnosed at Hiiumaa hospital, referred to stroke unit and

then referred back to Hiiumaa hospital for follow-up care and group D, treated in stroke unit and referred to Hiiumaa hospital for follow-up care. The distribution of patients in sub-groups in pre-implementation period is shown in table 3.

Table 3. Distribution of patients in sub-groups in pre-implementation period.

	Patients
Group A	46 (47.91%)
Female	29
Male	17
Group B	29 (30.2%)
Female	13
Male	16
Group C	16 (16.66%)
Female	9
Male	7
Group D	5 (5.20%)
Female	3
Male	2

The number of patients in group A was 46. Out of those 46, 80.43 % (N=37) of patients arrived to the hospital with ambulance, 13.04% (N=6) of patients came by themselves, 2.17% (N=1) of patient was referred by general practitioner and 4.34% (N=2) of patients were marked as "other arrival". The number of patients who were referred to stroke unit was 29. 44.82% (N=13) of patients were referred to North-Estonian hospital, 41.27% (N=12) to West-Tallinn hospital and 13.79% (N=4) to East-Tallinn hospital. There were 16 patients in group C. 75% (N=12) of patients were referred to West-Tallinn hospital and 25% (N=4) of patients to North-Estonian hospital. All of these patients were referred back to Hiiumaa hospital for follow-up care. Four patient's pathways started in West-Tallinn Central hospital and they all were referred to Hiiumaa hospital for follow-up care. The services provided in regional or central hospital are out of this thesis scope therefor these are not listed in the pathway. Patients pathways and services provided are described in Appendix 1. Patient pathways pre-implementation of global budget.

4.1.2 Demographics of post-implementation period

In the period of 1st of April 2018 to 29th of February 2020 there were 50 patients with stroke diagnose treated at Hiiumaa hospital. The basic demographic and clinical features of the patients can be seen in the table below (Table 4).

Table 4. Demographic and clinical feature of the patients in post-implementation period.

	Patients
N	50
Sex	
Female	26
Male	24
Diagnosis	
I60	1
I61	11 (22%)
I63	38 (76%)
In-hospital death	10 (20%)

Out of these 50 patients, the biggest age group at the time of diagnosis was 70-79 that was followed by 80-89, 60-69. The estimated mean age at the time of diagnosis was 75.37 and the estimated median age 78. The estimated mean age had difference between genders, being 79.23 for females and 71.68 for males, respectively.

Most of the patients (76%) of patients had diagnosis of AIS, 22% patients had diagnosis of ICH and one patient had SAH.

4.1.2.1 Distribution of patients in sub-groups in post-implementation period

The patients were divided into 4 sub-groups according to their pathways: group A, diagnosed and treated at Hiiumaa hospital; group B, diagnosed at Hiiumaa hospital and referred to stroke unit; group C, diagnosed at Hiiumaa hospital, referred to stroke unit and then referred back to Hiiumaa hospital for follow-up care and group D, treated in stroke unit and referred to Hiiumaa hospital for follow-up care. The distribution of patients in sub-groups in post-implementation period is shown in table 5.

Table 5. Distribution of patients in sub-groups in post-implementation period.

	Patients
Group A	27 (54%)
Female	18
Male	9
Group B	16 (32%)
Female	6
Male	10
Group C	4 (8%)
Female	2
Male	2
Group D	3 (6%)
Male	3

The number of patients diagnosed and treated at Hiiumaa hospital was 27. 96.29% (N=26) of patients arrived to the hospital with ambulance and 3.70% (N=1) of patient came by themselves. The number of patients referred to stroke unit was 16. In group B, 50% (N=8) of patients were referred to West-Tallinn hospital and 50% (N=8) of patients to North-Estonian Hospital. In group C, 75% (N=3) of patients were referred to West-Tallinn hospital and 25% (N=1) of patients to North-Estonian hospital All of these patients were then referred to Hiiumaa hospital for follow-up care. In group D, two patient's pathways started at North-Estonian hospital and one patient's pathways started at West-Tallinn Central hospital. All of the patients were referred back to Hiiumaa hospital for follow-up care. The services provided in regional or central hospital are out of this thesis scope therefor these are not listed in this pathway. Patients pathways and services provided are described in Appendix 1. Patient pathways post-implementation of global budget.

4.1.3 Demographics of shortened pre-implementation period for patient management

For the comparison of changes in stroke patient management in the following chapters the pre-implementation period was shortened to 23 months – from 1st of May 2016 to 31st of March 2018. The demographics of patients is shown in table 6.

Table 6. Demographics of patients in 1st of May 2016 to 31st of March 2018.

	Patients
N	48
Sex	
Female	29
Male	19
Diagnosis	
I60	1
I61	4 (8.33%)
I63	43 (89.58%)
In-hospital death	9 (18.75%)

Out of these 48 patients, the biggest age group at the time of diagnosis was 80-89 that was followed by 60-69, 70-79. The estimated mean age at the time of diagnosis was 74.16 and the estimated median age 77. The estimated mean age had no difference between genders, being 76.62 for females and 73.64 for males, respectively.

4.2 Changes in stroke patient management

The analysis report of logistic regression is shown in table 7. The results of regression analysis show that all variables are statistically not significant (p-value >0.05). Changing the value of independent variable does not predict whether the patient was treated in pre- or post-implementation period. Patient management variable "referred to stroke unit" was left out of the logistic regression analysis since it correlates with variable "treated at Hiiumaa hospital". The correlation between variables "referred to stroke unit" and "treated at Hiiumaa hospital" is shown in figure 2.

Table 7. The analysis report of logistic regression.

Term	Estimate	std.error	Statistic	p-value
(Intercept)	-0.8958632	1.4969875	-0.598444	0.549544
Sex	-0.2399212	0.4507919	-0.532222	0.594573
Age	0.01188897	0.0216853	0.5482512	0.583519
Treated at Hiiumaa hospital	0.26215438	0.5053173	0.5187916	0.603906
In-hospital death	-0.0879174	0.5876394	-0.149611	0.881072
Thrombolysis	0.28330648	0.841393	0.3367112	0.736335

According to the correlation table it can be said that referring to stroke unit has strong negative or none correlations with other variables. Also, treating at Hiiumaa hospital has strong positive correlation with age and in-hospital death. Overall correlations are on the weak side. The correlations are shown in the figure below (Figure 2).

