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Rethinking rehabilitation after percutaneous coronary intervention – rationale and design of a multicentre cohort study on continuity of care, health literacy, adherence and costs at all care levels (the CONCARD^{PCI})

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ABSTRACT

Introduction: Percutaneous coronary intervention (PCI) aims to provide instant relief of symptoms, improve functional capacity and prognosis in patients with coronary artery disease. Although patients may experience a quick recovery, continuity of care from hospital to home can be challenging. Within a short time span, patients must adjust their lifestyle, incorporate medication and acquire new support. Thus, CONCARD^{PCI} will identify bottlenecks in the patient journey from a patient perspective to lay the groundwork for integrated, coherent pathways with innovative modes of healthcare delivery. The main objective of the CONCARD^{PCI} is to investigate i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment, and iv) healthcare utilization and costs, and to determine associations with future short- and long-term health outcomes in patients after PCI.

Methods and analysis: This prospective multicentre cohort study organised in four thematic projects plans to include 3000 patients. All patients undergoing PCI at seven large PCI centres based in two Nordic countries are prospectively screened for eligibility and included in a cohort with a 1-year follow-up period including data collection of patient-reported outcomes (PROs) and a further 10-year follow-up for adverse events. In addition to PROs, data are collected from patient medical records and national compulsory registries.

Ethics and dissemination: Approval has been granted by the Norwegian Regional Committee for Ethics in Medical Research in Western Norway (REK 2015/57), and the Data Protection Agency in the Zealand region (REG-145-2017). Findings will be disseminated widely through peer-reviewed publications and to patients through patient organisations.

Registration: Clinicaltrials.gov identifier: NCT03810612.

Strengths and limitations of this study

- The CONCARD[PCI] is an interdisciplinary, multicentre effort with the unique combination of data from hospital medical records, patient self-report, and national registries providing opportunities to identify novel pathways for continuity of care that contribute to outcomes.
- Although the linkage to national registers will ensure complete follow-up of the study population, potential challenges include response rate of patient self-report at follow-up.
- Non-participants will be compared to participants on a limited number of registry variables to account for potential selection bias.

INTRODUCTION

The widespread commitment to involve patients in planning and service development has become a key element of current healthcare policy. Health literacy, as the ability to access, process and comprehend health information and services is thereby pivotal. The American Heart Association (AHA) recently published a scientific statement[1] addressing health literacy in cardiovascular disease as of fundamental relevance to primary and secondary prevention. Modern developments in primary healthcare provision have also led to increased interest in continuity of care as an essential element.[2, 3] However, the rehabilitation needs of large patient populations go unrecognised.[4, 5] Patients' transition from hospital to home is particularly challenging because patients need to adjust their lifestyle, incorporate new medications, and acquire diverse support.[6] Therefore, adherence to treatment is also of concern. Non-adherence to medications is common for patients with cardiovascular diseases.[7] Taking prescribed antiplatelet and other secondary preventive medication after percutaneous coronary intervention (PCI) is pivotal; however, it is unknown if non-adherence also applies for patients following PCI.

This paper describes a multicentre cohort study, the CONCARD^{PCI}, that seeks to identify bottlenecks and hurdles in the patient journey and suggest the optimal timing of services and alignment with patient preferences for patients with coronary artery disease (CAD) undergoing PCI. Of special interest are challenges with continuity of care, health literacy and self-management, adherence to treatment advice, costs at all care levels, and associations with future short- and long-term health outcomes.

CAD is the single most common cause of death in Europe as around 20% the of population die from the disease. However, there has been an encouraging decrease in mortality ascribed to improvements in risk-factor management, pharmacological treatment, and revascularization techniques; coronary artery bypass grafting and PCI.[8] Therefore, more

people need to manage life with CAD as a chronic disease. Although there is compelling evidence for secondary prevention following CAD, a large majority fail to achieve smoking cessation and appropriate physical activity, diet and therapeutic targets set by the ESC guidelines.[9]

Uptake to cardiac rehabilitation (CR) is suboptimal[9, 10], even though participation is associated with a markedly reduced risk of readmission, death, psychological distress, as well as improved self-management, health-related quality of life, and physical capacity.[11, 12] However, Denmark has had relatively high uptake of CR.[13] Few sufficiently powered real world studies have been undertaken with the explicit purpose of investigating continuity of care and pathways of CR in patients after PCI, although it concerns a large group of patients. This scarcity of sufficiently powered trials especially applies to vulnerable and underserved, including women, older adults, ethnic minorities, patients with lower socio-economic status and patients with comorbidities, and is due to factors associated with both referral and participation.[14] This is of particular concern as a recent study documented the benefits of invasive strategies in clinically stable very old patients with non-ST-elevation acute coronary syndrome.[15]

In addition to investigating factors associated with low referral, participation, health literacy and adherence rates among CR participants, studies are increasingly needed on evaluating alternative modes of providing CR. Follow-up of healthcare use, costs and predictors of costs following PCI in a non-clinical trial setting have been infrequently investigated.[16, 17] European leaders in secondary prevention have called for action in the post acute aftercare of patients with CAD.[18] Thus, a large cohort of real world observations that can ascertain interventions for future clinical trials is needed.[19] The CONCARD^{PCI} responds to this challenge. In CONCARD^{PCI}, we hypothesise that continuity of care, eHealth literacy

and self-management, and adherence to treatment in patients are directly associated to outcomes after PCI.

AIM OF THE RESEARCH PROGRAMME

The overall aim of CONCARD^{PCI} is to investigate i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment, and iv) healthcare utilization and costs, to determine associations with future short- and long-term health outcomes in patients after PCI. The study is organized into four thematic projects (Figure 1).

METHODS

Study design and setting

CONCARD^{PCI} is a large-scale multicentre cohort study with serial prospective survey data collection, clinical data and register-based follow-up. We collect data from hospital medical records, patient self-report surveys, and national registries (Figure 2). Preliminary work has been performed including in-depth interviews on patients' experiences of healthcare delivery to provide a context for the quantitative data and inform the content of the cohort survey questionnaires. Three follow-up surveys over one year are undertaken, and a 10-year follow-up for adverse events.

Seven large referral PCI centres in Norway and Denmark were selected based on the following considerations: presence of a committed research team including CONCARD^{PCI} study nurses and a local principal investigator, prior research experience including research infrastructure, geographic location and size. The PCI centres perform from 900 to >2000 (mean 1668) PCI procedures annually, having 629 to 1400 beds (mean 943), and are referral centres for coronary angiography and PCI for a total of 37 local hospitals (Figure 3, Table 1).

Haukeland University Hospital is the Sponsor Centre of this investigator initiated research programme. For study organisation, see online Appendix.

Study population

All patients undergoing PCI at seven large PCI centres are prospectively screened for eligibility. Screening is performed in the hospital setting by the site coordinator and trained CONCARD^{PCI} study nurses. Daily admissions records and the operating programme are reviewed to identify potentially eligible patients. Electronic medical records are reviewed to confirm eligibility according to the inclusion and exclusion criteria (Table 2). When cognitive impairment is suspected by clinical or study personnel and there is no medical record of the problem, the Confusion Assessment Method[20] and 4AT[21] are used to investigate whether the patient must be excluded. Patients who are delirious or too clinically unstable to participate following PCI, who would otherwise be eligible, are re-assessed until discharge. During the in-hospital assessment, participants provide informed consent. Because many of the questionnaires are designed for patient self-assessment, patients who need a complete proxy are ineligible. If participants need assistance in filling out the questionnaires, this is registered in the case report form (CRF). Regarding sample size and study power see *Data analysis and sample size determination.*

Measurement and data collection

In CONCARD^{PCI} a broad range of outcomes are measured and data are collected by physical assessment at baseline, review of the medical records, patient self-reported questionnaires (at baseline, 2, 6 and 12 months), and from national registries (Table 3 and Figure 2).

Trained CONCARD^{PCI} study nurses defined with research access review the electronic medical records for clinical status at admission. A comprehensive data dictionary and CRF are provided to ensure standardization of abstracted data. For the Danish centres, eCRFs are used. Patients included in the study undergo a brief physical assessment and complete the

self-report questionnaires at baseline after PCI (T0) (Table 3 and Figure 2). A follow-up with postal or electronic questionnaires are distributed to all patients included in the study, 2 months after discharge (T1). The time interval ensures time for follow-up care to evaluate early post-discharge continuity of care. A consecutive sub-group of patients (n=100) at the Sponsor Coordinating Center are approached for a re-test of the eHealth Literacy Scale (eHEALS)[22] and the Heart Continuity of Care Questionnaire (HCCQ)[23] as part of the validation process of the instruments. All patients are followed-up with postal or electronic questionnaires at 2 (T1), 6 (T2) and 12 (T3) months post-discharge. Non-responders receive one reminder. Vital status is identified to avoid sending questionnaires to deceased patients or their family. Patient adverse events are followed through national registers for 10 years or until death (T4) (Figure 2). Questionnaire packages are discussed with patient representatives and piloted at every measuring time point (T0-T3) before employed in the largescale cohort study.

To objectively assess adherence to therapy, serum levels of a wide panel of cardiac medications are measured. A consecutive subsample of 700 Norwegian patients from two centres will be invited to give a blood sample one year after the index procedure. The time is chosen as it corresponds to collection of patient-reported data on adherence. Moreover, adherence tends to diminish over time [24]; hence, the 1-year contact was chosen. Serum levels are submitted to an accredited clinical pharmacology laboratory, and quantified using liquid chromatography with mass spectrometry. Patients are labelled as non-adherent when serum level of at least one of the evaluated drugs is below the limit of quantification.

Management of cohort and registry data

For the *Norwegian centres*, baseline (T0) data are transferred to the National Coordinating Centre for data entry and/or review. The forms are reviewed and queries sent to the centre for missing or incomplete items. All follow-up data are collected by postal mail and managed at

the National Coordinating Centre. The paper version data are entered into electronic files by trained staff.

For *the Danish centres*, each centre registers patients who are screened, and either included or excluded in separate Microsoft Excel (version 2016) spreadsheets in a shared secure team site server hosted by the National Coordinating Centre. Data from medical records are entered into a shared SurveyXact (version 12.9) database at each study site and managed by the National Coordinating Center. Patient self-report at both baseline (T0) and follow-up are collected either electronically using a tablet via a SurveyXact-link or by paper as requested by the patient. Paper version data are entered into the SurveyXact database by trained study nurses. All follow-up data are collected and managed by the National Coordinating Centre.

Every resident in Norway and Denmark has a unique personal identifier that allows datasets from national registries to be merged on an individual level. The datasets will be released in a coded and de-identified form, but with a unique identifier common to the datasets making individual merging possible. The Heart registries, Prescription registries[25, 26], Cause of death registries[27, 28], and administrative registries on social security microdata and health care utilization[29, 30] are mandatory, and legally exempted from requirement of obtaining patient consent. Strict rules on how data can be used or linked are followed to secure privacy protection. Although these data are similar in composition, we are interested in contrasting and comparing Denmark with its high CR uptake to Norway with a lower uptake.

Data analysis and sample size determination

Descriptive statistics of the cohort by nation will be generated using proportions, means and standard deviations or medians and interquartile ranges as appropriate. Cross-sectional analysis will be used for continuity of care (Table 4) using multiple linear regression testing for a random effect for nation. For health literacy, there is a single follow-up and multiple

linear regression testing for a random nation effect will be used. The cohort's longitudinal observations over one year will be modelled using generalized linear mixed models (GLMM) that account for within person correlation for adherence to medications, healthcare utilization and cost (Table 4). We will test whether patients clustered within nation is significant. If so, we will include it as a hierarchy in the GLMMs. For time to readmission, and time to major adverse cardiac event, we will use competing risk models to account for censoring by death. We will construct risk stratification models that predict the probability of each outcome for specific combinations of risk factors. We will establish internal validity by using bootstrapping techniques. We will test whether missing data is at random. If not, we will estimate the probability of missingness and include it as a weight or covariate factor in the models.

Power calculations for the cohort study are based on time-to-first event outcomes, as these require the most patients. To maintain at family-wise Type I error of 0.05 and 80% power using the method of Hsieh et al[31] for adjusted Cox regression models 2550 patients are needed. To adjust for losses to follow-up, we increased this estimate by 18% for a total of 3000 patients. Thus, all outcomes will have ≥80% power with alpha ≤ 0.05.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The ethical guidelines of the World Medical Association, Declaration of Helsinki and the legislation in Norway and Denmark guide the study (Declaration of Helsinki, 2008). At inclusion, a detailed letter informing the potential participant of the study, and the right to withdraw from the study at any time without any reason is underlined. The identifying key is kept in a separate file from the data. The data are kept in strict confidence in locked files at research servers to protect the participants' privacy. Approval by the Norwegian Regional Committee for Ethics in Medical Research in Western Norway has been granted (REK

2015/57), and from the Data Protection Agency in the Zealand region for the Danish centres (REG-145-2017). Written agreements between the Sponsor Coordinating Centre, and the local principal investigators and directors of the departments in each participating study centre, are signed before initiation of data collection. The study is registered at clinicaltrials.gov (NCT03810612).

PATIENT AND USER INVOLVEMENT

CONCARD^{PCI} involves patients and stakeholders to target aspects of the patient journey to identify bottle-necks and carve out a user-friendly intervention. Patient involvement is carried out in several ways: Two patient representatives with a history of CAD, and trained to be patient representatives both in healthcare and research settings[32], provide input to the planning, implementing and reporting of results from the study. Representatives from all healthcare levels will be end users of knowledge from the project and are actively involved in the project through the CONCARD^{PCI} Expert Group (Appendix). Reporting of patient involvement will follow the GRIPP 2 reporting checklists.[33]

COMMUNICATION OF RESULTS AND TRANSITION OF KNOWLEDGE

The CONCARD^{PCI} has a close to practice and clinical approach, which will be an advantage in dissemination and communication with end users. Results will be disseminated to patients through patient organisations, and to healthcare professionals in PCI treatments teams and CR teams, as well as in primary care through seminars and scientific meetings. Due to the comprehensiveness of the outcome measures in the thematic projects (Table 4), numerous scientific papers are expected. Long-term follow-up will be reported as data becomes accessible. Authorship on publications from the study will be allocated using the guidelines

for authorship defined by the International Committee of Medical Journal Editors and depends on personal involvement.