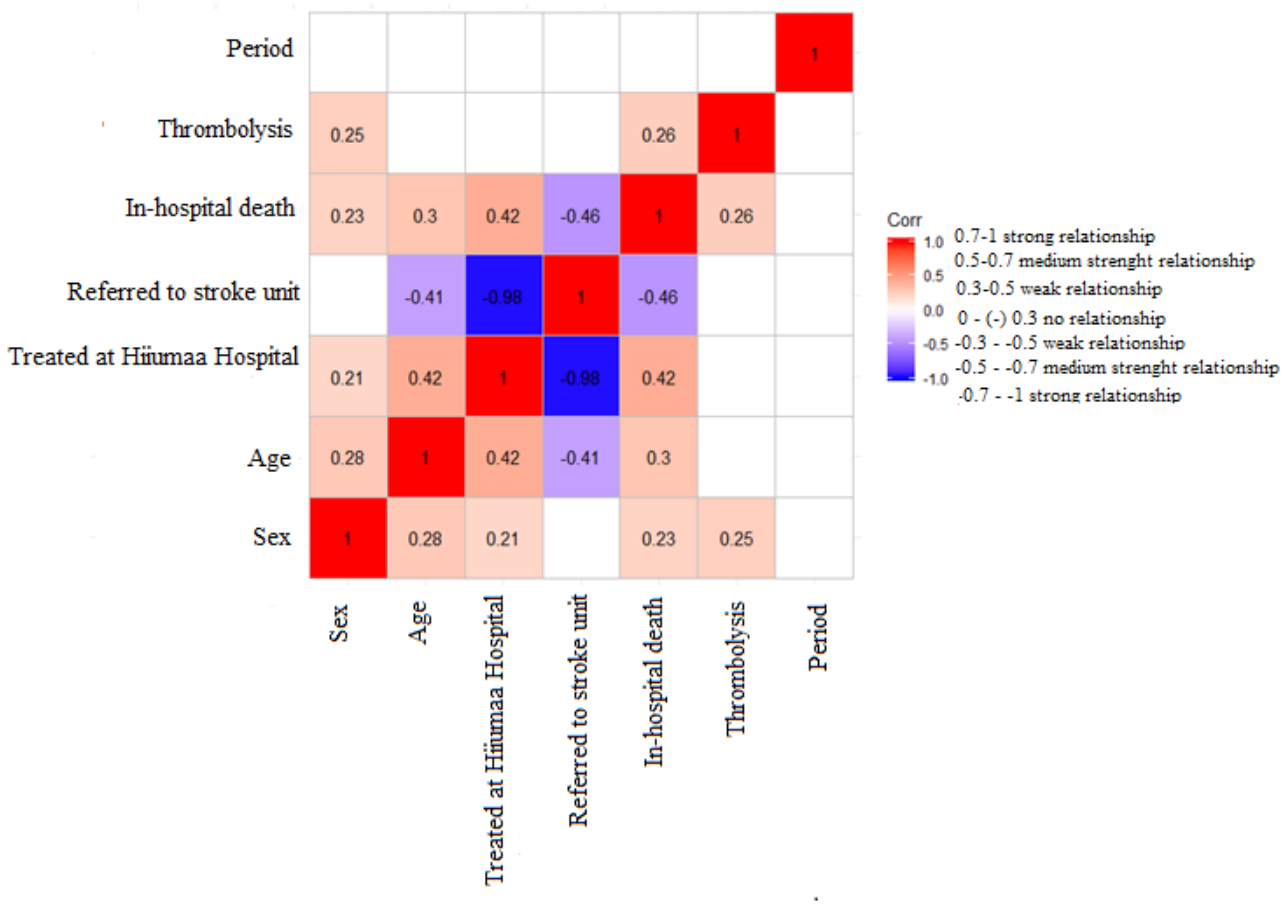

Figure 2. Correlations between patient demographics, management and health outcome.

4.3 Atrial fibrillation and anticoagulants

Prescribed active ingredient can be seen in figure below (Figure 3). In the pre-implementation period, 22 patients had the diagnose of AF. Less than half of the patients with AF diagnose had a prescription for anticoagulant. The main active ingredients described were warfarin, followed by dabigatran. In the post-implementation period, 15 patients had the diagnose of AF. Prescription of anticoagulant were prescribed to eight patients. The active ingredients prescribed were apixaban and dabigatran.

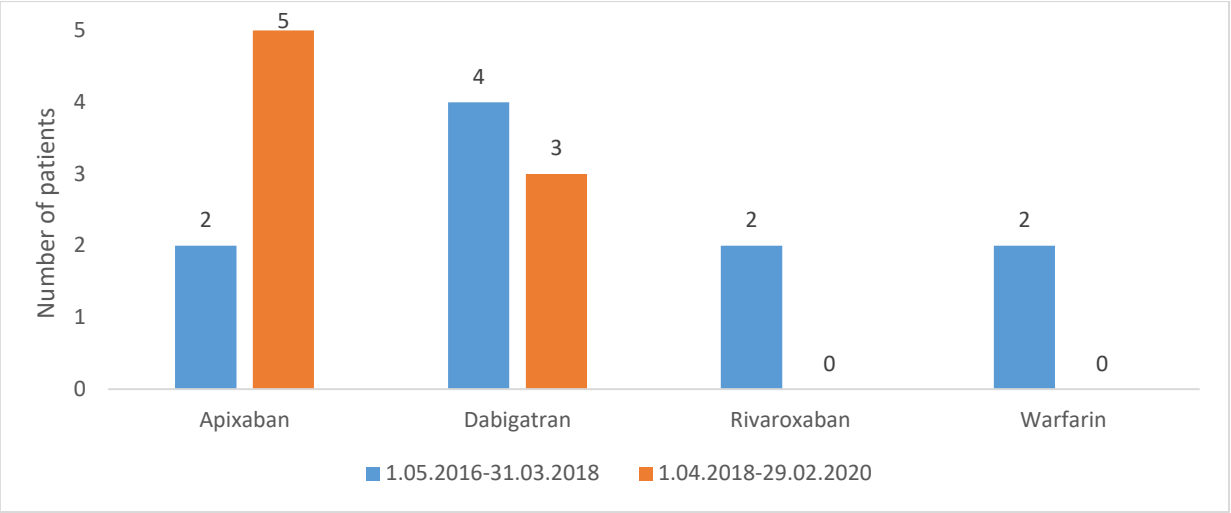

Figure 3. Prescribed active agent.

In the pre- and postimplementation of global budget, the healthcare facility prescribing the anticoagulants were more or less similar. Treating hospital prescribed anticoagulants for six and seven patients and GP for three and one patient in pre-and post-implementation period, respectively.

4.4 Length of hospital stay

The length of stay in sub-groups and periods can be seen in a figure below (Figure 4). In the post-implementation period, the mean and median length of stay in department of internal diseases has shortened for group A. As well as the median stay in department of internal diseases. There is a significant change in the length of stay for patients in group B in post-implementation period. The mean length of stay in department on internal diseases is longer, 3.85 days respectively. The results show that not all patients are directed to stroke unit on the day of diagnosing. In group C the mean and median length of stay in department of follow-up care has shortened in the post-implementation period.

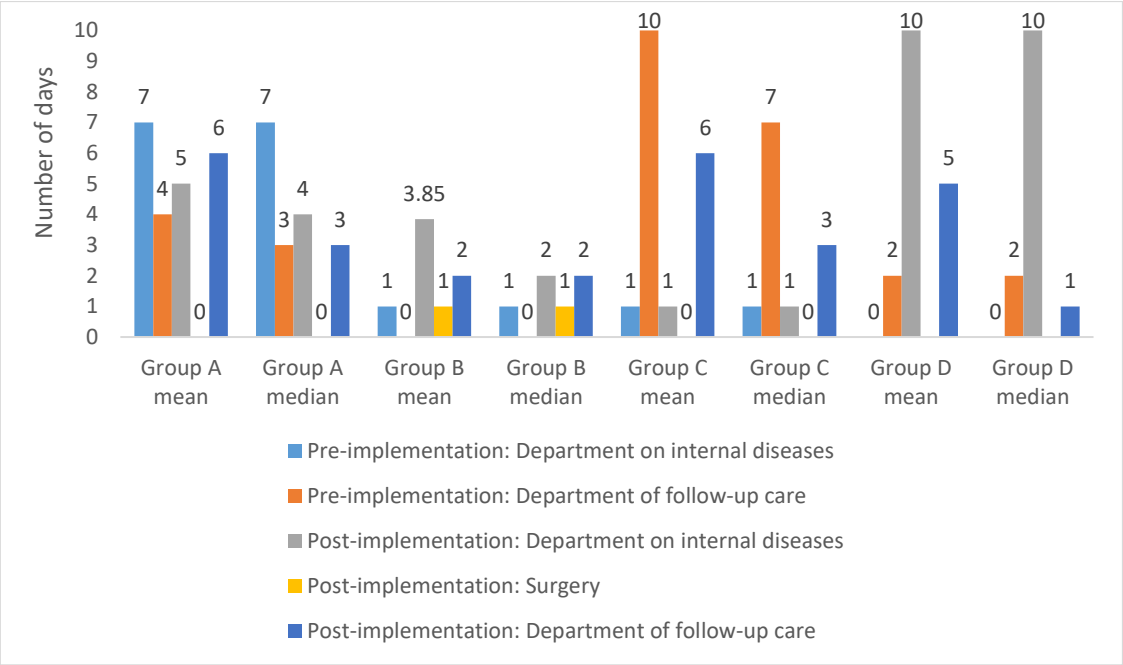

Figure 4. Length of hospital stay in sub-groups and periods.

In the post-implementation period group B, there was only one patient admitted to department of surgery and follow-up care. Also, one patient was admitted to department of internal diseases in group D.

4.5 General practitioners first visit after discharge

The analysis of EHIF medical bills showed in the pre-implementation period 39 (79.59%) patients and in post-implementation 29 (58%) patients visited their GP after discharge. There is a small difference in average days to GPs first visit after discharge, being 41.1 days in pre-implementation period and 48.86 days in post-implementation period. Also, there is a difference in the median days to GPs first visit, 28 days and 33.5 days for pre- and post-implementation period. There is also a decline in the maximum days for GP's first visit from 185 days to 165 days, respectively. The long delay from discharge to GPs' visit may be explained with patients visit to neurologist out-patient appointment.

Tests prescribed by the GP:

- Blood tests: glycose, glycohemoglobin; creatinine, urea, urine acid; cholesterol; triglycerides; cholesterol: HDL, LDL, hemogram; N; K; Ca; CRP; EKG;

enzymes: ALP, ASAT, ALAT, LDH, CK, GGT; coagulation screening: PT, APTT; anaemia, heart, cancer markers;

- Albumin in urine, urine test.

4.6 Adherence to Guidelines for the Early Management of Patients with Acute Ischemic Stroke

In this chapter the results of assessing the adherence of antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department to Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke [32] are described.

According to the AHA/ASA guideline telemedicine paragraph the recommendation is that the use of telemedicine/telestroke resources and systems should be supported by healthcare institutions, governments, payers, and vendors [32]. There are also recommendations that the telestroke network, teleradiology systems should be approved by the US Food and Drug Administration but those recommendations do not apply in Estonia. Hiiumaa hospital is using video conference call possibility with North-Estonian hospital when a stroke patient is considered to be eligible for thrombolysis and neurologist is not on-call in emergency department. This complies with the recommendations.

The instructions stipulate that thrombolysis is performed if the probable onset of stroke was less than 4.5 hours ago and there are no contraindications. Head CT and CTA of neck and brain arteries must be done. The procedure can be started without the results of blood tests if there is no clinical need. And the potential risks should be discussed during performing the procedure. These instructions comply with the strong recommendation about IV alteplase eligibility and time windows [32].

According to the antithrombotic treatment of AIS recombinant tissue plasminogen is administered intravenously 0.9mg/kg, but not over 90mg. 10% of the whole dose is given as bolus over 1 minute at the beginning of the procedure. Rest of the dose as infusion over one hour. The instruction complies with the administration recommendation of guideline [32].

5 Discussion

5.1 Stroke patient's management at Hiiumaa hospital

To construct the stroke patients' pathways at Hiiumaa hospital EHIF medical bill data was analysed. According to the medical bills data patients were divided into four groups:
group A - diagnosed and treated at Hiiumaa hospital;
group B - diagnosed at Hiiumaa hospital and referred to stroke unit;
group C –diagnosed at Hiiumaa hospital, referred to stroke unit and referred back to Hiiumaa hospital for follow up care;
group D - diagnosed and admitted to regional or central hospitals and were referred to Hiiumaa hospital for follow-up care.
In the pre- and post-implementation different group pathways all healthcare services provided at Hiiumaa hospital for stroke patients are listed.

In the four-year pre-implementation period, there were 96 patients and in post-implementation period 50 patients with stroke treated at Hiiumaa hospital. Stroke patients were mainly brought to the hospital by ambulance, still there were patients who came by themselves but usually several days after the onset of stroke symptoms according to doctor Volmer, Hiiumaa hospitals neurologist. Patients who had referral letter from general practitioner and previous agreement with doctor Kreis by GP were admitted to department of internal diseases. Meaning that these patients were first admitted for another reason and then during the hospital stay stroke was diagnosed. There were 14 and seven patients in pre- and post-implementation period, respectively, who were admitted to department of internal diseases for routine study and during hospital stay stroke was diagnosed.

Patients who enter the health care system via emergency department all received (ECG)-Gated CT, head CT and/or CTA and blood tests. Doctor Elo Volmer stated that if CTA was not performed on admission by doctor on-call she will perform it in following days when she is on-call. The overall agreement is all stroke patient will receive CTA. A change compared to pre-implementation period is in post-implementation period medical bills shows that patients admitted through emergency department have not received chest x-ray.

5.2 Changes in stroke patient management

5.2.1 Treated at Hiiumaa hospital

From 1st of September 2019 ambulance will transport all patients with suspected stroke to stroke unit. Follow-up care and rehabilitation will be provided in general hospital of the place of residence [30]. The number of patients treated at Hiiumaa hospital is nearly the same for both time periods, being 23 and 27 for pre- and post-implementation of global budget. Furthermore, there was no difference between mean age and sex of patients treated at Hiiumaa hospital. Although, there is a difference in the type of strokes treated at Hiiumaa hospital. In the pre-implementation period 21 patients with AIS, one patient with ICH and one patient with SAH were treated at Hiiumaa hospital, both died. In post-implementation period 20 patients with AIS, six patients with ICH and one patient with SAH were treated at Hiiumaa hospital, two ICH and one SAH patient died. In both periods SAH patients were treated at Hiiumaa hospital. As it is the severest type of stroke, the patient with SAH diagnose have to be directed to stroke unit [20]. The reasons why the decision was made to treat them at Hiiumaa hospital is hard to tell without looking through the medical record but the cause may be old age, comorbidities and unknown onset of symptoms. The number of ICH patients treated at Hiiumaa hospital is greater in post-implementation period.

5.2.2 Referred to stroke unit

It is important that stroke patients are treated in hospital and if possible, in stroke unit. Research has shown that patients treated in stroke unit compared to treated in department have less deaths (3%), less need for assistance (5%) and less the need for placement in a care facility (2%). The benefits extend to all sexes, age, stroke type and severity. [38] The number of patients referred to stroke unit are nearly the same for both period, 23 and 20, for pre- and post-implementation period. In the pre-implementation period six patients were referred to North-Estonian hospital and 17 to West-Tallinn hospital. In post-implementation period nine patients were referred to North-Estonian hospital and 11 patients were referred to West-Tallinn hospital. Overall patients are referred more to West-Tallinn hospital. Doctor Volmer explained that North-Estonian hospital looks at the age of the patients, they prefer younger patient with better prognosis since they already have a big workload. She added that patients with normal head CT but stroke symptoms are directed to West-Tallinn hospital for MRI. In conclusion she said that patients, even

at high age, are referred to stroke unit if the prognosis is good. Elderly patients with multiple comorbidities and bedridden patients who will not benefit from transportation or patients with too severe condition for transportation are treated at Hiiumaa hospital. Every patient is assessed individually.

In the periods under observation only one patient was transported with helicopter to stroke unit. Doctor Volmer explained that if the patient is eligible for transportation the doctor at Hiiumaa hospital will forward the status of the patient and the reanimation doctor decides what kind of transport (helicopter, ambulance) is needed. Most of the stroke patients at Hiiumaa hospital are transported by ambulance to stroke unit. Patients with SAH are transported with helicopter.