DISCUSSION

While medicine has produced large advances in cardiac treatment, there is need for more consistent patient pathways and systematic follow-up care. In order to do so, bottlenecks in the patient journey need to be identified. CONCARD^{PCI} aims to close knowledge gaps related to four main areas: i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment and iv) healthcare utilization and costs of care. Although landmark cohort studies have been carried out to describe the aftercare of patients after acute MI, less is described of the patient journey, specifically after PCI, and rarely have these included extensive self-report from patients. In the past decade, an increasing number of studies using patient-reported outcomes have been performed, but in a different setting, with shorter follow-up and targeting subgroups of acute MI patients.[34-38] The US-based SILVER-AMI study focused on older adults[34], the VIRGO study[35] concentrated on younger women after acute MI, TRIUMPH[36] was designed to examine racial differences after acute MI, VICS[37] included both patients after acute MI and patients with heart failure, and NOR-COR[38] retrospectively surveyed patients below 80 years of age 2-38 months after the index event including also patients with coronary artery bypass surgery or no intervention. In contrast, CONCARD^{PCI} has an extended perspective by prospectively including adult patients, engaging stakeholders throughout the study, applying a comprehensive interdisciplinary approach, and including data from national registries. One great asset of the participating Nordic countries is infrastructure in research with access to demographics and health information through the national registries. The registries include all citizens, and a personal identifying number ensures no loss to follow up. In addition to national compulsory registries on death (National

Death Registry[27, 28]), readmission and use of healthcare services (National Patient Registry[29, 30]), and prescription and medication consumption (National Prescription Registry[25, 26]), the countries have disease specific national medical quality registries (e. g. NORIC). With establishing national registries, opportunities for nationwide comparisons and quality improvement of healthcare service is created.

While the aforementioned studies[34-38] also have detailed data abstracted from medical records and self-report, CONCARD^{PCI} has a timely approach in the four thematic projects – one of which concerns health literacy, and specifically eHealth literacy, is of particular relevance in information technology driven societies. The AHA Scientific Statement on health literacy[1] calls for studies examining health literacy and cardiovascular outcomes beyond 30-day readmission. It is suggested that health literacy can be evaluated as part of programs aiming to improve secondary prevention in that health literacy influences drop-out rates in CR. CONCARD^{PCI} responds to this challenge.

Lack of continuity of care and low health literacy are likely to carry increased healthcare utilization (e.g. readmission to hospital) and increased cost.[39] The potential need for re-thinking CR based on patient preferences and in-built economic analysis is a relevant path to follow. Moving towards a more patient-centred care aim to maximize patients' self-care abilities. Increased self-care is an overarching goal when healthcare expenditure rises to unaffordable levels. Further, in additional parameters, patient-reported outcomes can potentially identify patients at high risk of adverse outcomes and hospital readmissions[40, 41] which is of importance both to patients and society.

The importance of increased patient involvement and shared decision-making at all levels of healthcare is underlined in policy documents at a governmental and regional level.[42] Patient involvement is a unique feature of CONCARD^{PCI} scarcely described in comparable large-scale studies. The use of standardized patient-reported outcome measures may provide

information that can assist in this decision-making.[40, 41] In CONCARD[PCI], we pose research questions related to patient pathways that concerns a large group of patients. We anticipate that treatment outcome (adherence), safe communication (continuity and health literacy) and self-management will prove important to future healthcare.

However, the study has some limitations. We lack participating hospitals from northern Norway. The remoteness and distance to the PCI centre is a feature of that area and therefore of particular concern. However, travel time to the PCI centre from the most remote fjords in western Norway is also long and this catchment area is included in the study (Figure 3). Further, we exclude patients with delirium and dementia due to ethical reasons regarding informed consent and logistical difficulties. Delirious patients and patients too clinically unstable to be included following the PCI procedure, who would otherwise be eligible, are re-assessed until discharge. Non-participants will be compared to participants on a limited number of registry variables to account for potential selection bias. Extensive self-report is a feature of CONCARD[PCI], and we use validated questionnaires and only a few de-novo-created questions based on patient interviews. Still, the response rate of follow-up (T1-T3) may be a potential limitation. However, previous methodological work in patients with CAD showed high acceptability of comprehensive questionnaires[43] and patient representatives participating in planning of CONCARD[PCI] ensured relevance of the questionnaires.

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AUTHOR CONTRIBUTIONS

TMN is the principal investigator of CONCARD[PCI] and was responsible for study conception, development of the project outline, and ethical approval. HA, GB, NF, TBH, TRP, IV, and SR

contributed to the development of the project outline. HA is chairing the Scientific Advisory Board, NF is the coordinator of the cohort study in CONCARD[PCI] with TBH as national coordinator in Denmark, and GB, TRP, TBH and IV are leaders of thematic projects. TMN wrote the first draft of the manuscript. All authors revised the manuscript critically, and read and approved the final manuscript. A more detailed description of the roles of all authors are in the online Appendix.

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CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors have no competing interests.

STATUS

Data collection for the cohort study commenced on 12 June 2017 and is expected to continue until July 2020, with a 10-year follow-up until July 2029. The inclusion of patients for the blood sampling for objective medication adherence measurement has not yet started.

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REFERENCES

1. Magnani JW, Mujahid MS, Aronow HD, *et al*. Health Literacy and Cardiovascular Disease: Fundamental Relevance to Primary and Secondary Prevention: A Scientific Statement From the American Heart Association. *Circulation* 2018;**138**:e48-e74. doi:10.1161/CIR.0000000000000579.

2. Riley DL, Stewart DE, Grace SL. Continuity of cardiac care: cardiac rehabilitation participation and other correlates. *Int J Cardiol* 2007;**119**:326-333. doi:10.1016/j.ijcard.2006.07.158.
3. Barker I, Steventon A, Deeny SR. Association between continuity of care in general practice and hospital admissions for ambulatory care sensitive conditions: cross sectional study of routinely collected, person level data. *BMJ* 2017;**356**:j84. doi: https://doi.org/10.1136/bmj.j84
4. Aragam KG, Dai D, Neely ML, *et al*. Gaps in referral to cardiac rehabilitation of patients undergoing percutaneous coronary intervention in the United States. *J Am Coll Cardiol* 2015;**65**:2079-2088. doi:10.1016/j.jacc.2015.02.063.
5. Tavella R, Arstall M, Beltrame JF. Gaps in Cardiac Rehabilitation Referral: A Universal Problem. *J Am Coll Cardiol* 2015;**66**:2572-2573. doi:10.1016/j.jacc.2015.06.1358
6. Piepoli MF, Corra U, Dendale P, *et al*. Challenges in secondary prevention after acute myocardial infarction: A call for action. *Eur J Prev Cardiol* 2016;**23**:1994-2006. doi:10.1177/2047487316663873.
7. Naderi SH, Bestwick JP, Wald DS. Adherence to drugs that prevent cardiovascular disease: meta-analysis on 376,162 patients. *Am J Med* 2012;**125**:882-887. doi:10.1016/j.amjmed.2011.12.013.
8. Timmis A, Townsend N, Gale C, *et al*. European Society of Cardiology: Cardiovascular Disease Statistics 2017. *Eur Heart J* 2018;**39**:508-579. doi:10.1093/eurheartj/ehx628.
9. Kotseva K, Wood D, De Bacquer D, *et al.* EUROASPIRE IV: A European Society of Cardiology survey on the lifestyle, risk factor and therapeutic management of coronary patients from 24 European countries. *Eur J Prev Cardiol* 2016;**23**:636-648. doi:10.1177/2047487315569401.
10. Resurreccion DM, Moreno-Peral P, Gomez-Herranz M, *et al*. Factors associated with non-participation in and dropout from cardiac rehabilitation programmes: a systematic review of prospective cohort studies. *Eur J Cardiovasc Nurs* 2019;**18**:38-47. doi:10.1177/1474515118783157.
11. Anderson L, Thompson DR, Oldridge N, *et al*. Exercise-based cardiac rehabilitation for coronary heart disease. *Cochrane Database Syst Rev* 2016;**1**:Cd001800. doi:10.1002/14651858.CD001800.pub3.
12. Dalal HM, Doherty P, Taylor RS. Cardiac rehabilitation. *BMJ* 2015;**351**:h5000. doi:10.1136/bmj.h5000.
13. Dansk Hjerterehabiliteringsdatabase (DHRD). Årsrapport 2017. 1. juni 2017-31.maj 2018. [Final version 28 Jan 2019]. Available from: https://www.sundhed.dk/content/cms/93/59693_dhrd_årsrapport-2017_28012019endelig_inkl-struktur-tabel-og-figur.pdf (Accessed 27 May 2019).
14. Clark AM, King-Shier KM, Duncan A, *et al*. Factors influencing referral to cardiac rehabilitation and secondary prevention programs: a systematic review. *Eur J Prev Cardiol* 2013;**20**:692-700. doi:10.1177/2047487312447846.
15. Tegn N, Abdelnoor M, Aaberge L, et al. Invasive versus conservative strategy in patients aged 80 years or older with non-ST-elevation myocardial infarction or unstable angina pectoris (After Eighty study): an open-label randomised controlled trial. *Lancet* 2016;**387**:1057-1065. doi:https://doi.org/10.1016/S0140-6736(15)01166-6.
16. Bakhai A, Ferrieres J, Iniguez A, *et al*. Clinical outcomes, resource use, and costs at 1 year in patients with acute coronary syndrome undergoing PCI: results from the

multinational APTOR registry. *J Interven Cardiol* 2012;**25**:19-27. doi:10.1111/j.1540-8183.2011.00690.x.
17. Ho PM, O'Donnell CI, Bradley SM, *et al*. 1-year risk-adjusted mortality and costs of percutaneous coronary intervention in the Veterans Health Administration: insights from the VA CART Program. *J Am Coll Cardiol* 2015;**65**:236-242. doi:10.1016/j.jacc.2014.10.048.
18. Piepoli MF, Corra U, Dendale P, *et al*. Challenges in secondary prevention after acute myocardial infarction: A call for action. *Eur J Cardiovasc Nurs* 2017;**16**:369-380. doi:10.1177/2047487316663873.
19. Swieczkowski D, Mogielnicki M, Cwalina N, *et al*. Medication adherence in patients after percutaneous coronary intervention due to acute myocardial infarction: From research to clinical implications. *Cardiol J* 2016. Jul 21. doi:10.5603/CJ.a2016.0048. [Epub ahead of print].
20. Inouye SK, van Dyck CH, Alessi CA, *et al*. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. *Ann Intern Med* 1990;**113**:941-948.
21. Bellelli G, Morandi A, Davis DH, *et al*. Validation of the 4AT, a new instrument for rapid delirium screening: a study in 234 hospitalised older people. *Age Ageing* 2014;**43**:496-502. doi:10.1093/ageing/afu021.
22. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res* 2006;8:e27. doi:10.2196/jmir.8.4.e27.
23. Hadjistavropoulos HD, Biem HJ, Kowalyk KM. Measurement of continuity of care in cardiac patients: reliability and validity of an in-person questionnaire. *Can J Cardiol* 2004;**20**:883-891.
24. Ho PM, Bryson CL and Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation 2009;119:3028-35. doi: 10.1161/CIRCULATIONAHA.108.768986.
25. Furu K. Establishment of the nationwide Norwegian Prescription Database. *Nor J Epidemiol* 2008;**18**:129-136. doi:https://doi.org/10.5324/nje.v18i2.23.
26. Kildemoes HW, Sorensen HT, Hallas J. The Danish National Prescription Registry. *Scand J Public Health* 2011;**39**(7 Suppl):38-41. doi:10.1177/1403494810394717.
27. Helweg-Larsen K. The Danish Register of Causes of Death. *Scand J Public Health* 2011;**39**(7 Suppl):26-29. doi:10.1177/1403494811399958.
28. Gjertsen F. Cause of death registry-an important data source for medical research. *Tidsskr Nor Laegeforen* 2002;**122**:2551-2554.
29. Bakken IJ, Suren P, Haberg SE, *et al*. The Norwegian patient register--an important source for research. *Tidsskr Nor Laegeforen* 2014;**134**:12-13. doi:10.4045/tidsskr.13.1417.
30. Schmidt M, Schmidt SA, Sandegaard JL, et al. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol* 2015;**7**:449-490. doi:10.2147/CLEP.S91125.
31. Hsieh FY, Lavori PW. Sample-size calculations for the Cox proportional hazards regression model with nonbinary covariates. *Control Clin Trials* 2000;**21**:552-560.
32. National Institute for Health Research: Involving users in the research process. A 'how to' guide for researchers. 2010.
33. Staniszewska S, Brett J, Simera I, *et al*. GRIPP2 reporting checklists: tools to improve reporting of patient and public involvement in research. *BMJ* 2017;**358**:j3453. doi:https://doi.org/10.1136/bmj.j3453.