5.2.3 Thrombolysis

According to the new stroke management plan conducted by Ludvig Puusepp Society of Neurologists and Neurosurgeons in cooperation with all regional, central and general hospitals, rehabilitation centres', ambulance and EHIF representatives stipulates that Saaremaa and Hiiumaa will provide thrombolysis procedure on site with telemedicine support from stroke units [30]. In the pre-implementation period three thrombolysis procedures were performed at Hiiumaa hospital. One patient was referred to stroke unit, two patients died. In the post-implementation period four thrombolysis procedures were performed. All four patients were treated at Hiiumaa hospital, two of them died. EHIF quality indicators report shows that in 2017 two and 2018 three thrombolysis procedures were performed [2]. In conclusion a slight positive trend in performing thrombolysis procedure at Hiiumaa hospital can be seen.

Previously Hiiumaa hospital used videocall solution with East-Tallinn hospital when a patient was eligible for thrombolysis. The solution did not work because of the heavy workload at East-Tallinn hospital. Now the same solution is used with North-Estonian hospital. Doctor on-call at Hiiumaa hospital forwards the health status of the patient to neurologist at North-Estonian hospital and if eligibility for thrombolysis is confirmed the neurologist in Tallinn will lead the execution of the procedure. When asked from doctor Volmer why the number of thrombolysis procedure is low compared to other hospitals she answered that patients do not turn to the emergency department on the onset of symptoms therefor the up to 24-hour time window has already passed. Additionally, elderly patients have many comorbidities or unnormal level of INR that are contraindications for thrombolysis.

5.3 Atrial fibrillation and anticoagulants

Anticoagulants are used for secondary prevention of stroke in patients with AF [39]. Research has shown patients with stroke related to AF are at high risk of recurrent stroke in first days after stroke. The estimated event rates are 0.1-1.3% per day. [40] There were 22 patients with AF diagnose and ten (45.45%) patients had a prescription for anticoagulants in pre-implementation period. In post-implementation period there was 15 patients with AF diagnose and eight (53.33%) had a prescription for anticoagulants. EHIF quality indicators showed in 2017 in Hiiu county three patients out of eight with AIS and AF had a prescription for anticoagulants 30 days after discharge. The threshold for indicator is set for 75% for patients with AIS and AF 12 months+1 day after discharge. [2] Patients are discharged with the recommendation to start the anticoagulant treatment in a few weeks [25]. It may happen that patients forget to notify their GP about the stroke and need for prescription of anticoagulants. One reason for not having a prescription for anticoagulant may be contraindications. Unfortunately, medical bills do not have information about the contraindications and therefor the results may be distorted.

5.4 Length of hospital stay

The results of analysis show the length of hospital stay for patients in group A and patients in group C has shortened. Mean days for group A in department of internal diseases two days for both department of internal diseases and follow-up care. Mean and median days of length of hospital stay for group C has shortened four days. It would be too premature to conclude that the hospital stay has shortened due to implementation of global budget because the number of patients in both periods is small. The length of hospital stay is influenced by other factors like the severity of stroke, respondence to treatment, patient compliance to treatment and patients will to stay in hospital. As doctor Volmer pointed out that patients do prefer to go home as soon as possible and come to out-patient visit for rehabilitation.

5.5 GPs first visit after discharge from hospital

According to doctor Volmer stroke patients should visit his or her GP in one-month period after discharge from hospital. It was also pointed out that the patients she has treated are scheduled to her out-patient appointment. According to the financing agreement between

EHIF and Hiiumaa hospital there must be a neurologist out-patient appointment at least once a month [11]. In both periods over half of the patients visited their GP after discharge from hospital. The mean days to GPs first visit were 41.1 days and 48.86 days for pre- and post-implementation period. The long delay from discharge to GPs' visit may be explained with patients visit to neurologist out-patient appointment.

5.6 Adherence to guidelines

The adherence of the antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department to Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association was assessed.

The instructions concerning telemedicine, IV alteplase eligibility and alteplase administration are in compliance with the Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association recommendations. The contraindications for thrombolysis are in compliance to the contraindications listed in the AHA/ASA guideline. Since the instructions are given to a very narrow part of the stroke patient treatment only the adherence to small number of recommendations could be assessed.

EHIF has done over the years clinical audits that evaluate the compliance of diseases specific guideline. The last clinical audit that evaluated stroke treatment justification and quality was conducted in 2009 [19].

5.7 Limitations

The number of patients for pre- and post-implementation periods are relatively small, 48 and 50. Therefore, one might argue that the results of the analysis are random. On the other hand, it is important that the patients in general hospitals receive the same quality of healthcare as patients in central and regional hospitals. Also, it is important EHIF reimburses quality healthcare.

The logistic regression analysis revealed that all variables are statistically not significant (p-value >0.05). Changing the value of independent variable does not predict whether the patient was treated in pre- or post-implementation period. Still, there may be other predictors that were not measured due to not being able to identify them based on available data.

Since the instructions are given to a very narrow part of the stroke patient treatment only the adherence to small number of recommendations could be assessed.

5.8 Future Research

Analysing the results of this study some new areas of investigation were identified:

- The study should be conduct again after a few years to evaluate the impact of global budget to patient management.
- Future research is needed to evaluate the reason why doctors do not prescribe anticoagulants for patients with AF who have suffered from stroke.
- Further research is needed to evaluate the treatment compliance with international guidelines.

6 Conclusions

Based on the medical bills from EHIF database four patient pathways are identified: group A, diagnosed and treated at Hiiumaa hospital; group B, diagnosed at Hiiumaa hospital and referred to stroke unit; group C, diagnosed at Hiiumaa hospital, referred to stroke unit and then referred back to Hiiumaa hospital for follow-up care and group D, treated in stroke unit and referred to Hiiumaa hospital for follow-up care. The patient groups are the same for pre-and post-implementation of global budget.

The results of logistic regression analysis show that there is no statistical significance in stroke patient management.

Almost half of the patients with AF have a prescription for anticoagulant 30 days after discharge from hospital.

The analysis of medical bills showed that the length of stay for patient in group A and C has shortened but it is impossible to conclude based on the medical bills that the change is due to implementation of global budget.

Over half of the patients visited their GP after discharge from hospital. There is large variation on individual level of first visit to GP. This may be explained with the visit to neurologist out-patient appointment.

The antithrombotic treatment of AIS instructions used at Hiiumaa hospital emergency department complies with the Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association recommendations.

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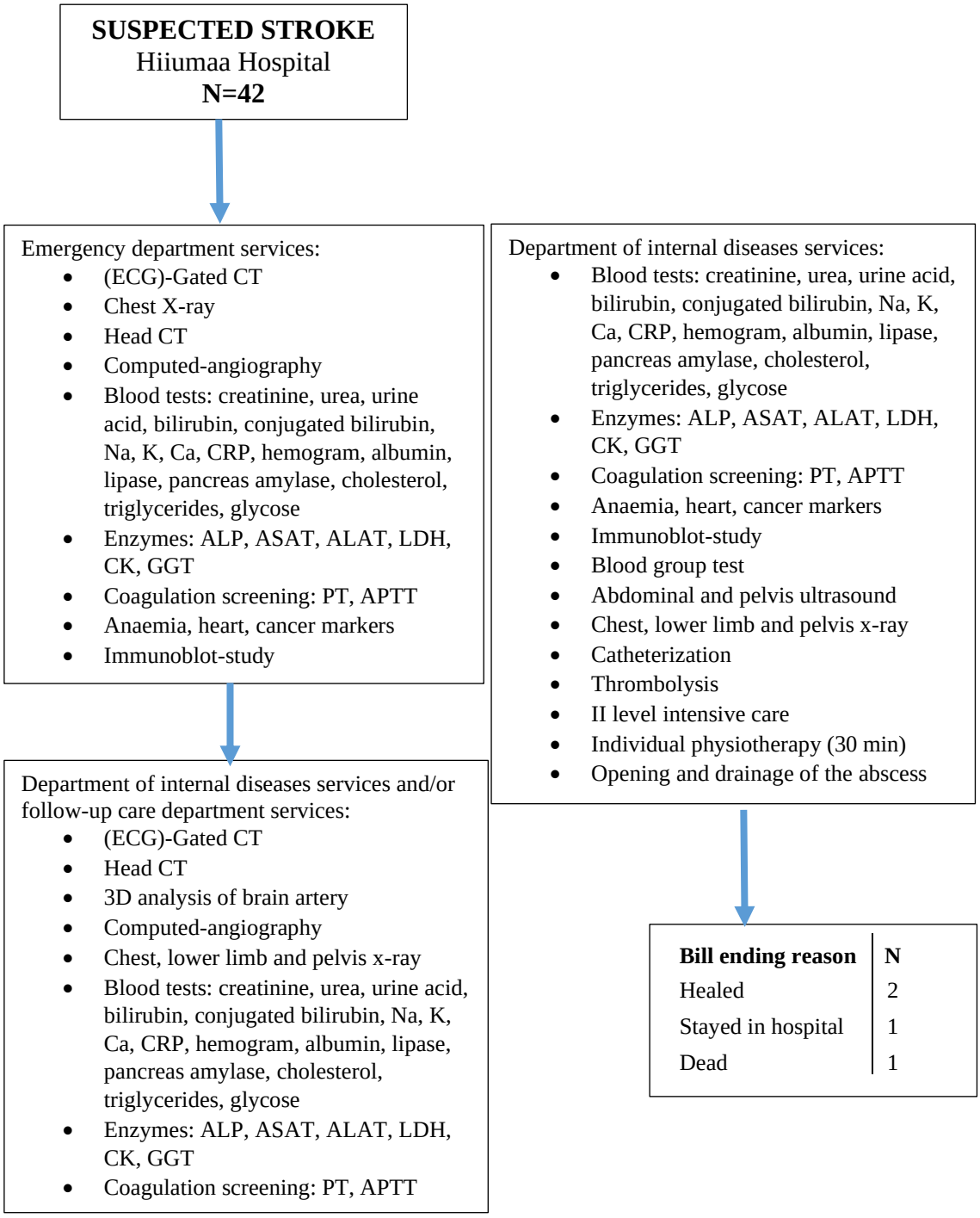
Appendix 1. Patient pathways pre-implementation of global budget

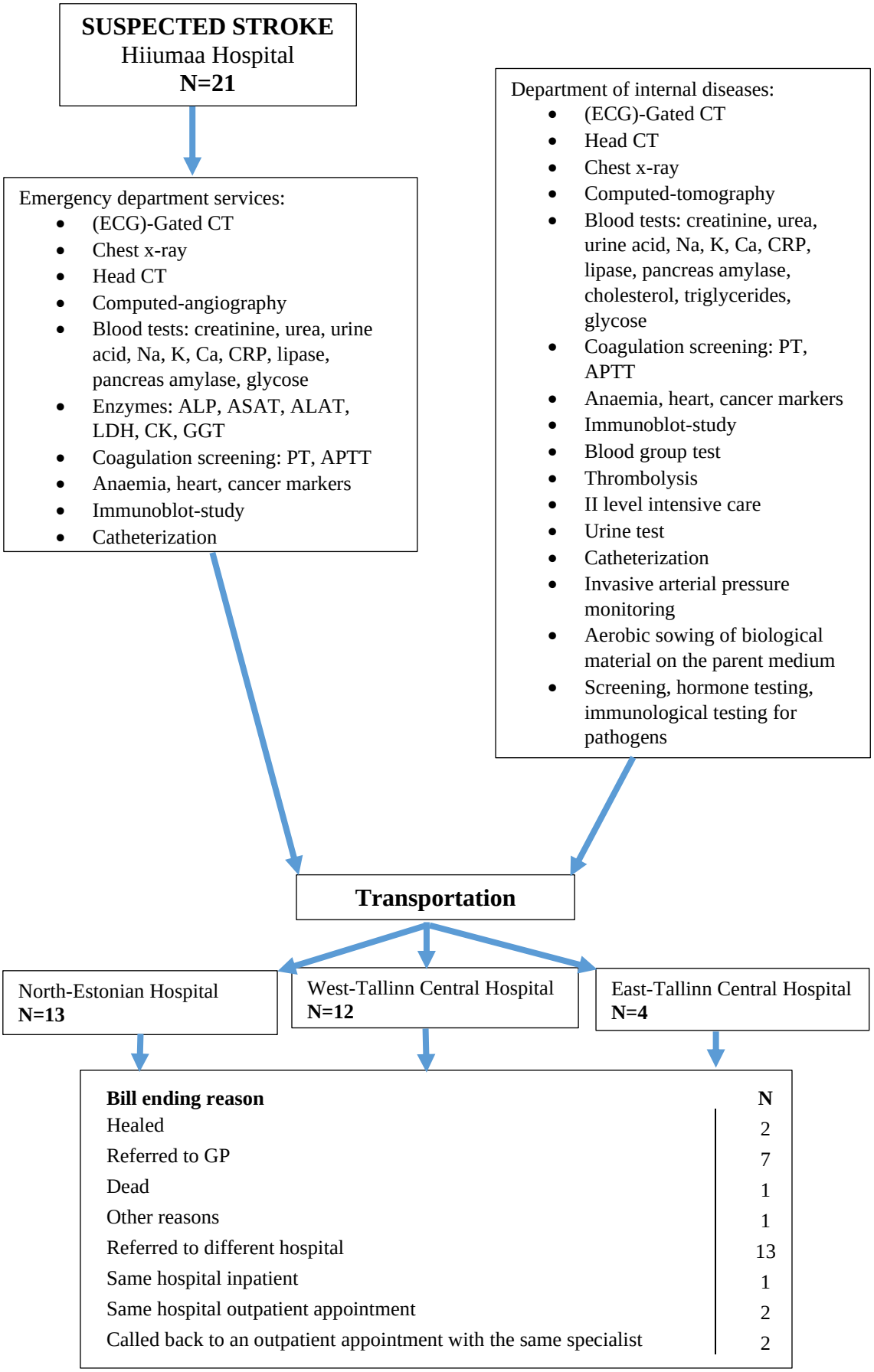
Appendix 1.1 Patient pathway for group A



- Anaemia, heart, cancer markers
- Immunoblot-study
- Acid-based balance
- Blood group test
- Abdominal and pelvis ultrasound
- Thrombolysis
- Catheterization
- II level intensive care
- Opening and drainage of the abscess
- Seeding of biological material in a special/automated seeding system
- Aerobic sowing of biological material on the parent medium
- Identification of a micro-organism by individual biochemical or immunological reactions
- Determination of drug sensitivity
- Determination of residual urine by ultrasound
- Urine test
- Massage session
- Individual physiotherapy (30 min)