34. Dodson JA, Geda M, Krumholz HM, *et al.* Design and rationale of the comprehensive evaluation of risk factors in older patients with AMI (SILVER-AMI) study. *BMC Health Serv Res* 2014;**14**:506-506. doi:10.1186/s12913-014-0506-4.
35. Lichtman JH, Lorenze NP, D'Onofrio G, *et al*. Variation in recovery: Role of gender on outcomes of young AMI patients (VIRGO) study design. *Circ Cardiovasc Qual Outcomes* 2010;**3**:684-693. doi:10.1161/CIRCOUTCOMES.109.928713.
36. Arnold SV, Chan PS, Jones PG, *et al*. Translational Research Investigating Underlying Disparities in Acute Myocardial Infarction Patients' Health Status (TRIUMPH): design and rationale of a prospective multicenter registry. *Circ Cardiovasc Qual Outcomes* 2011;**4**:467-476. doi:10.1161/CIRCOUTCOMES.110.960468.
37. Meyers AG, Salanitro A, Wallston KA, *et al*. Determinants of health after hospital discharge: rationale and design of the Vanderbilt Inpatient Cohort Study (VICS). *BMC Health Serv Res* 2014;**14**:10. doi:10.1186/1472-6963-14-10.
38. Munkhaugen J, Sverre E, Peersen K, *et al*. The role of medical and psychosocial factors for unfavourable coronary risk factor control. *Scand Cardiovasc J* 2016;**50**:1-8. doi:10.3109/14017431.2015.1111408.
39. Haun JN, Patel NR, French DD, *et al*. Association between health literacy and medical care costs in an integrated healthcare system: a regional population based study. *BMC Health Serv Res* 2015;**15**:249-249. doi:https://doi.org/10.1186/s12913-015-0887-z.
40. Rumsfeld JS, Alexander KP, Goff DC, *et al*. Cardiovascular health: the importance of measuring patient-reported health status: a scientific statement from the American Heart Association. *Circulation* 2013;**127**:2233-2249. doi:10.1161/CIR.0b013e3182949a2e.
41. Anker SD, Agewall S, Borggrefe M, *et al*. The importance of patient-reported outcomes: a call for their comprehensive integration in cardiovascular clinical trials. *Eur Heart J* 2014;**35**:2001-2009. doi:10.1093/eurheartj/ehu205.
42. Barry MJ, Edgman-Levitan S. Shared decision making--pinnacle of patient-centered care. *N Engl J Med* 2012;**366**:780-781. doi:10.1056/NEJMp1109283.
43. Peersen K, Munkhaugen J, Gullestad L, *et al*. Reproducibility of an extensive self-report questionnaire used in secondary coronary prevention. *Scand J Public Health* 2017;**45**:269-276. doi:10.1177/1403494816688375.
44. Horne R, Weinman J, Hankins M. The Beliefs about Medicines Questionnaire: The development and evaluation of a new method for assessing the cognitive representation of medication. *Psychol Health* 1999;**14**:1-24. doi:https://doi.org/10.1080/08870449908407311.
45. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. *Ann Med* 2001;**33**:337-343.
46. Osborne RH, Batterham RW, Elsworth GR, *et al*. The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ). *BMC Public Health* 2013;**13**:658. doi:10.1186/1471-2458-13-658.
47. Oldridge N, Hofer S, McGee H, *et al*. The HeartQoL: part II. Validation of a new core health-related quality of life questionnaire for patients with ischemic heart disease. *Eur J Prev Cardiol* 2014;**21**:98-106. doi:10.1177/2047487312450545.
48. Horne R, Weinman J. Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *J Psychosom Res* 1999;**47**:555-567.
49. Hellström A, Hagell P, Fagerström C, *et al*. Measurement properties of the Minimal Insomnia Symptom Scale (MISS) in an elderly population in Sweden. *BMC Geriatr* 2010;**10**:84-84. doi:https://doi.org/10.1186/1471-2318-10-84.

50. Amofah HA, Brostrom A, Fridlund B, *et al*. Sleep in octogenarians during the postoperative phase after transcatheter or surgical aortic valve replacement. *Eur J Cardiovasc Nurs* 2016;**15**:168-177. doi:10.1177/1474515115620992.
51. Hibbard JH, Mahoney ER, Stockard J, *et al*. Development and testing of a short form of the patient activation measure. *Health Serv Res* 2005;**40**:1918-1930. doi:10.1111/j.1475-6773.2005.00438.x.
52. Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996;**34**:220-233.
53. Brostrom A, Hubbert L, Jakobsson P, *et al*. Effects of long-term nocturnal oxygen treatment in patients with severe heart failure. *J Cardiovasc Nurs* 2005;**20**:385-396.
54. Ensrud KE, Ewing SK, Taylor BC, *et al*. Frailty and risk of falls, fracture, and mortality in older women: the study of osteoporotic fractures. *J Gerontol A Biol Sci Med Sci* 2007;**62**:744-751.
55. Bjelland I, Dahl A, Haug T, *et al*. The validity of the Hospital Anxiety and Depression Scale: An updated literature review. *J Psychosom Res* 2002;**52**:69-77.
56. Thompson DR, Jenkinson C, Roebuck A, *et al*. Development and validation of a short measure of health status for individuals with acute myocardial infarction: the myocardial infarction dimensional assessment scale (MIDAS). *Qual Life Res* 2002;**11**:535-543.
57. Skudal KE, Garratt AM, Eriksson B, *et al*. The Nordic Patient Experiences Questionnaire (NORPEQ): cross-national comparison of data quality, internal consistency and validity in four Nordic countries. *BMJ Open* 2012;**2**:e000864. doi:10.1136/bmjopen-2012-000864.
58. Chan PS, Jones PG, Arnold SA, *et al*. Development and validation of a short version of the Seattle angina questionnaire. *Circ Cardiovasc Qual Outcomes* 2014;**7**:640-647. doi:10.1161/CIRCOUTCOMES.114.000967.
59. Hanestad BR, Rustoen T, Knudsen O Jr, *et al*. Psychometric properties of the WHOQOL-BREF questionnaire for the Norwegian general population. *J Nurs Meas* 2004;**12**:147-159.
60. Weintraub WS, Spertus JA, Kolm P, *et al*. Effect of PCI on Quality of Life in Patients with Stable Coronary Disease. *N Engl J Med* 2008;**359**:677-687. doi:10.1056/NEJMoa072771.

Table 1. Description of centres participating in CONCARD[PCI]

	Centre 1 (HUS)	**Centre 2 (SUS)**	**Centre 3 (RH^{Osl})**	**Centre 4 (HGH)**	**Centre 5 (ZUH)**	**Centre 6 (RH^{Cph})****	**Centre 7 (OUH)**
Total hospital beds	1400	482	697	949	629	1377	1064
PCI procedures per year*	1565	905	2124	1290	921	2243	2633
Catchment area of number of local hospitals	7	1	9	4	5	5	6

Centre 1 is the Sponsor Coordinating Centre.
*Figures from 2017.
** RH^{Cph} has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region.
Abbreviations: HGH: Herlev and Gentofte University Hospital, Copenhagen, Denmark; HUS: Haukeland University Hospital, Bergen, Norway; OUH: Odense University Hospital, Odense, Denmark; RH^{Cph}: Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; RH^{Osl}: Oslo University Hospital, Rikshospitalet, Oslo, Norway; SUS: Stavanger University Hospital, Stavanger, Norway; ZUH: Zealand University Hospital, Roskilde, Denmark. PCI; percutaneous coronary intervention.

Table 2. Eligibility criteria for CONCARD^{PCI}

Inclusion criteria	• Patients undergoing percutaneous coronary intervention (PCI) • ≥ 18 years of age • Living at home at the time of index hospitalization and inclusion • Informed consent
Exclusion criteria	• Patients who do not speak Norwegian/Danish • Patients who are unable to fill in the questionnaires due to reduced capacities • Patients who are institutionalized • Patients with expected lifetime less than one year • Patients undergoing PCI without stent implementation, or related to Transcatheter Aortic Valve Implantation (TAVI) or MitraClip examination • Previous enrolment in CONCARD^{PCI} (readmissions)

Table 3. Socio-demographic, clinical and patient-reported measures, and timing of assessments in the CONCARD^{PCI} prospective cohort study

Measure	Details	Self-report	Hospital medical records	National Registry	Time*
Socio-demographic data	Marital status, cohabitation status, education, work status, immigration status, income, rehabilitation participation, available support system, readmission to hospital, time of first meeting with general practitioner.	X		X	T0-T3
Clinical characteristics	Clinical status at admission (blood pressure, heart rate, laboratory results (hemoglobin, creatinine, troponin, total-, high/low density lipoproteins), body weight, height, waist circumference, medical history including comorbidity and frailty, and previous hospital admissions, procedural and angiographic findings including completeness of revascularization, complications during hospital stay, additional procedures, length of hospital stay, death.	X	X	X	T0
Medication	Medication at discharge (type and dosage), consumption of prescribed medication during follow-up, side effects from medication, polypharmacy, discontinuation, serum levels of cardiac medications (quantified using liquid chromatography with mass spectrometry).	X	X	X	T0-T3
Lifestyle	Physical activity (frequency, duration, intensity [45]) sexual activity, tobacco use (current, previous, never), alcohol consumption (frequency, units per week), diet (frequency and amount of intake of different foods, beverages, supplements).	X			T0-T3
Healthcare utilization	Patients' use of the healthcare system (community vs. hospital-based services, specialist vs. general provider, urban vs. rural setting).	X		X	T1-T3
Internet use	Patients' use of electronic equipment with internet access, use of internet to find health information, and use of the web-portal helsenorge.no	X			T0- T3
Major life events	Comprises three items assessing major life events.	X			T1-T3
Beliefs about Medicines Questionnaire (BMQ)[44]	Comprises 11 items (the BMQ-Specific) and assesses the key psychological constructs that underpin the core beliefs influencing adherence to medicines.	X			T1-T3
eHealth Literacy scale (eHEALS)[22]	Comprises 10 items and assesses patients' combined knowledge, comfort, and perceived skills at finding, evaluating, and applying electronic health information to health problems.	X			T0, T3
EQ-5D-5L scale[45]	Comprises 5 items and is widely used for measuring economic preferences for health states.	X			T0-T3
Health literacy questionnaire (HLQ)[46]	Comprises 20 items measuring four levels of health literacy: Appraisal of health information (5 items); social support for health (5 items); Ability to find good information (5 items); and Understanding health information (5 items).	X			T0,T3
Heart Continuity of Care Questionnaire (HCCQ)[23]	Comprises 33 items covering eight topic areas: heart condition explained, communication among providers, preparation for discharge, post-hospital review of treatment, receipt of conflicting information, information on medications and on physical and dietary needs.	X			T1
HeartQol[47]	Comprises 14 items with 10-item physical and 4-item emotional subscales.	X			T3
Medication Adherence Report	Comprises 5 items and measures self-reported adherence to medicines, and assesses both intentional	X			T1-T3

Scale (MARS-5)[48]	and unintentional non-adherence.				
Minimal Insomnia Symptom Scale (MISS)[49, 50, 59]	Comprises 3 items assessing major features of insomnia, i.e. difficulties initiating sleep, waking at night and not feeling refreshed by sleep.	X			T0-T3
Patient Activation Measure (PAM)[51]	Comprises 13 items assessing patient knowledge, skill and confidence for self-management.	X			T2
RAND-12[52]	Comprises 12 items with 3 to 5 response levels. It generates two health indices: mental and physical health.	X			T0-T3
Sleep Sufficient Index (SSI)[50, 53]	Comprises 2 items assessing amount of actual and desired sleep	X			T0-T3
Study of Osteoporotic Fractures (SOF index)[54]	Comprises 3 items and assess weight loss, inability to rise from a chair five times without using the arms and self-reported poor energy.	X			T0, T3
The Hospital Anxiety and Depression Scale (HADS)[55]	Comprises 14 items and determine the levels of anxiety and depression that a patient is experiencing, and generates 2 sub-scales; HADS-D and HADS-A.	X			T0-T3
The Myocardial Infarction Dimensional Assessment Scale (MIDAS)[56]	Comprises 35 items specifically measuring seven different domains of health status and daily life challenges in individuals who have suffered a myocardial infarction: physical activity (12 items), insecurity (9 items), emotional reaction (4 items), dependency (3 items), diet (3 items), concerns over medication (2 items) and side effects (2 items).	X			T1-T3
The Nordic Patient Experiences Questionnaire (NORPEQ)[57]	Comprises 8 items and gives a brief measure of patient experiences in evaluation of the quality of healthcare delivery.	X			T1
The Seattle Angina Questionnaire (SAQ-7)[58]	Comprises 7 dimensions of coronary artery disease: physical limitation, angina frequency and quality of life.	X			T0-T3
WHOQOL-BREF[59]	Comprises one global item on overall quality of life.	X			T0-T3

* T0: Baseline, T1: 2-month follow-up, T2: 6-month follow-up, T3: 12-month follow-up

Table 4. Definition of outcomes in CONCARD[PCI]

Outcome	Definition
Continuity of care	As measured by the Heart Continuity of Care Questionnaire (HCCQ).[23]
Health literacy and eHealth literacy	As measured by the Health Literacy Questionnaire (HLQ)[46] and eHealth Literacy Questionnaire (eHEALS).[22]
Adherence to medication	As measured by the Medication Adherence Report Scale (MARS-5)[48], Beliefs about Medicines Questionnaire (BMQ)[44] and data related to consumption of prescribed medication identified through national prescription registries, and serum levels of cardiac medication.
Healthcare utilization	As measured by patients' use of primary care services (general practitioner visits) and secondary care services (inpatient admissions and outpatient visits).
Healthcare (associated) costs	As measured by the tariffs of national agreements between the professional associations of medical specialists and the National Health Services, and the tariffs of the national case-mix system of the diagnosis-related groupings (DRG) and the ambulatory grouping system (DAGS).
Time to readmission	Cardiac and all cause readmissions.
Time to death	Cardiac and all-cause mortality.
Time to major adverse cardiac events (MACE)	A composite of cardiac mortality and hospitalization for cardiovascular disease or chest pain.

FIGURE LEGENDS

Figure 1: Projects in CONCARD^{PCI} researching bottle necks for good and efficient patient pathways across levels of health care

Figure 2: Measuring time points and data collection in the cohort study in CONCARD^{PCI}

Figure 3. Study sites in cohort study in CONCARD^{PCI}

H= PCI centres including the local hospitals in their catchment area.
Copenhagen University Hospital, RH has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region.

ADDITIONAL FILES

Additional file: Scientific environment, collaboration and organisation of the project.