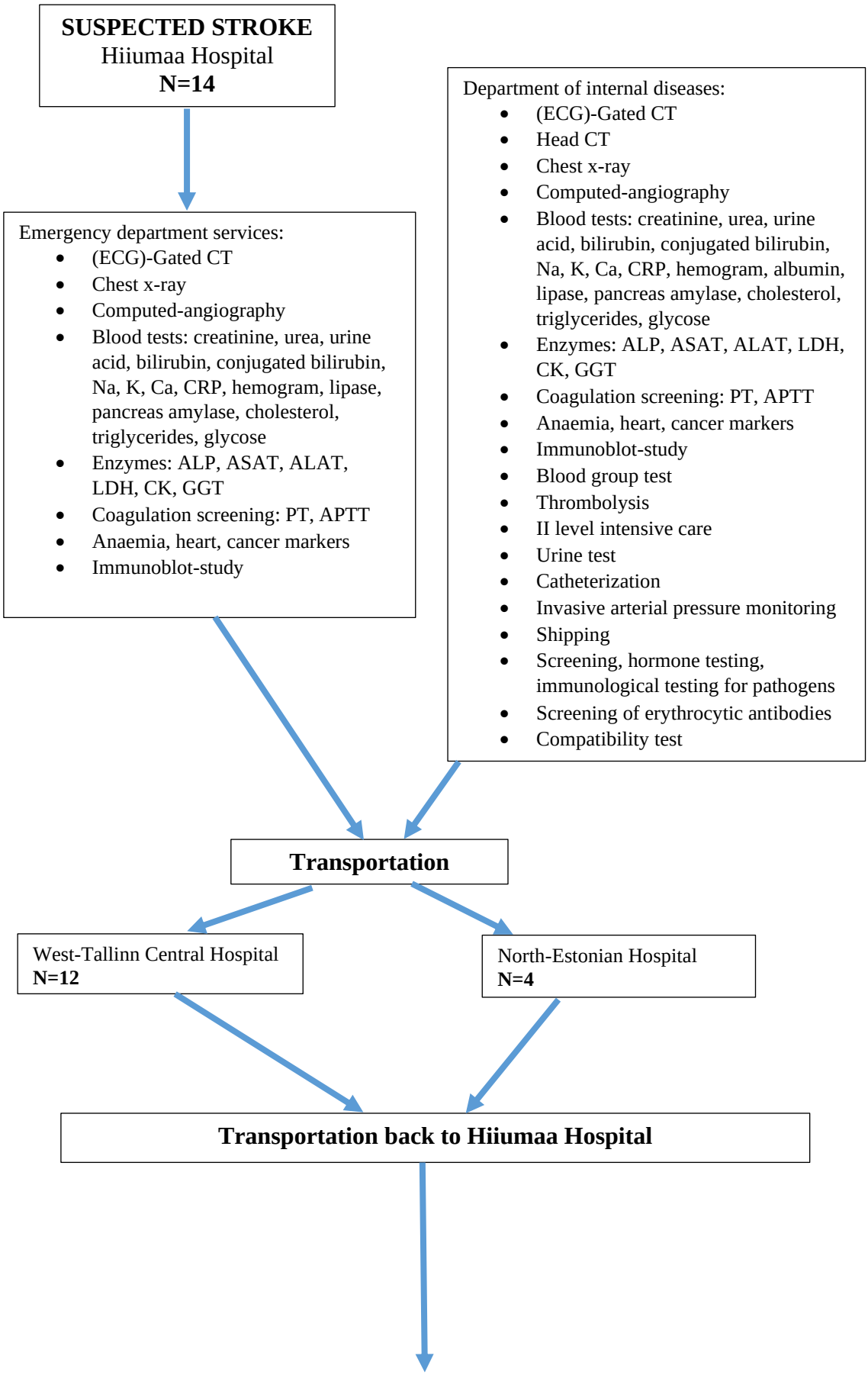
Bill ending reason	**N**
Healed	16
Dead	12
Other reasons	14

Appendix 1.2 Patient pathway for group B



Bill ending reason	N
Healed	2
Referred to GP	7
Dead	1
Other reasons	1
Referred to different hospital	13
Same hospital inpatient	1
Same hospital outpatient appointment	2
Called back to an outpatient appointment with the same specialist	2

Appendix 1.3 Patient pathway for group C

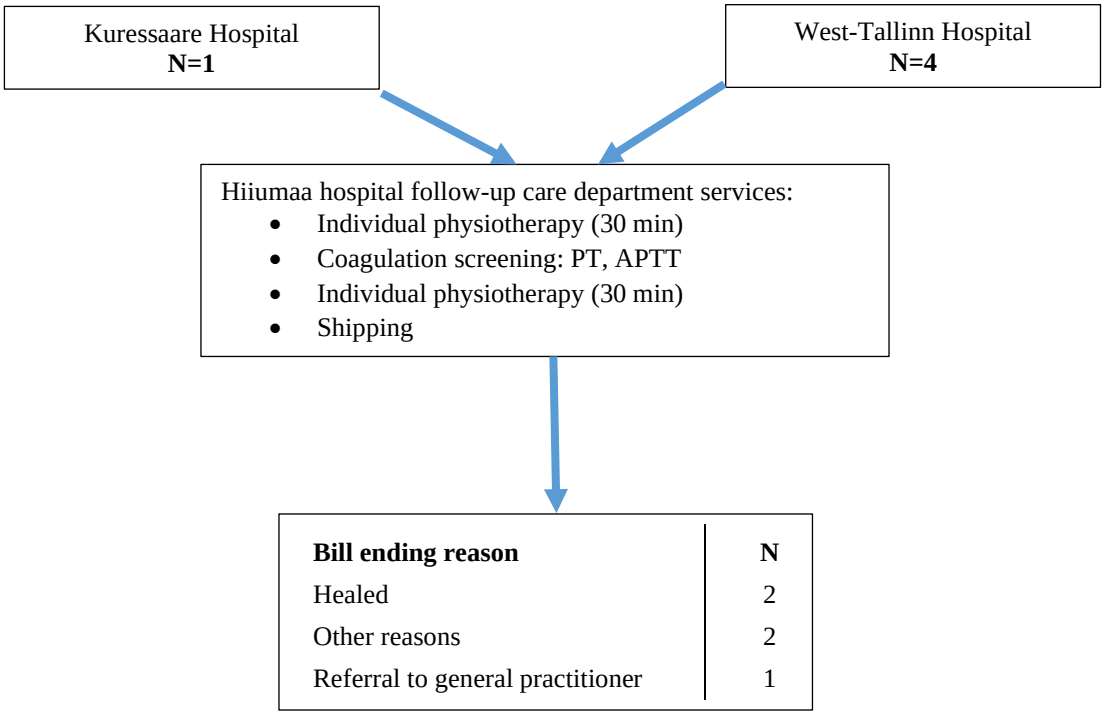


Hiiumaa Hospital follow-up care department:

- Computed-tomography
- Blood tests: creatinine, urea, urine acid, Na, K, Ca, CRP, hemogram, glycohemoglobin, glycose
- Enzymes: ALP, ASAT, ALAT, LDH, CK, GGT
- Coagulation screening: PT, APTT
- Anaemia, heart, cancer markers
- Aerobic sowing of biological material on basic medium
- Stool screens (hidden blood, fatty acids)
- Determination of a marker of a micro-organism in an agglutination, hemagglutination, latex agglutination reaction
- Urine test
- Massage session
- Individual physiotherapy (30min)
- Shipping