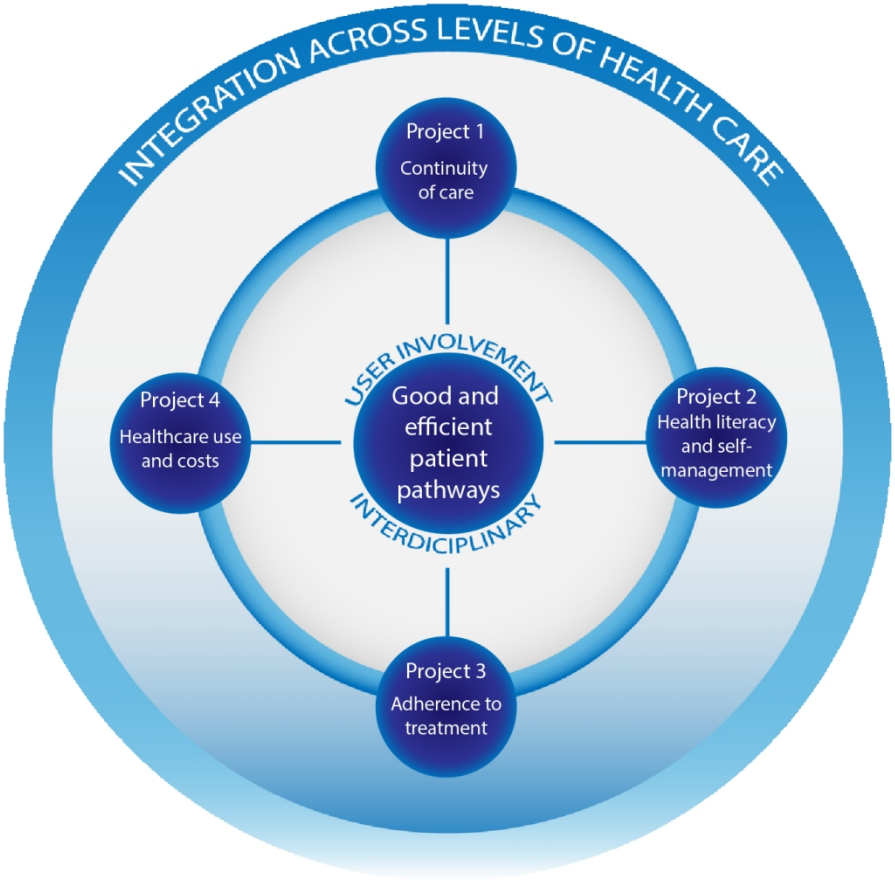

Figure 1: Projects in CONCARDPCI researching bottle necks for good and efficient patient pathways across levels of health care

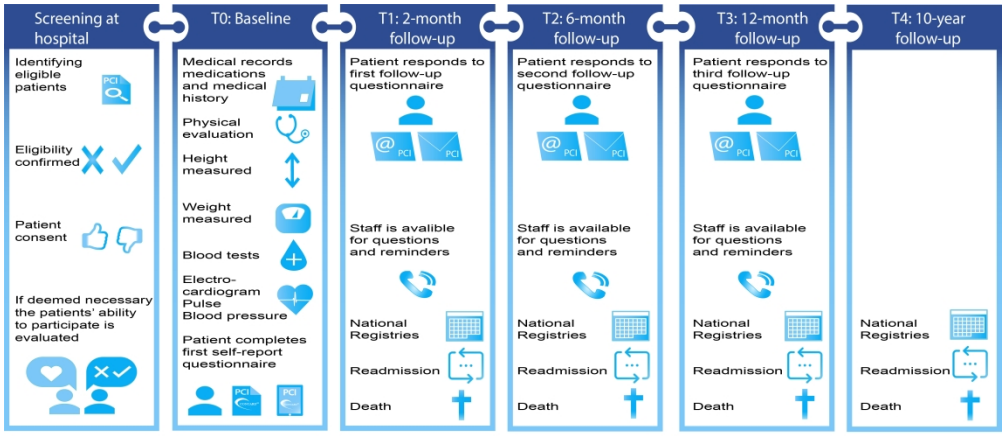

Figure 2: Measuring time points and data collection in the cohort study in CONCARDPCI

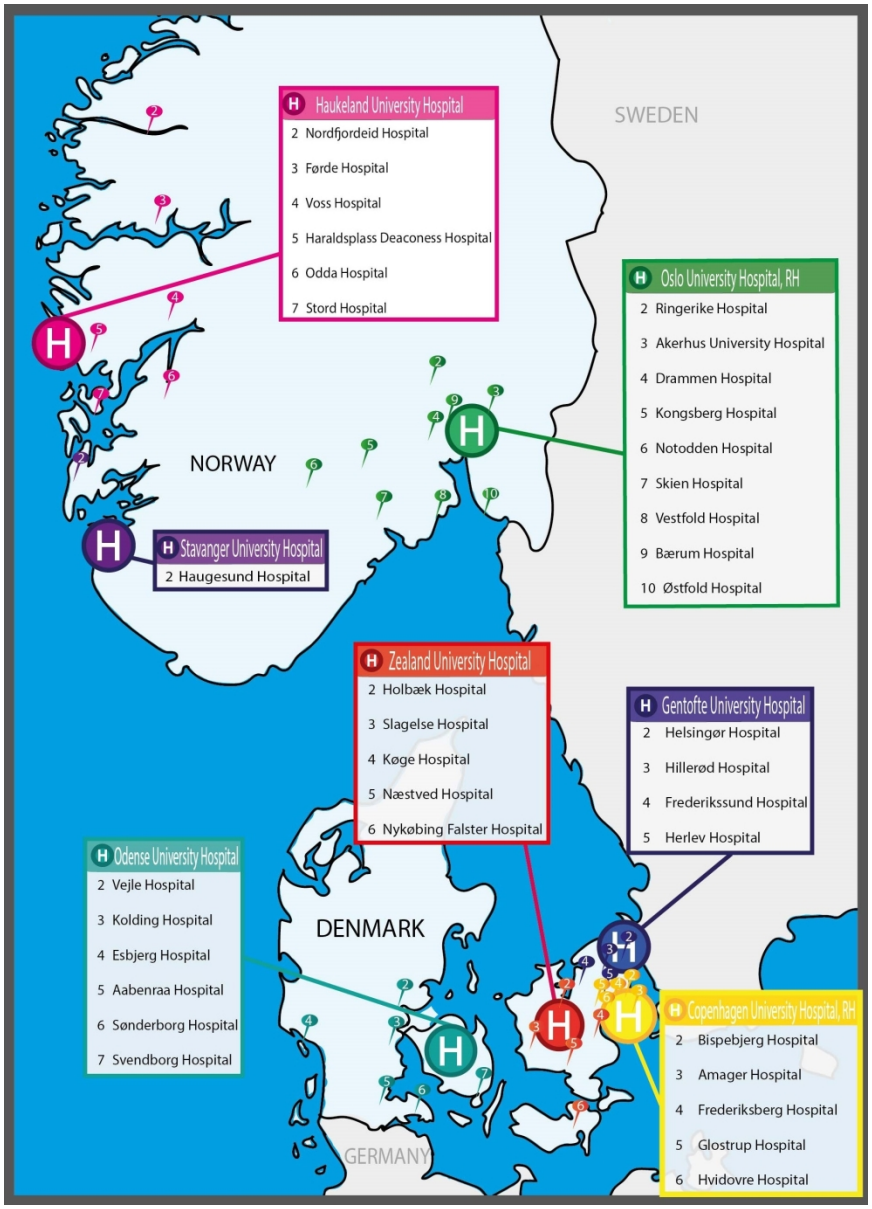

Figure 3. Study sites in cohort study in CONCARDPCI
H= PCI centres including the local hospitals in their catchment area.
Copenhagen University Hospital, RH has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region

495x686mm (96 x 96 DPI)

APPENDIX

SCIENTIFIC ENVIRONMENT, COLLABORATION AND ORGANISATION OF CONCARD[PCI]

We have built a research team with a broad interdisciplinary profile involving local, regional, national and international collaborators. Collaborators range from emerging leaders as thematic project leaders to world-renowned senior scientists in the Scientific Advisory Board. Each member is a specialist in her/his field providing expert knowledge into the research project. An Expert Group who will be pivotal in translating evidence into healthcare has been established including representatives from Learning and Mastery Networks, Healthy Life Centres, health trusts, cardiac rehabilitation services, and patient organisations. Two patient representatives identified through the Norwegian Heart and Lung Patient Organisation are providing input to the planning, implementing and reporting of results from the programme. As these groups join forces, we will be especially well suited to undertake this large-scale registry-based multimethod multicentre study on patient pathways after percutaneous coronary intervention.

Table I. The Scientific Advisory Board of CONCARD[PCI]

Scientific Advisory Board	Institution	Expertise
Heather Allore, PhD, Professor of Medicine (Geriatrics) and of Public Health (Biostatistics), and Director of the Yale Program on Aging Biostatistics Core	Yale University, USA	Design and analysis of studies of multi-component interventions and observational studies of multifactorial health conditions.
Christi Deaton, PhD, RN, FAHA, FESC, Florence Nightingale Foundation Professor of Clinical Nursing Research	University of Cambridge, UK	Wide clinical and research experience in acute cardiovascular patient care. Contributed to clinical practice guidelines development (European level). Participated in the COURAGE Trial.[60]
Heather Hadjistavropoulos, PhD, Professor of Psychology	University of Regina, CA	Quality of healthcare across the continuum of care including integrated care pathways. Developed the HCCQ.[23]
Ann Dorthe Zwisler, MD, PhD, Professor of Medicine	University of Odense, DK	Experience in programs of health and morbidity, rehabilitation and palliative programs.
Rikke Søgaard, MSc, MPH, PhD, Professor of Health economics	Aarhus University, DK	Econometric modelling for policy evaluation, and preference elicitation, and use of standardised measures for costs and outcomes measurement.

Table II. The Expert Group of regional, national and international collaborators of CONCARD[PCI]

Collaborators	Institution	Expertise
Torbjørg Aasen, Patient representative	The Norwegian Heart and Lung Patient Organisation	Experience from peer support.
Bjørn Bendz, MD, PhD. Associate professor, Head ICCU, interventional cardiologist	Oslo University Hospital, and University of Oslo	Experienced interventional cardiologist with his latest research on the oldest old and PCI.[15]
Cathrine Bjorvatn, RN, MSc, PhD, Associate professor, Head Learning and Mastery Services at Bergen Health Trust	Haukeland University Hospital, and University of Bergen	Chair of Network on Learning and Mastery including all three levels of healthcare; 24 municipalities as well as Haraldsplass Deaconess Hospital, and Haukeland University Hospital.
Ellen Blom, PTH, PhD-candidate	Western Norway University of Applied Sciences, Campus Sogndal	Physiotherapist with extensive research experience from Healthy Life Centres.
Gunhild Brørs, RN, MSc, PhD-candidate	St. Olav University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing.
Anne K Drange, BSc, Radiographer	Askøy Municipality	Head, Health and Care Services, Askøy Municipality. Project on multidisciplinary team follow-up of patients with severe heart disease in primary care.
Bengt Fridlund, RNT, PhD, Senior Professor	Centre of Interprofessional Collaboration within Emergency care (CISE), Linnaeus University, SE	Long experience in cardiac research, supervised >50 PhD candidates, published 400 papers. PhD in one of the earliest research studies on cardiac rehabilitation.
Stig Igland, RN, MA, Chair of Network on Learning and Mastery Services at Førde Hospital Trust	Førde Hospital Trust	Extensive leadership and project experience from interdisciplinary rehabilitation and Learning and Mastery services across administrative levels.
Alf Inge Larsen, MD, PhD. Professor and interventional cardiologist.	Stavanger University Hospital and University of Bergen	Extensive experience in interventional cardiology and research leadership.
Jan Erik Nordrehaug, MD, PhD. Professor and interventional cardiologist	Stavanger University Hospital and University of Bergen	Built PCI network and logistics in Western Norway, >200 papers & extensive supervision.
Trond Røed Pettersen, RN, MSc, PhD-candidate	Haukeland University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing.
Svein Rotevatn, MD, PhD. Chair of NORIC, and interventional cardiologist	Haukeland University Hospital	Experienced interventional cardiologist and responsible for register data in CONCARD. Will be taking the lead together with Norekvål.
Maj-Britt Råholm, RN, MNSc, PhD, Professor	Western Norway University of Applied Sciences, Campus Førde	Clinical nurse leader and researcher, experienced in both qualitative and quantitative research methods.
Jan Schjøtt, MD, PhD, Professor, and senior consultant in clinical pharmacology	Haukeland University Hospital and University of Bergen	Experience in clinical pharmacology, drug information to health care professionals and patients, and pharmacovigilance.
Marit Solheim, RN, MA, Director Center of Health Research, Førde	Førde Hospital Trust, Western Norway University of Applied Sciences, Campus Førde	Experienced in interdisciplinary collaboration across institutions, and research across primary and secondary care levels.
Rune Stiansen, Patient representative	The Norwegian Heart and Lung Patient Organisation	Experience from peer support and cardiac rehabilitation.
David Thompson, RN, PhD, Professor and Director	Queens University, Belfast, UK	Expert in developing disease-specific PRO measures[56], and novel psychosocial interventions.
Irene Valaker, RN, MA, PhD-candidate	Western Norway University of Applied Sciences, Campus Førde	Cardiovascular clinical nurse specialist with MA in organizational models in cardiac care.
Trine Vingsnes, MD, Cardiologist and Head of Department of Medicine	Førde Hospital Trust	Extensive experience in implementation of new clinical pathways between hospitals and primary care.
Tore Wentzel-Larsen, MSc, Biostatistician	Haukeland University Hospital, and Eastern Southern Health Trust	Statistical advisor in close to 200 scientific papers.

Table III. Project administration for the cohort study in CONCARD^{PCI}

Project administration	Institution	Role
Tone M Norekvål, RN, MSc, PhD, Chair PROCARD, Professor	Haukeland University Hospital, Western Norway University of Applied Sciences and University of Bergen, NO	Principal Investigator CONCARD^{PCI}
Nina Fålun, RN, MSc	Haukeland University Hospital, and Western Norway University of Applied Sciences, NO	Main project coordinator CONCARD^{PCI} Project coordinator Norway Centre coordinator Haukeland University Hospital
Tina Birgitte Hansen, RN, MSc, PhD, Post doc	Zealand University Hospital, Roskilde, and University of Southern Denmark, DK	Project coordinator Denmark Local PI and Centre coordinator Zealand University Hospital Leader Project 4
Irene Valaker, RN, MA, PhD-candidate	Western Norway University of Applied Sciences, Campus Førde, NO	Leader Project 1
Gunhild Brørs, RN, MSc, PhD-candidate	St. Olav University Hospital, NO	Leader Project 2
Trond Røed Pettersen, RN, MSc, PhD-candidate	Haukeland University Hospital, NO	Leader Project 3
Svein Rotevatn, MD, PhD, Chair NORIC, interventional cardiologist	Haukeland University Hospital, NO	Co-Investigator CONCARD^{PCI} NORIC data
Kristin Rykkje, RN **Kristin J Ramstad,** RN, MSc-student **Irene Instenes**, RN, MSc **Tom Jakobsen**, RN, **Marie TN Hayes**, BA, MA	Haukeland University Hospital, NO	Study nurses Haukeland University Hospital Data management, Haukeland University Hospital
Alf Inge Larsen, MD, PhD. Professor, interventional cardiologist.	Stavanger University Hospital and University of Bergen, NO	Local PI, Stavanger University Hospital.
Mari Espedal, RN, ICN **Peggy Elin Bjørheim**, RN **Ulrika Eva Kulling Johnsson**, RN	Stavanger University Hospital, NO	Study nurses Stavanger University Hospital
Bjørn Bendz, MD, PhD. Assoc. professor, interventional cardiologist, Head ICCU.	Oslo University Hospital, and University of Oslo, NO	Local PI, Oslo University Hospital, Rikshospitalet
Rønnaug Dahlviken, RN, MSc **Tuva Grønsund**, RN **Liv Marit Torbjørnsen**, RN **Maren Leifson**, RN	Oslo University Hospital, NO	Study nurses Oslo University Hospital, Rikshospitalet
Trine Bernholdt Rasmussen, RN, MSc, PhD, Post-doc	Herlev and Gentofte University Hospital, DK	Local PI, Herlev and Gentofte University Hospital
Sofie-Amalie Kristensen, RN-student **Margrethe Herning,** CNS **Anne Kirstine Vinther,** RN **Kristina Brejnholt Jacobsen,** RN	Herlev and Gentofte University Hospital, DK	Study nurses Herlev and Gentofte University Hospital
Pernille Palm, RN, MSc, PhD	Copenhagen University Hospital, Rigshospitalet, DK	Local PI, Copenhagen University Hospital, Rigshospitalet
Signe West Christensen, MSc **Hanne Møller Kongshavn,** RN	Copenhagen University Hospital, Rigshospitalet, DK	Study nurses Copenhagen University Hospital, Rigshospitalet
Kirsten Charlotte Helmark, RN, MSc Trine Schier Morsing, RN Ulla Werner Hansen, RN Mette Busk Hansen, RN Helle Back Schønemann, RN	Zealand University Hospital, Roskilde, DK	Study nurses Zealand University Hospital, Roskilde
Carsten Toftager Larsen, MD, PhD, Head of the cardiac invasive laboratory	Zealand University Hospital, Roskilde, DK	Registry data
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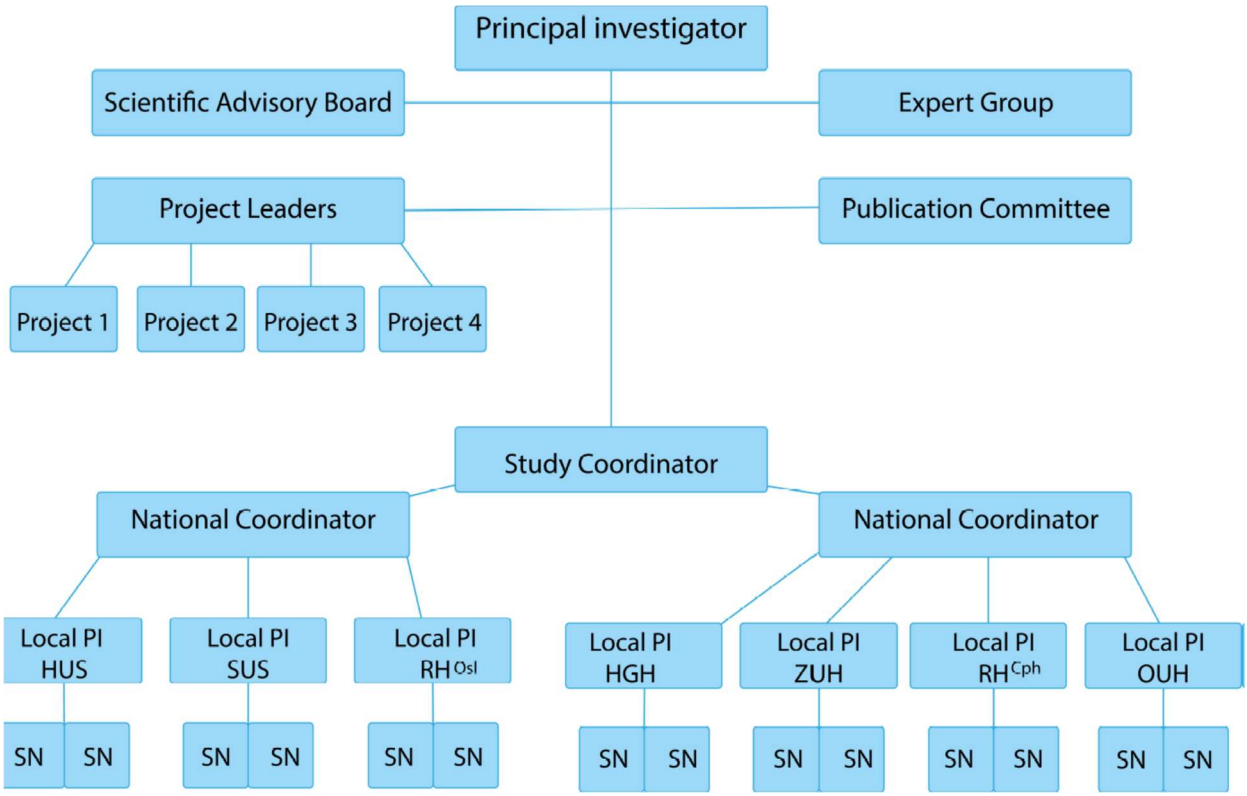

Figure I. Project organisation of the CONCARD^{PCI} cohort study

Abbreviations: HGH: Herlev and Gentofte University Hospital, Copenhagen, Denmark; HUS: Haukeland University Hospital, Bergen, Norway; OUH: Odense University Hospital, Odense, Denmark; RH^{Cph}: Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; RH^{Osl}: Oslo University Hospital, Rikshospitalet, Oslo, Norway; SUS: Stavanger University Hospital, Stavanger, Norway; ZUH: Zealand University Hospital, Roskilde, Denmark.

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Rethinking rehabilitation after percutaneous coronary intervention – a protocol of a multicentre cohort study on continuity of care, health literacy, adherence and costs at all care levels (the CONCARD^{PCI})

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ABSTRACT

Introduction: Percutaneous coronary intervention (PCI) aims to provide instant relief of symptoms, improve functional capacity and prognosis in patients with coronary artery disease. Although patients may experience a quick recovery, continuity of care from hospital to home can be challenging. Within a short time span, patients must adjust their lifestyle, incorporate medication and acquire new support. Thus, CONCARD^{PCI} will identify bottlenecks in the patient journey from a patient perspective to lay the groundwork for integrated, coherent pathways with innovative modes of healthcare delivery. The main objective of the CONCARD^{PCI} is to investigate i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment, and iv) healthcare utilization and costs, and to determine associations with future short- and long-term health outcomes in patients after PCI.

Methods and analysis: This prospective multicentre cohort study organised in four thematic projects plans to include 3000 patients. All patients undergoing PCI at seven large PCI centres based in two Nordic countries are prospectively screened for eligibility and included in a cohort with a 1-year follow-up period including data collection of patient-reported outcomes (PROs) and a further 10-year follow-up for adverse events. In addition to PROs, data are collected from patient medical records and national compulsory registries.

Ethics and dissemination: Approval has been granted by the Norwegian Regional Committee for Ethics in Medical Research in Western Norway (REK 2015/57), and the Data Protection Agency in the Zealand region (REG-145-2017). Findings will be disseminated widely through peer-reviewed publications and to patients through patient organisations.

Registration: Clinicaltrials.gov identifier: NCT03810612.

Strengths and limitations of this study

- The CONCARD[PCI] is an interdisciplinary, multicentre effort with the unique combination of data from hospital medical records, patient self-report, and national registries providing opportunities to identify novel pathways for continuity of care that contribute to outcomes.
- Although the linkage to national registers will ensure complete follow-up of the study population, potential challenges include response rate of patient self-report at follow-up.
- Non-participants will be compared to participants on a limited number of registry variables to account for potential selection bias.

INTRODUCTION

The widespread commitment to involve patients in planning and service development has become a key element of current healthcare policy. Health literacy, as the ability to access, process and comprehend health information and services is thereby pivotal. The American Heart Association (AHA) recently published a scientific statement[1] addressing health literacy in cardiovascular disease as of fundamental relevance to primary and secondary prevention. European leaders in secondary prevention have called for action in the post-acute aftercare of patients with coronary artery disease (CAD).[2] Although CAD is the single most common cause of death in Europe as around 20% of the population die from the disease, there has been an encouraging decrease in mortality ascribed to improvements in risk-factor management, pharmacological treatment, and revascularization techniques; coronary artery bypass grafting and percutaneous coronary intervention (PCI).[3] Therefore, more people need to manage life with CAD as a chronic disease. Modern developments in primary healthcare provision have also led to increased interest in continuity of care as an essential element.[4-6] Patients' transition from hospital to home is particularly challenging because patients need to adjust their lifestyle, incorporate new medications, and acquire additional sources of support.[7] Although there is compelling evidence for secondary prevention following CAD, a large majority fail to achieve life style changes and therapeutic targets set by the ESC guidelines.[8] Therefore, adherence to treatment is also of concern. Non-adherence to medications is common for patients with cardiovascular diseases.[9] Taking prescribed antiplatelet and other secondary preventive medication after PCI is pivotal; however, it is unknown if non-adherence also applies for patients following PCI.

This paper describes a multicentre cohort study, the CONCARD^{PCI}, that seeks to identify bottlenecks and hurdles in the patient journey and suggest the optimal timing of services and alignment with patient preferences for patients with CAD undergoing PCI. Of

special interest are challenges with continuity of care, health literacy and self-management, adherence to treatment advice, costs at all care levels, and associations with future short- and long-term health outcomes.

Uptake to cardiac rehabilitation (CR) is suboptimal[8, 10, 11], even though participation is associated with a markedly reduced risk of readmission, death, psychological distress, as well as improved self-management, health-related quality of life, and physical capacity.[12, 13] However, Denmark has had relatively high uptake of CR.[14] Few sufficiently powered real world studies have been undertaken with the explicit purpose of investigating continuity of care and pathways of CR in patients after PCI, although it concerns a large group of patients.

In addition to investigating factors associated with low referral, participation, health literacy and adherence rates among CR participants, studies are increasingly needed on evaluating alternative modes of providing CR. Follow-up of healthcare use, costs and predictors of costs following PCI in a non-clinical trial setting have been infrequently investigated.[15, 16] Thus, a large cohort of real world observations that can ascertain interventions for future clinical trials is needed.[17] The CONCARD^{PCI} responds to this challenge. In CONCARD^{PCI}, we hypothesise that continuity of care, eHealth literacy and self-management, and adherence to treatment in patients are directly associated to outcomes after PCI.

AIM OF THE RESEARCH PROGRAMME

The overall aim of CONCARD^{PCI} is to investigate i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment, and iv) healthcare utilization and costs, to determine associations with future short- and long-term health outcomes in patients after PCI. The study is organized into four thematic projects (Figure 1).

METHODS

Study design and setting

CONCARD[PCI] is a large-scale multicentre cohort study with serial prospective survey data collection, clinical data and register-based follow-up. We collect data from hospital medical records, patient self-report surveys, and national registries (Figure 2). Preliminary work has been performed including in-depth interviews on patients' experiences of healthcare delivery to provide a context for the quantitative data and inform the content of the cohort survey questionnaires. Three follow-up surveys over one year are undertaken, and a 10-year follow-up for adverse events.

Seven large referral PCI centres in Norway and Denmark were selected based on the following considerations: presence of a committed research team including CONCARD[PCI] study nurses and a local principal investigator, prior research experience including research infrastructure, geographic location and size. The PCI centres perform from 900 to >2000 (mean 1668) PCI procedures annually, having 629 to 1400 beds (mean 943), and are referral centres for coronary angiography and PCI for a total of 37 local hospitals (Figure 3, Table 1). Haukeland University Hospital is the Sponsor Centre of this investigator initiated research programme. For study organisation, see online Appendix.

Study population

All patients undergoing PCI at seven large PCI centres are prospectively screened for eligibility. Screening is performed in the hospital setting by the site coordinator and trained CONCARD[PCI] study nurses. Daily admissions records and the operating programme are reviewed to identify potentially eligible patients. Electronic medical records are reviewed to confirm eligibility according to the inclusion and exclusion criteria (Table 2). When cognitive impairment is suspected by clinical or study personnel and there is no medical record of the problem, the Confusion Assessment Method[18] and 4AT[19] are used to investigate whether the

patient must be excluded. Patients who are delirious or too clinically unstable to participate following PCI, who would otherwise be eligible, are re-assessed until discharge. During the in-hospital assessment, participants provide informed consent. Because many of the questionnaires are designed for patient self-assessment, patients who need a complete proxy are ineligible. If participants need assistance in filling out the questionnaires, this is registered in the case report form (CRF). Regarding sample size and study power see *Data analysis and sample size determination.*

Measurement and data collection

In CONCARD^{PCI} a broad range of outcomes are measured and data are collected by physical assessment at baseline, review of the medical records, patient self-reported questionnaires (at baseline, 2, 6 and 12 months), and from national registries (Table 3 and Figure 2). A comprehensive data dictionary and CRF are provided to ensure standardization of abstracted data. For the Danish centres, eCRFs are used. Patients included in the study undergo a brief physical assessment and complete the self-report questionnaires at baseline after PCI (T0) (Table 3 and Figure 2). A follow-up with postal or electronic questionnaires are distributed to all patients included in the study, 2 months after discharge (T1). The time interval ensures time for follow-up care to evaluate early post-discharge continuity of care. A consecutive sub-group of patients (n=100) at the Sponsor Coordinating Center are approached for a re-test of the eHealth Literacy Scale (eHEALS)[20] and the Heart Continuity of Care Questionnaire (HCCQ)[21] as part of the validation process of the instruments. All patients are followed-up with postal or electronic questionnaires at 2 (T1), 6 (T2) and 12 (T3) months post-discharge. Non-responders receive one reminder. Vital status is identified to avoid sending questionnaires to deceased patients or their family. Patient adverse events are followed through national registers for 10 years or until death (T4) (Figure 2). Questionnaire packages

are discussed with patient representatives and piloted at every measuring time point (T0-T3) before employed in the largescale cohort study.