Bill ending reason	**N**
Healed	10
Other reasons	5
Referred to GP	1

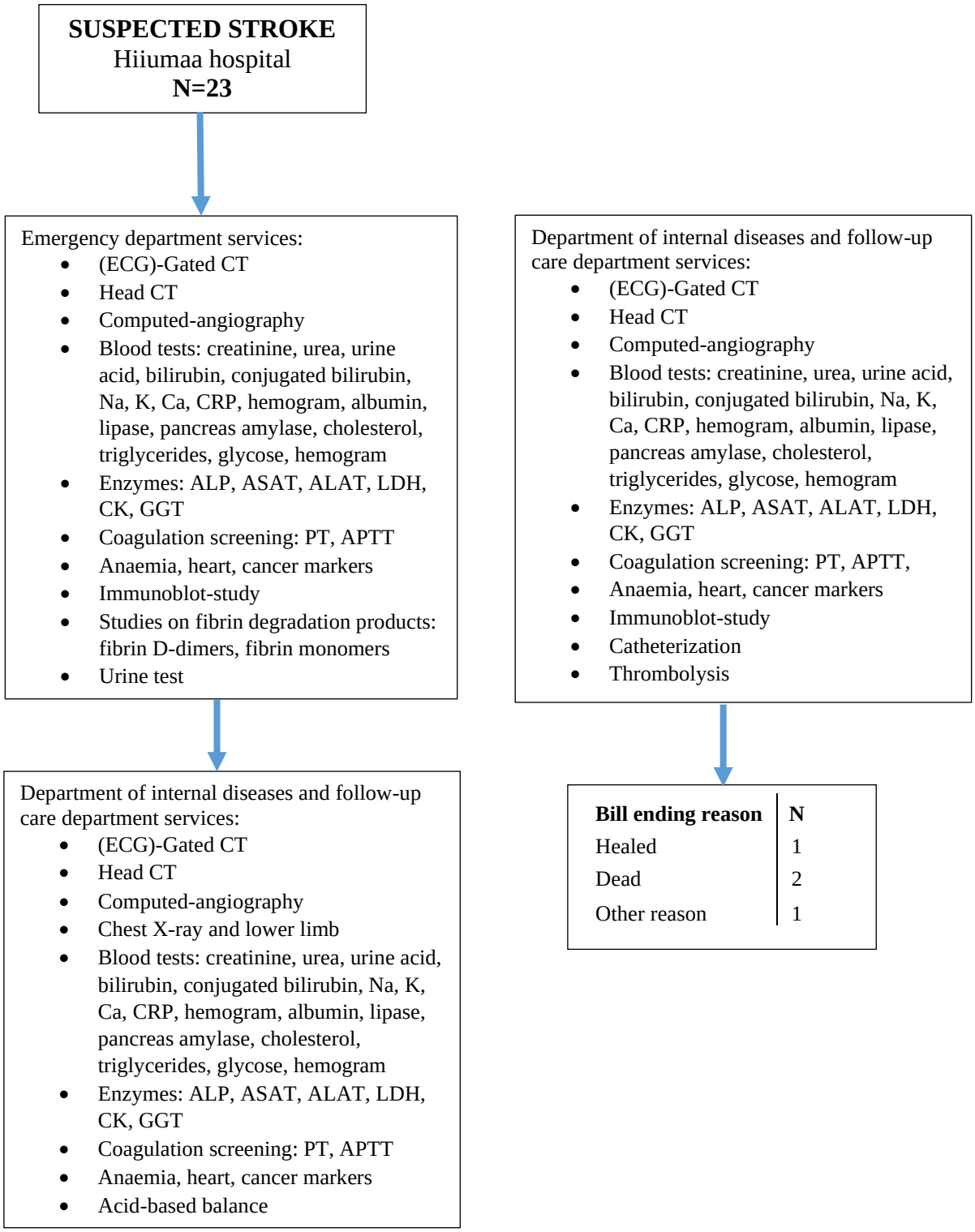
Appendix 1.4 Patient pathway for group D



Bill ending reason	N
Healed	2
Other reasons	2
Referral to general practitioner	1

Appendix 2. Patient pathways post-implementation of global budget

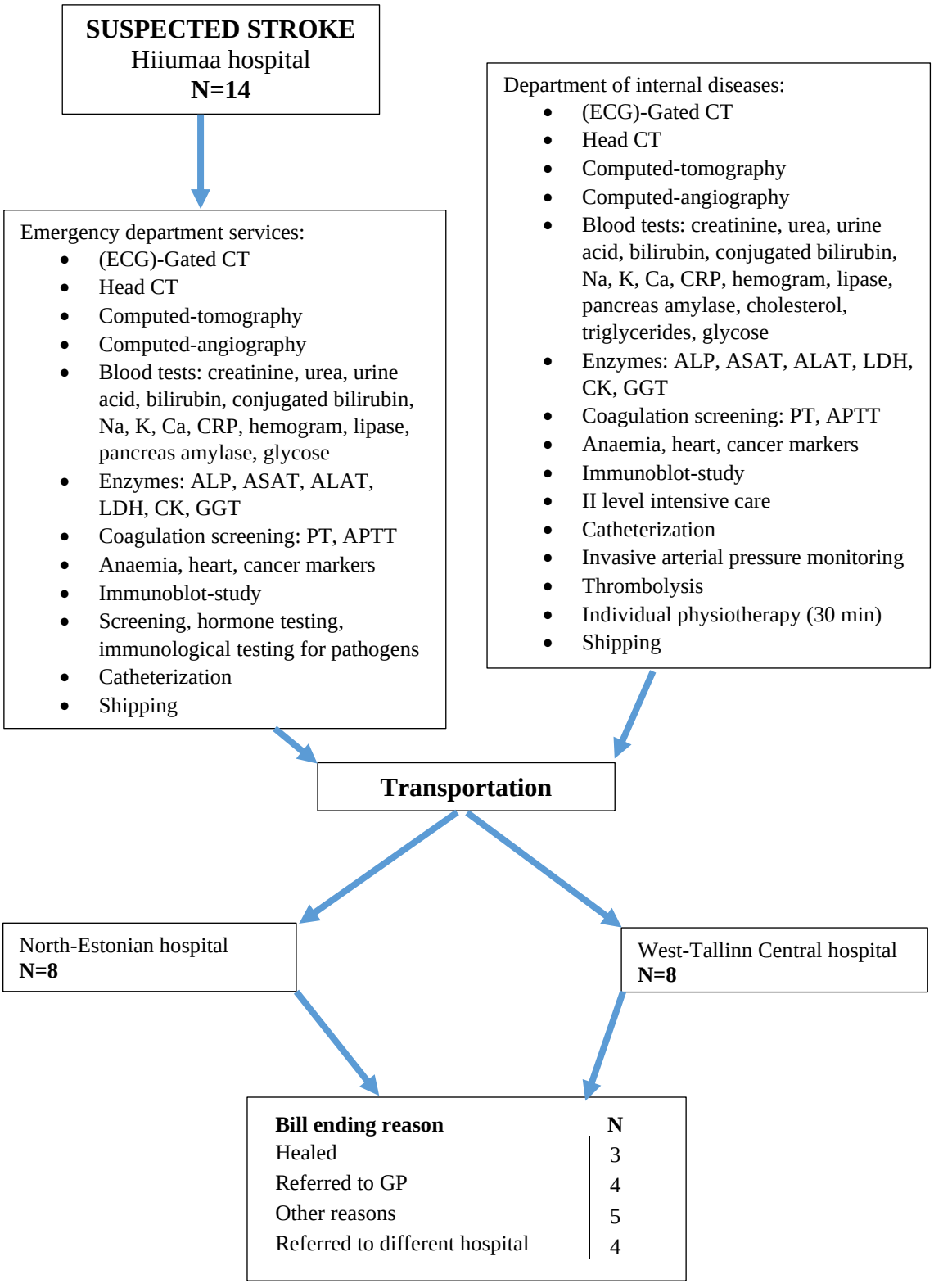
Appendix 2.1 Patient pathway for group A