To objectively assess adherence to therapy, serum levels of a wide panel of cardiac medications are measured. A consecutive subsample of 700 Norwegian patients from two centres will be invited to give a blood sample one year after the index procedure. The time is chosen as it corresponds to collection of patient-reported data on adherence. Moreover, adherence tends to diminish over time [22]; hence, the 1-year contact was chosen. Serum levels are submitted to an accredited clinical pharmacology laboratory, and quantified using liquid chromatography with mass spectrometry. Patients are labelled as non-adherent when serum level of at least one of the evaluated drugs is below the limit of quantification.

Management of cohort and registry data

For the *Norwegian centres*, baseline (T0) data are transferred to the National Coordinating Centre for data entry and/or review. The forms are reviewed and queries sent to the centre for missing or incomplete items. All follow-up data are collected by postal mail and managed at the National Coordinating Centre. The paper version data are entered into electronic files by trained staff.

For *the Danish centres*, each centre registers patients who are screened, and either included or excluded in separate Microsoft Excel (version 2016) spreadsheets in a shared secure team site server hosted by the National Coordinating Centre. Data from medical records are entered into a shared SurveyXact (version 12.9) database at each study site and managed by the National Coordinating Center. Patient self-report at both baseline (T0) and follow-up are collected either electronically using a tablet via a SurveyXact-link or by paper as requested by the patient. Paper version data are entered into the SurveyXact database by trained CONCARD^{PCI} study nurses. All follow-up data are collected and managed by the National Coordinating Centre.

Every resident in Norway and Denmark has a unique personal identifier that allows datasets from national registries to be merged on an individual level. The datasets will be released in a coded and de-identified form, but with a unique identifier common to the datasets making individual merging possible. The Heart registries, Prescription registries[23, 24], Cause of death registries[25, 26], and administrative registries on social security microdata and health care utilization[27, 28] are mandatory, and legally exempted from requirement of obtaining patient consent. Strict rules on how data can be used or linked are followed to secure privacy protection. Although these data are similar in composition, we are interested in contrasting and comparing Denmark with its high CR uptake to Norway with a lower uptake.

Data analysis and sample size determination

Descriptive statistics of the cohort by nation will be generated using proportions, means and standard deviations or medians and interquartile ranges as appropriate. Cross-sectional analysis will be used for continuity of care (Table 4) using multiple linear regression testing for a random effect for nation. For health literacy, there is a single follow-up and multiple linear regression testing for a random nation effect will be used. The cohort's longitudinal observations over one year will be modelled using generalized linear mixed models (GLMM) that account for within person correlation for adherence to medications, healthcare utilization and cost (Table 4). We will test whether patients clustered within nation is significant. If so, we will include it as a hierarchy in the GLMMs. For time to readmission, and time to major adverse cardiac event, we will use competing risk models to account for censoring by death. We will construct risk stratification models that predict the probability of each outcome for specific combinations of risk factors. We will establish internal validity by using bootstrapping techniques. We will test whether missing data is at random. If not, we will estimate the probability of missingness and include it as a weight or covariate factor in the models. For psychometric evaluation of translated instruments we evaluate the **s**tructural,

discriminant and convergent validity, and reliability of the scales. For internal consistency, Cronbach's alpha is used. Test-retest reliability is evaluated by using intraclass correlation (ICC) coefficients of patients' results obtained at a 2-week retest interval. Confirmatory factor analysis (CFA) is used for evaluating the factor structure of the original eHEALS[20] and HCCQ[21] instruments.

Power calculations for the cohort study are based on time-to-first event outcomes, as these require the most patients. To maintain at family-wise Type I error of 0.05 and 80% power using the method of Hsieh et al[29] for adjusted Cox regression models 2550 patients are needed. To adjust for losses to follow-up, we increased this estimate by 18% for a total of 3000 patients. Thus, all outcomes will have ≥80% power with alpha ≤ 0.05.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The ethical guidelines of the World Medical Association, Declaration of Helsinki and the legislation in Norway and Denmark guide the study (Declaration of Helsinki, 2008). At inclusion, a detailed letter informing the potential participant of the study, and the right to withdraw from the study at any time without any reason is underlined. The identifying key is kept in a separate file from the data. The data are kept in strict confidence in locked files at research servers to protect the participants' privacy. Approval by the Norwegian Regional Committee for Ethics in Medical Research in Western Norway has been granted (REK 2015/57), and from the Data Protection Agency in the Zealand region for the Danish centres (REG-145-2017). Written agreements between the Sponsor Coordinating Centre, and the local principal investigators and directors of the departments in each participating study centre, are signed before initiation of data collection. The study is registered at clinicaltrials.gov (NCT03810612).

PATIENT AND USER INVOLVEMENT

CONCARD[PCI] involves patients and stakeholders to target aspects of the patient journey to identify bottle-necks and carve out a user-friendly intervention. Patient involvement is carried out in several ways: Two patient representatives with a history of CAD, and trained to be patient representatives both in healthcare and research settings[30], provide input to the planning, implementing and reporting of results from the study. Representatives from all healthcare levels will be end users of knowledge from the project and are actively involved in the project through the CONCARD[PCI] Expert Group (Appendix). Reporting of patient involvement will follow the GRIPP 2 reporting checklists.[31]

COMMUNICATION OF RESULTS AND TRANSITION OF KNOWLEDGE

The CONCARD[PCI] has a close to practice and clinical approach, which will be an advantage in dissemination and communication with end users. Results will be disseminated to patients through patient organisations, and to healthcare professionals in PCI treatments teams and CR teams, as well as in primary care through seminars and scientific meetings. Due to the comprehensiveness of the outcome measures in the thematic projects (Table 4), numerous scientific papers are expected. Long-term follow-up will be reported as data becomes accessible. Authorship on publications from the study will be allocated using the guidelines for authorship defined by the International Committee of Medical Journal Editors and depends on personal involvement.

DISCUSSION

While medicine has produced large advances in cardiac treatment, there is need for more consistent patient pathways and systematic follow-up care. In order to do so, bottlenecks in the patient journey need to be identified. CONCARD[PCI] aims to close knowledge gaps

related to four main areas: i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment and iv) healthcare utilization and costs of care. Although landmark cohort studies have been carried out to describe the aftercare of patients after acute MI, less is described of the patient journey, specifically after PCI, and rarely have these included extensive self-report from patients. In the past decade, an increasing number of studies using patient-reported outcomes have been performed, but in a different setting, with shorter follow-up and targeting subgroups of acute MI patients.[32-36] The US-based SILVER-AMI study focused on older adults[32], the VIRGO study[33] concentrated on younger women after acute MI, TRIUMPH[34] was designed to examine racial differences after acute MI, VICS[35] included both patients after acute MI and patients with heart failure, and NOR-COR[36] retrospectively surveyed patients below 80 years of age 2-38 months after the index event including also patients with coronary artery bypass surgery or no intervention. Age is of particular concern as it is documented that invasive strategies benefits clinically stable very old patients with non-ST-elevation acute coronary syndrome.[37] In contrast, CONCARD^{PCI} has an extended perspective by prospectively including adult patients with no age limit, engaging stakeholders throughout the study, applying a comprehensive interdisciplinary approach, and including data from national registries. One great asset of the participating Nordic countries is infrastructure in research with access to demographics and health information through the national registries. The registries include all citizens, and a personal identifying number ensures no loss to follow up. In addition to national compulsory registries on death (National Death Registry[25, 26]), readmission and use of healthcare services (National Patient Registry[27, 28]), and prescription and medication consumption (National Prescription Registry[23, 24]), the countries have disease specific national medical quality registries (e. g. NORIC). With establishing national registries, opportunities for nationwide comparisons and quality improvement of healthcare service is created.

While the aforementioned studies[32-36] also have detailed data abstracted from medical records and self-report, CONCARD[PCI] has a timely approach in the four thematic projects – one of which concerns health literacy, and specifically eHealth literacy, is of particular relevance in information technology driven societies. The AHA Scientific Statement on health literacy[1] calls for studies examining health literacy and cardiovascular outcomes beyond 30-day readmission. It is suggested that health literacy can be evaluated as part of programs aiming to improve secondary prevention in that health literacy influences drop-out rates in CR. CONCARD[PCI] responds to this challenge.

Lack of continuity of care and low health literacy are likely to carry increased healthcare utilization (e.g. readmission to hospital) and increased cost.[38] The potential need for re-thinking CR based on patient preferences and in-built economic analysis is a relevant path to follow. Moving towards a more patient-centred care aim to maximize patients' self-care abilities. Increased self-care is an overarching goal when healthcare expenditure rises to unaffordable levels. Further, in additional parameters, patient-reported outcomes can potentially identify patients at high risk of adverse outcomes and hospital readmissions[39, 40] which is of importance both to patients and society.

The importance of increased patient involvement and shared decision-making at all levels of healthcare is underlined in policy documents at a governmental and regional level.[41] Patient involvement is a unique feature of CONCARD[PCI] scarcely described in comparable large-scale studies. The use of standardized patient-reported outcome measures may provide information that can assist in this decision-making.[39, 40] In CONCARD[PCI], we include patient-reported outcome measures on a global, generic and disease-specific level, [42] and pose research questions related to patient pathways that concerns a large group of patients. We anticipate that treatment outcome (adherence), safe communication (continuity and health literacy) and self-management will prove important to future healthcare.

However, the study has some limitations. We lack participating hospitals from northern Norway. The remoteness and distance to the PCI centre is a feature of that area and therefore of particular concern. However, travel time to the PCI centre from the most remote fjords in western Norway is also long and this catchment area is included in the study (Figure 3). Further, we exclude patients with delirium and dementia due to ethical reasons regarding informed consent and logistical difficulties. Delirious patients and patients too clinically unstable to be included following the PCI procedure, who would otherwise be eligible, are re-assessed until discharge. Non-participants will be compared to participants on a limited number of registry variables to account for potential selection bias. Extensive self-report is a feature of CONCARD^{PCI}, and we use validated questionnaires and only a few de-novo-created questions based on patient interviews. Still, the response rate of follow-up (T1-T3) may be a potential limitation. However, previous methodological work in patients with CAD showed high acceptability of comprehensive questionnaires[43] and patient representatives participating in planning of CONCARD^{PCI} ensured relevance of the questionnaires.

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AUTHOR CONTRIBUTIONS

TMN is the principal investigator of CONCARD^{PCI} and was responsible for study conception, development of the project outline, and ethical approval. HA, GB, NF, TBH, TRP, IV, and SR contributed to the development of the project outline. HA is chairing the Scientific Advisory Board with CD, HH, RS and ADZ as contributing members. NF is the coordinator of the cohort study in CONCARD^{PCI} with TBH as national coordinator in Denmark, and AIL, BBe, BBo, PP, TBH and TBR are local principal investigators. CB and IS give specific input on

transition of care. GB, TRP, TBH and IV are leaders of thematic projects. JS is a major contributor in design of studies on serum levels of cardiac medications and Project 3 in general. TMN wrote the first draft of the manuscript. All authors revised the manuscript critically, and read and approved the final manuscript. A more detailed description of the roles of all authors are in the online Appendix.

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CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors have no competing interests.

STATUS

Data collection for the cohort study commenced on 12 June 2017 and is expected to continue until July 2020, with a 10-year follow-up until July 2029. The inclusion of patients for the blood sampling for objective medication adherence measurement has not yet started.

AVAILABILITY OF DATA AND MATERIALS

Datasets used and/or analysed during the current study with a limited number of variables are available from the corresponding author upon reasonable request, provided patient privacy can be assured, and after the study database has been closed. Analysis files (R scripts, SPSS syntaxes, other) can be made publicly available from the corresponding author upon reasonable request.

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REFERENCES

1. Magnani JW, Mujahid MS, Aronow HD, *et al*. Health Literacy and Cardiovascular Disease: Fundamental Relevance to Primary and Secondary Prevention: A Scientific Statement From the American Heart Association. *Circulation* 2018;**138**:e48-e74. doi:10.1161/CIR.0000000000000579.
2. Piepoli MF, Corra U, Dendale P, *et al*. Challenges in secondary prevention after acute myocardial infarction: A call for action. *Eur J Cardiovasc Nurs* 2017;**16**:369-380. doi:10.1177/2047487316663873.
3. Timmis A, Townsend N, Gale C, *et al*. European Society of Cardiology: Cardiovascular Disease Statistics 2017. *Eur Heart J* 2018;**39**:508-579. doi:10.1093/eurheartj/ehx628.
4. Haggerty R, Freeman GK, Starfield BH, Adair CE, McKendry R. Continuity of care: a multidisciplinary review. BMJ. 2003;327(7425):1219–21.
5. Riley DL, Stewart DE, Grace SL. Continuity of cardiac care: cardiac rehabilitation participation and other correlates. *Int J Cardiol* 2007;**119**:326-333. doi:10.1016/j.ijcard.2006.07.158.
6. Barker I, Steventon A, Deeny SR. Association between continuity of care in general practice and hospital admissions for ambulatory care sensitive conditions: cross sectional study of routinely collected, person level data. *BMJ* 2017;**356**:j84. doi: https://doi.org/10.1136/bmj.j84
7. Prvu Bettger J, Alexander KP, Dolor RJ, *et al.* Transitional care after hospitalization for acute stroke or myocardial infarction: a systematic review. *Ann Intern Med* 2012;157:407-16.
8. Kotseva K, Wood D, De Bacquer D, *et al.* EUROASPIRE IV: A European Society of Cardiology survey on the lifestyle, risk factor and therapeutic management of coronary patients from 24 European countries. *Eur J Prev Cardiol* 2016;**23**:636-648. doi:10.1177/2047487315569401.
9. Naderi SH, Bestwick JP, Wald DS. Adherence to drugs that prevent cardiovascular disease: meta-analysis on 376,162 patients. *Am J Med* 2012;**125**:882-887. doi:10.1016/j.amjmed.2011.12.013.
10. Resurreccion DM, Moreno-Peral P, Gomez-Herranz M, *et al*. Factors associated with non-participation in and dropout from cardiac rehabilitation programmes: a systematic review of prospective cohort studies. *Eur J Cardiovasc Nurs* 2019;**18**:38-47. doi:10.1177/1474515118783157.
11. Aragam KG, Dai D, Neely ML, *et al*. Gaps in referral to cardiac rehabilitation of patients undergoing percutaneous coronary intervention in the United States. *J Am Coll Cardiol* 2015;**65**:2079-2088. doi:10.1016/j.jacc.2015.02.063.
12. Dalal HM, Doherty P, Taylor RS. Cardiac rehabilitation. *BMJ* 2015;**351**:h5000. doi:10.1136/bmj.h5000.
13. Anderson L, Thompson DR, Oldridge N, *et al*. Exercise-based cardiac rehabilitation for coronary heart disease. *Cochrane Database Syst Rev* 2016;**1**:Cd001800. doi:10.1002/14651858.CD001800.pub3.
14. Dansk Hjerterehabiliteringsdatabase (DHRD). Årsrapport 2017. 1. juni 2017-31.maj 2018. [Final version 28 Jan 2019]. Available from: https://www.sundhed.dk/content/cms/93/59693_dhrd_årsrapport-2017_28012019endelig_inkl-struktur-tabel-og-figur.pdf (Accessed 27 May 2019).