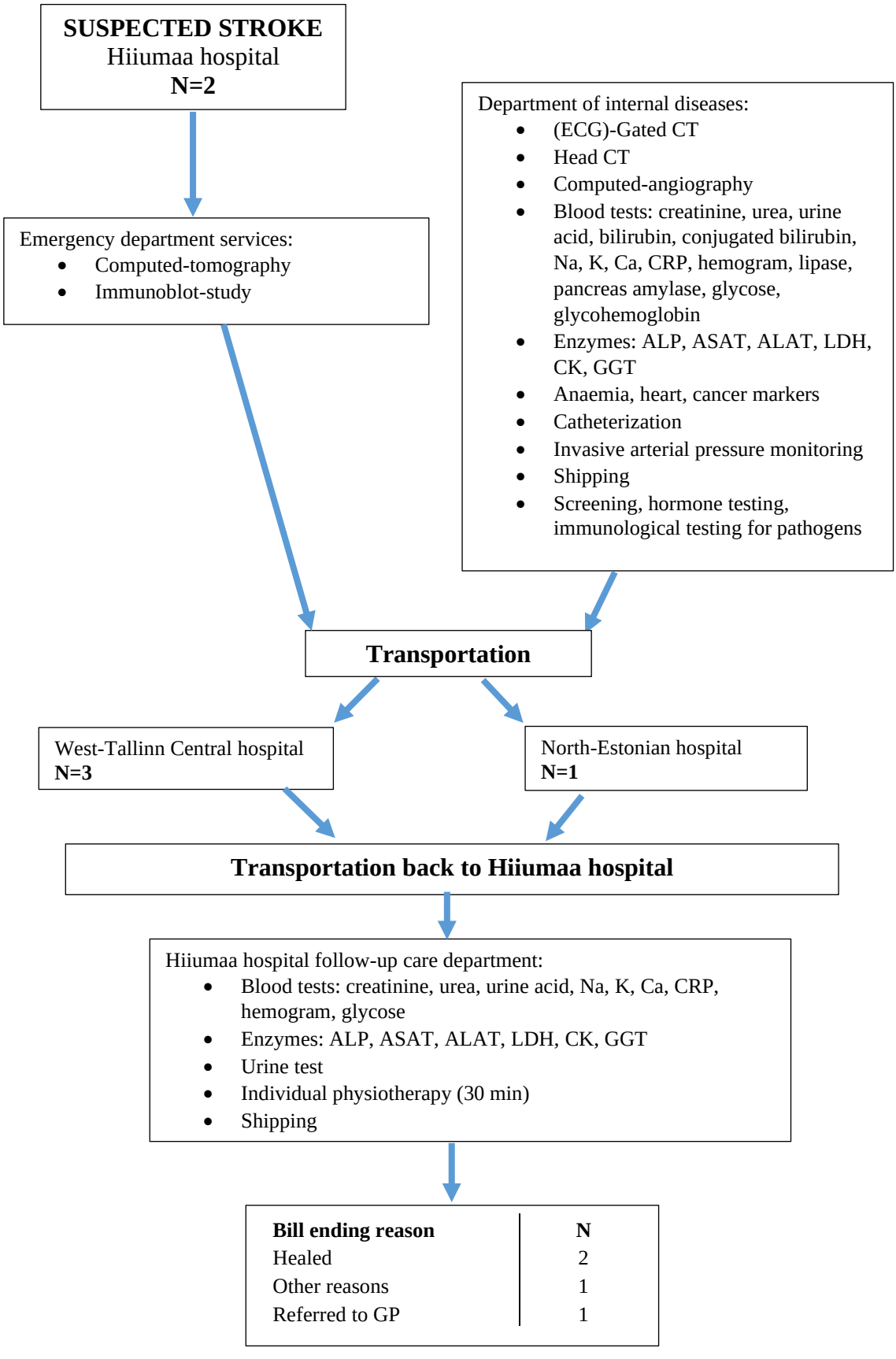
- Soluble transferrin receptors
- Catheterization
- II level intensive care
- Invasive arterial pressure monitoring
- Determination of residual urine by ultrasound
- Microbiological tests
- Determination of drug sensitivity
- Individual physiotherapy (30 min)

Bill ending reason	**N**
Healed	7
Dead	8
Other reason	7
Stayed in hospital	1

Appendix 2.2 Patient pathway for group B

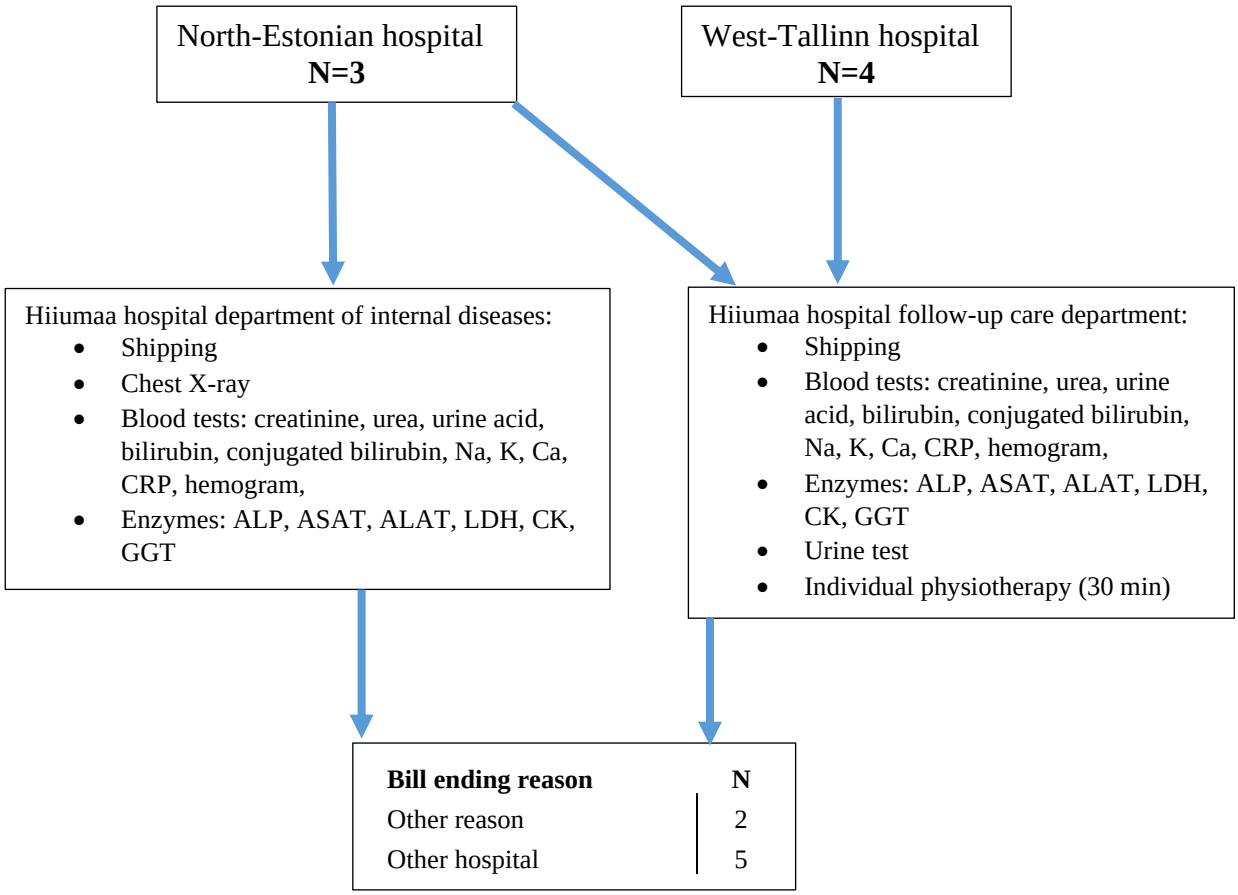


Appendix 2.3 Patient pathway for group C



Bill ending reason	N
Healed	2
Other reasons	1
Referred to GP	1

Appendix 2.4 Patient pathway for group D



Bill ending reason	**N**
Other reason	2
Other hospital	5