15. Ho PM, O'Donnell CI, Bradley SM, *et al*. 1-year risk-adjusted mortality and costs of percutaneous coronary intervention in the Veterans Health Administration: insights from the VA CART Program. *J Am Coll Cardiol* 2015;**65**:236-242. doi:10.1016/j.jacc.2014.10.048.
16. Bakhai A, Ferrieres J, Iniguez A, *et al*. Clinical outcomes, resource use, and costs at 1 year in patients with acute coronary syndrome undergoing PCI: results from the multinational APTOR registry. *J Interven Cardiol* 2012;**25**:19-27. doi:10.1111/j.1540-8183.2011.00690.x.
17. Swieczkowski D, Mogielnicki M, Cwalina N, *et al*. Medication adherence in patients after percutaneous coronary intervention due to acute myocardial infarction: From research to clinical implications. *Cardiol J* 2016. Jul 21. doi:10.5603/CJ.a2016.0048. [Epub ahead of print].
18. Inouye SK, van Dyck CH, Alessi CA, *et al*. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. *Ann Intern Med* 1990;**113**:941-948.
19. Bellelli G, Morandi A, Davis DH, *et al*. Validation of the 4AT, a new instrument for rapid delirium screening: a study in 234 hospitalised older people. *Age Ageing* 2014;**43**:496-502. doi:10.1093/ageing/afu021.
20. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res* 2006;8:e27. doi:10.2196/jmir.8.4.e27.
21. Hadjistavropoulos HD, Biem HJ, Kowalyk KM. Measurement of continuity of care in cardiac patients: reliability and validity of an in-person questionnaire. *Can J Cardiol* 2004;**20**:883-891.
22. Ho PM, Bryson CL and Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation 2009;119:3028-35. doi: 10.1161/CIRCULATIONAHA.108.768986.
23. Furu K. Establishment of the nationwide Norwegian Prescription Database. *Nor J Epidemiol* 2008;**18**:129-136. doi:https://doi.org/10.5324/nje.v18i2.23.
24. Kildemoes HW, Sorensen HT, Hallas J. The Danish National Prescription Registry. *Scand J Public Health* 2011;**39**(7 Suppl):38-41. doi:10.1177/1403494810394717.
25. Helweg-Larsen K. The Danish Register of Causes of Death. *Scand J Public Health* 2011;**39**(7 Suppl):26-29. doi:10.1177/1403494811399958.
26. Gjertsen F. Cause of death registry-an important data source for medical research. *Tidsskr Nor Laegeforen* 2002;**122**:2551-2554.
27. Bakken IJ, Suren P, Haberg SE, *et al*. The Norwegian patient register--an important source for research. *Tidsskr Nor Laegeforen* 2014;**134**:12-13. doi:10.4045/tidsskr.13.1417.
28. Schmidt M, Schmidt SA, Sandegaard JL, et al. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol* 2015;**7**:449-490. doi:10.2147/CLEP.S91125.
29. Hsieh FY, Lavori PW. Sample-size calculations for the Cox proportional hazards regression model with nonbinary covariates. *Control Clin Trials* 2000;**21**:552-560.
30. National Institute for Health Research: Involving users in the research process. A 'how to' guide for researchers. 2010.
31. Staniszewska S, Brett J, Simera I, *et al*. GRIPP2 reporting checklists: tools to improve reporting of patient and public involvement in research. *BMJ* 2017;**358**:j3453. doi:https://doi.org/10.1136/bmj.j3453.
32. Dodson JA, Geda M, Krumholz HM, *et al.* Design and rationale of the comprehensive evaluation of risk factors in older patients with AMI (SILVER-AMI) study. *BMC Health Serv Res* 2014;**14**:506-506. doi:10.1186/s12913-014-0506-4.

33. Lichtman JH, Lorenze NP, D'Onofrio G, *et al*. Variation in recovery: Role of gender on outcomes of young AMI patients (VIRGO) study design. *Circ Cardiovasc Qual Outcomes* 2010;**3**:684-693. doi:10.1161/CIRCOUTCOMES.109.928713.
34. Arnold SV, Chan PS, Jones PG, *et al*. Translational Research Investigating Underlying Disparities in Acute Myocardial Infarction Patients' Health Status (TRIUMPH): design and rationale of a prospective multicenter registry. *Circ Cardiovasc Qual Outcomes* 2011;**4**:467-476. doi:10.1161/CIRCOUTCOMES.110.960468.
35. Meyers AG, Salanitro A, Wallston KA, *et al*. Determinants of health after hospital discharge: rationale and design of the Vanderbilt Inpatient Cohort Study (VICS). *BMC Health Serv Res* 2014;**14**:10. doi:10.1186/1472-6963-14-10.
36. Munkhaugen J, Sverre E, Peersen K, *et al*. The role of medical and psychosocial factors for unfavourable coronary risk factor control. *Scand Cardiovasc J* 2016;**50**:1-8. doi:10.3109/14017431.2015.1111408.
37. Tegn N, Abdelnoor M, Aaberge L, et al. Invasive versus conservative strategy in patients aged 80 years or older with non-ST-elevation myocardial infarction or unstable angina pectoris (After Eighty study): an open-label randomised controlled trial. *Lancet* 2016;**387**:1057-1065. doi:https://doi.org/10.1016/S0140-6736(15)01166-6.
38. Haun JN, Patel NR, French DD, *et al*. Association between health literacy and medical care costs in an integrated healthcare system: a regional population based study. *BMC Health Serv Res* 2015;**15**:249-249. doi:https://doi.org/10.1186/s12913-015-0887-z.
39. Rumsfeld JS, Alexander KP, Goff DC, *et al*. Cardiovascular health: the importance of measuring patient-reported health status: a scientific statement from the American Heart Association. *Circulation* 2013;**127**:2233-2249. doi:10.1161/CIR.0b013e3182949a2e.
40. Anker SD, Agewall S, Borggrefe M, *et al*. The importance of patient-reported outcomes: a call for their comprehensive integration in cardiovascular clinical trials. *Eur Heart J* 2014;**35**:2001-2009. doi:10.1093/eurheartj/ehu205.
41. Barry MJ, Edgman-Levitan S. Shared decision making--pinnacle of patient-centered care. *N Engl J Med* 2012;**366**:780-781. doi:10.1056/NEJMp1109283.
42. Norekvål TM, Fålun N, Fridlund B; Patient-Reported Outcomes in Cardiology (PROCARD) research group. Patient-reported outcomes on the agenda in cardiovascular clinical practice. *Eur J Cardiovasc Nurs* 2016 Apr;15(2):108-11.
43. Peersen K, Munkhaugen J, Gullestad L, *et al*. Reproducibility of an extensive self-report questionnaire used in secondary coronary prevention. *Scand J Public Health* 2017;**45**:269-276. doi:10.1177/1403494816688375.
44. Horne R, Weinman J, Hankins M. The Beliefs about Medicines Questionnaire: The development and evaluation of a new method for assessing the cognitive representation of medication. *Psychol Health* 1999;**14**:1-24. doi:https://doi.org/10.1080/08870449908407311.
45. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. *Ann Med* 2001;**33**:337-343.
46. Osborne RH, Batterham RW, Elsworth GR, *et al*. The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ). *BMC Public Health* 2013;**13**:658. doi:10.1186/1471-2458-13-658.
47. Oldridge N, Hofer S, McGee H, *et al*. The HeartQoL: part II. Validation of a new core health-related quality of life questionnaire for patients with ischemic heart disease. *Eur J Prev Cardiol* 2014;**21**:98-106. doi:10.1177/2047487312450545.

48. Horne R, Weinman J. Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *J Psychosom Res* 1999;**47**:555-567.
49. Hellström A, Hagell P, Fagerström C, *et al*. Measurement properties of the Minimal Insomnia Symptom Scale (MISS) in an elderly population in Sweden. *BMC Geriatr* 2010;**10**:84-84. doi:https://doi.org/10.1186/1471-2318-10-84.
50. Amofah HA, Brostrom A, Fridlund B, *et al*. Sleep in octogenarians during the postoperative phase after transcatheter or surgical aortic valve replacement. *Eur J Cardiovasc Nurs* 2016;**15**:168-177. doi:10.1177/1474515115620992.
51. Hibbard JH, Mahoney ER, Stockard J, *et al*. Development and testing of a short form of the patient activation measure. *Health Serv Res* 2005;**40**:1918-1930. doi:10.1111/j.1475-6773.2005.00438.x.
52. Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996;**34**:220-233.
53. Brostrom A, Hubbert L, Jakobsson P, *et al*. Effects of long-term nocturnal oxygen treatment in patients with severe heart failure. *J Cardiovasc Nurs* 2005;**20**:385-396.
54. Ensrud KE, Ewing SK, Taylor BC, *et al*. Frailty and risk of falls, fracture, and mortality in older women: the study of osteoporotic fractures. *J Gerontol A Biol Sci Med Sci* 2007;**62**:744-751.
55. Bjelland I, Dahl A, Haug T, *et al*. The validity of the Hospital Anxiety and Depression Scale: An updated literature review. *J Psychosom Res* 2002;**52**:69-77.
56. Thompson DR, Jenkinson C, Roebuck A, *et al*. Development and validation of a short measure of health status for individuals with acute myocardial infarction: the myocardial infarction dimensional assessment scale (MIDAS). *Qual Life Res* 2002;**11**:535-543.
57. Skudal KE, Garratt AM, Eriksson B, *et al*. The Nordic Patient Experiences Questionnaire (NORPEQ): cross-national comparison of data quality, internal consistency and validity in four Nordic countries. *BMJ Open* 2012;**2**:e000864. doi:10.1136/bmjopen-2012-000864.
58. Chan PS, Jones PG, Arnold SA, *et al*. Development and validation of a short version of the Seattle angina questionnaire. *Circ Cardiovasc Qual Outcomes* 2014;**7**:640-647. doi:10.1161/CIRCOUTCOMES.114.000967.
59. Hanestad BR, Rustoen T, Knudsen O Jr, *et al*. Psychometric properties of the WHOQOL-BREF questionnaire for the Norwegian general population. *J Nurs Meas* 2004;**12**:147-159.

Table 1. Description of centres participating in CONCARD[PCI]

	Centre 1 (HUS)	**Centre 2 (SUS)**	**Centre 3 (RH^{Osl})**	**Centre 4 (HGH)**	**Centre 5 (ZUH)**	**Centre 6 (RH^{Cph})****	**Centre 7 (OUH)**
Total hospital beds	1400	482	697	949	629	1377	1064
PCI procedures per year*	1565	905	2124	1290	921	2243	2633
Catchment area of number of local hospitals	7	1	9	4	5	5	6

Centre 1 is the Sponsor Coordinating Centre.
*Figures from 2017.
** RH^{Cph} has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region.
Abbreviations: HGH: Herlev and Gentofte University Hospital, Copenhagen, Denmark; HUS: Haukeland University Hospital, Bergen, Norway; OUH: Odense University Hospital, Odense, Denmark; RH^{Cph}: Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; RH^{Osl}: Oslo University Hospital, Rikshospitalet, Oslo, Norway; SUS: Stavanger University Hospital, Stavanger, Norway; ZUH: Zealand University Hospital, Roskilde, Denmark. PCI; percutaneous coronary intervention.

Table 2. Eligibility criteria for CONCARD^{PCI}

Inclusion criteria	• Patients undergoing percutaneous coronary intervention (PCI) • ≥ 18 years of age • Living at home at the time of index hospitalization and inclusion • Informed consent
Exclusion criteria	• Patients who do not speak Norwegian/Danish • Patients who are unable to fill in the questionnaires due to reduced capacities • Patients who are institutionalized • Patients with expected lifetime less than one year • Patients undergoing PCI without stent implementation, or related to Transcatheter Aortic Valve Implantation (TAVI) or MitraClip examination • Previous enrolment in CONCARD^{PCI} (readmissions)

Table 3. Socio-demographic, clinical and patient-reported measures, and timing of assessments in the CONCARD^{PCI} prospective cohort study

Measure	Details	Self-report	Hospital medical records	National Registry	Time*	Project§
Socio-demographic data	Marital status, cohabitation status, education, work status, immigration status, income, rehabilitation participation, available support system, readmission to hospital, time of first meeting with general practitioner.	X		X	T0-T3	1-4
Clinical characteristics	Clinical status at admission (blood pressure, heart rate, laboratory results (hemoglobin, creatinine, troponin, total-, high/low density lipoproteins), body weight, height, waist circumference, upper arm circumference, medical history including comorbidity and frailty, and previous hospital admissions, procedural and angiographic findings including completeness of revascularization, complications during hospital stay, additional procedures, length of hospital stay, death.	X	X	X	T0	1-4
Medication	Medication at discharge (type and dosage), consumption of prescribed medication during follow-up, side effects from medication, polypharmacy, discontinuation, serum levels of cardiac medications (quantified using liquid chromatography with mass spectrometry).	X	X	X	T0-T3	3
Lifestyle	Physical activity (frequency, duration, intensity) sexual activity, tobacco use (current, previous, never), alcohol consumption (frequency, units per week), diet (frequency and amount of intake of different foods, beverages, supplements).	X			T0-T3	1-3
Healthcare utilization	Patients' use of the healthcare system (community vs. hospital-based services, specialist vs. general provider, urban vs. rural setting).	X		X	T1-T3	4
Internet use	Patients' use of electronic equipment with internet access, use of internet to find health information, and use of the web-portal helsenorge.no	X			T0- T3	2, 3
Major life events	Comprises three items assessing major life events.	X			T1-T3	1-3
Beliefs about Medicines Questionnaire (BMQ)[44]	Comprises 11 items (the BMQ-Specific) and assesses the key psychological constructs that underpin the core beliefs influencing adherence to medicines.	X			T1-T3	3
eHealth Literacy scale (eHEALS)[20]	Comprises 10 items and assesses patients' combined knowledge, comfort, and perceived skills at finding, evaluating, and applying electronic health information to health problems.	X			T0, T3	2
EQ-5D-5L[45]	Comprises 5 items and is widely used for measuring economic preferences for health states.	X			T0-T3	4
Health literacy questionnaire (HLQ)[46]	Comprises 20 items measuring four levels of health literacy: Appraisal of health information (5 items); social support for health (5 items); Ability to find good information (5 items); and Understanding health information (5 items).	X			T0,T3	2
Heart Continuity of Care Questionnaire (HCCQ)[21]	Comprises 33 items covering eight topic areas: heart condition explained, communication among providers, preparation for discharge, post-hospital review of treatment, receipt of conflicting information, information on medications and on physical and dietary needs.	X			T1	1
HeartQol[47]	Comprises 14 items with 10-item physical and 4-item emotional subscales.	X			T3	1-4
Medication Adherence Report	Comprises 5 items and measures self-reported adherence to medicines, and assesses both intentional	X			T1-T3	3

Scale (MARS-5)[48]	and unintentional non-adherence.					
Minimal Insomnia Symptom Scale (MISS)[49, 50]	Comprises 3 items assessing major features of insomnia, i.e. difficulties initiating sleep, waking at night and not feeling refreshed by sleep.	X			T0-T3	1-3
Patient Activation Measure (PAM)[51]	Comprises 13 items assessing patient knowledge, skill and confidence for self-management.	X			T2	2
RAND-12[52]	Comprises 12 items with 3 to 5 response levels. It generates two health indices: mental and physical health.	X			T0-T3	1-4
Sleep Sufficient Index (SSI)[50, 53]	Comprises 2 items assessing amount of actual and desired sleep	X			T0-T3	1-3
Study of Osteoporotic Fractures (SOF index)[54]	Comprises 3 items and assess weight loss, inability to rise from a chair five times without using the arms and self-reported poor energy.	X			T0, T3	1-3
The Hospital Anxiety and Depression Scale (HADS)[55]	Comprises 14 items and determine the levels of anxiety and depression that a patient is experiencing, and generates 2 sub-scales; HADS-D and HADS-A.	X			T0-T3	1-4
The Myocardial Infarction Dimensional Assessment Scale (MIDAS)[56]	Comprises 35 items specifically measuring seven different domains of health status and daily life challenges in individuals who have suffered a myocardial infarction: physical activity (12 items), insecurity (9 items), emotional reaction (4 items), dependency (3 items), diet (3 items), concerns over medication (2 items) and side effects (2 items).	X			T1-T3	1-3
The Nordic Patient Experiences Questionnaire (NORPEQ)[57]	Comprises 8 items and gives a brief measure of patient experiences in evaluation of the quality of healthcare delivery.	X			T1	1
The Seattle Angina Questionnaire (SAQ-7)[58]	Comprises 7 dimensions of coronary artery disease: physical limitation, angina frequency and quality of life.	X			T0-T3	1-3
WHOQOL-BREF[59]	Comprises one global item on overall quality of life.	X			T0-T3	1-4

* T0: Baseline, T1: 2-month follow-up, T2: 6-month follow-up, T3: 12-month follow-up
§ Project 1: Continuity of care, Project 2: Health literacy and self-management, Project 3: Adherence to treatment, Project 4: Health care use and costs

Table 4. Definition of outcomes in CONCARD[PCI]

Outcome	Definition
Continuity of care	As measured by the Heart Continuity of Care Questionnaire (HCCQ).[21]
Health literacy and eHealth literacy	As measured by the Health Literacy Questionnaire (HLQ)[46] and eHealth Literacy Questionnaire (eHEALS).[20]
Adherence to medication	As measured by the Medication Adherence Report Scale (MARS-5)[48], Beliefs about Medicines Questionnaire (BMQ)[44] and data related to consumption of prescribed medication identified through national prescription registries, and serum levels of cardiac medication.
Healthcare utilization	As measured by patients' use of primary care services (general practitioner visits) and secondary care services (inpatient admissions and outpatient visits).
Healthcare (associated) costs	As measured by the tariffs of national agreements between the professional associations of medical specialists and the National Health Services, and the tariffs of the national case-mix system of the diagnosis-related groupings (DRG) and the ambulatory grouping system (DAGS).
Time to readmission	Cardiac and all-cause readmissions.
Time to death	Cardiac and all-cause mortality.
Time to major adverse cardiac events (MACE)	A composite of cardiac mortality and hospitalization for cardiovascular disease or chest pain.

FIGURE LEGENDS

Figure 1: Projects in CONCARD^{PCI} researching bottle necks for good and efficient patient pathways across levels of health care

Figure 2: Measuring time points and data collection in the cohort study in CONCARD^{PCI}

Figure 3. Study sites in cohort study in CONCARD^{PCI}

H= PCI centres including the local hospitals in their catchment area.
Copenhagen University Hospital, RH has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region.

ADDITIONAL FILES

Additional file: Scientific environment, collaboration and organisation of the project.

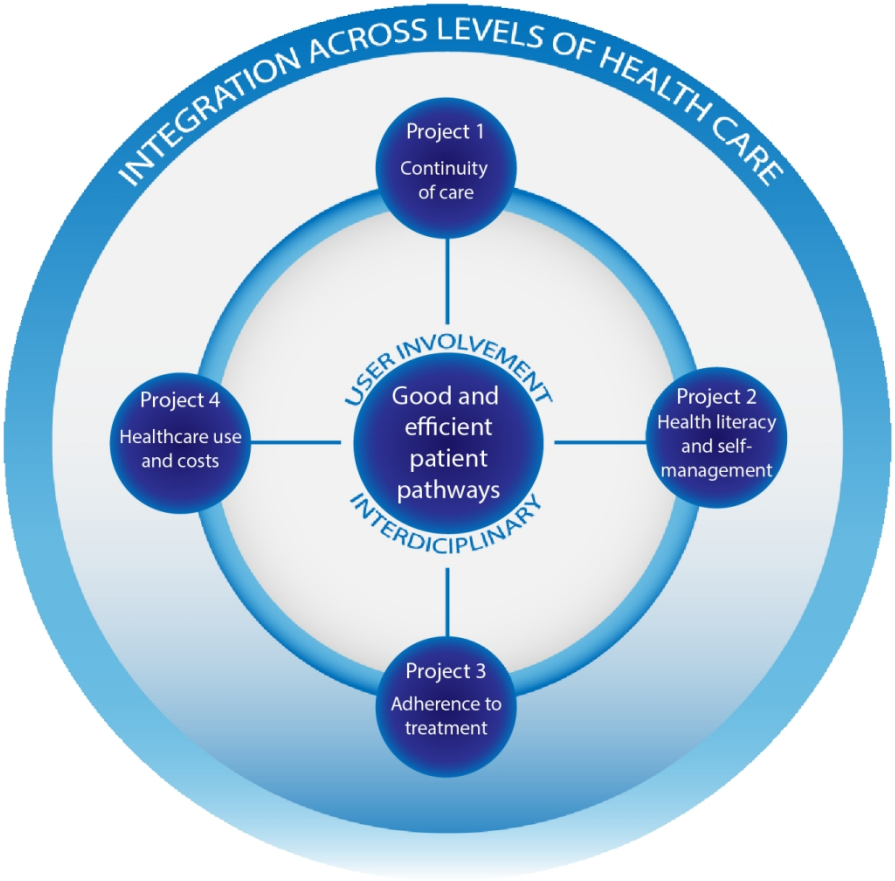

Figure 1: Projects in CONCARDPCI researching bottle necks for good and efficient patient pathways across levels of health care

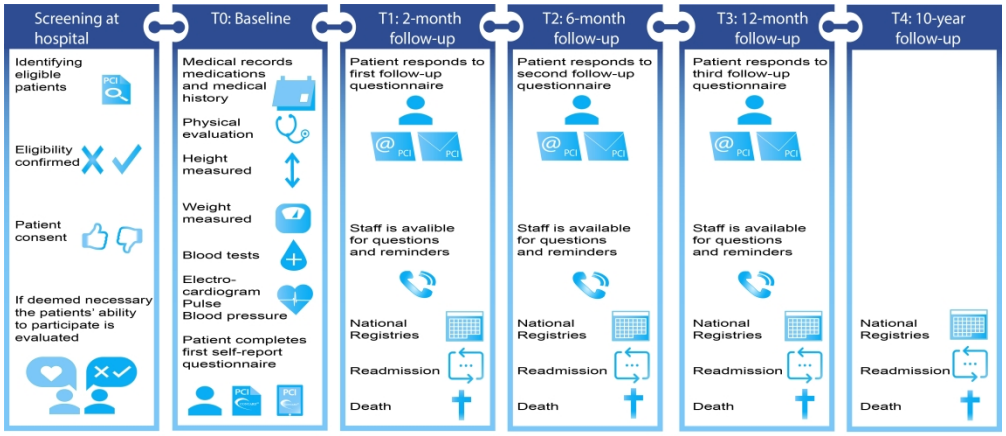

Figure 2: Measuring time points and data collection in the cohort study in CONCARDPCI

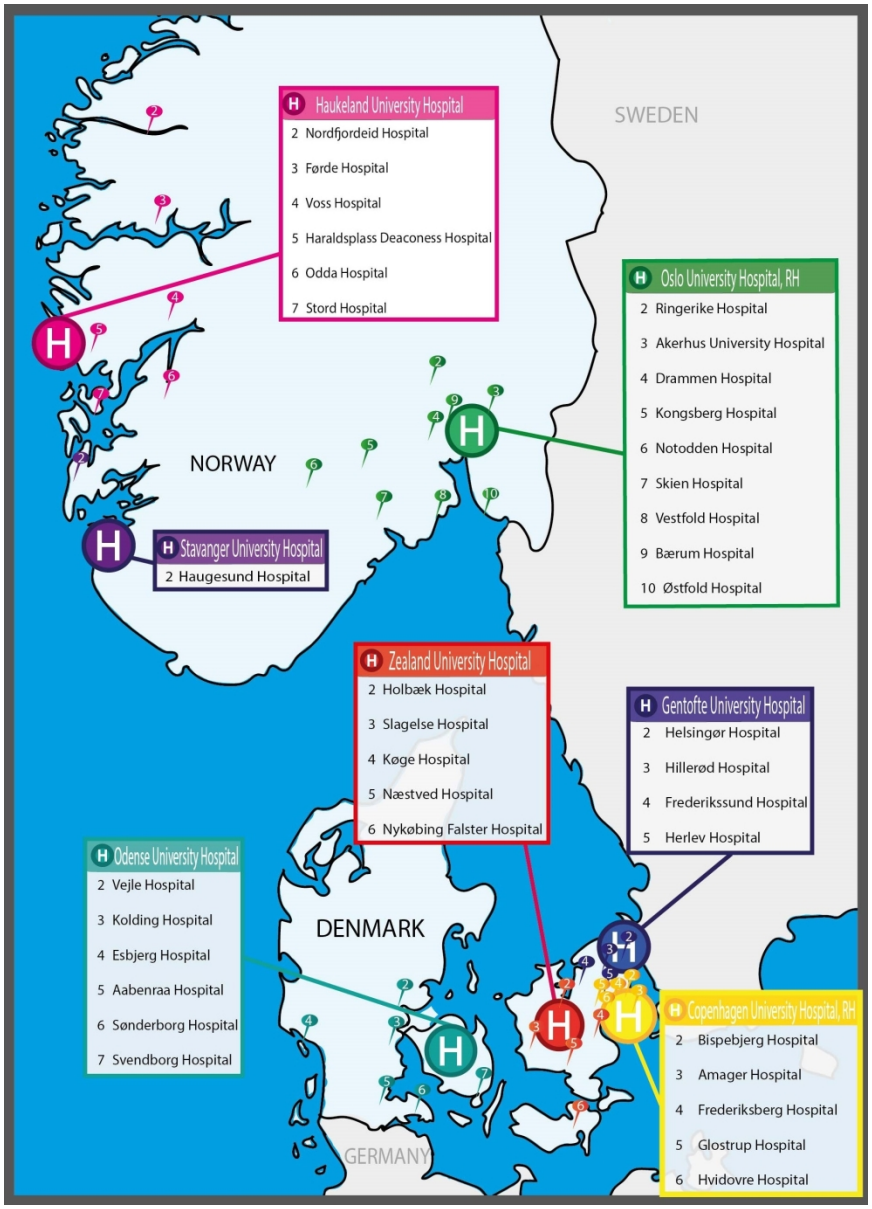

Figure 3. Study sites in cohort study in CONCARDPCI
H= PCI centres including the local hospitals in their catchment area.
Copenhagen University Hospital, RH has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region

495x686mm (96 x 96 DPI)

APPENDIX

SCIENTIFIC ENVIRONMENT, COLLABORATION AND ORGANISATION OF CONCARD[PCI]

We have built a research team with a broad interdisciplinary profile involving local, regional, national and international collaborators. Collaborators range from emerging leaders as thematic project leaders to world-renowned senior scientists in the Scientific Advisory Board. Each member is a specialist in her/his field providing expert knowledge into the research project. An Expert Group who will be pivotal in translating evidence into healthcare has been established including representatives from Learning and Mastery Networks, Healthy Life Centres, health trusts, cardiac rehabilitation services, and patient organisations. Two patient representatives identified through the Norwegian Heart and Lung Patient Organisation are providing input to the planning, implementing and reporting of results from the programme. As these groups join forces, we will be especially well suited to undertake this large-scale registry-based multimethod multicentre study on patient pathways after percutaneous coronary intervention.

Table I. The Scientific Advisory Board of CONCARD[PCI]

Scientific Advisory Board	Institution	Expertise
Heather Allore, PhD, Professor of Medicine (Geriatrics) and of Public Health (Biostatistics), and Director of the Yale Program on Aging Biostatistics Core	Yale University, USA	Design and analysis of studies of multi-component interventions and observational studies of multifactorial health conditions.
Christi Deaton, PhD, RN, FAHA, FESC, Florence Nightingale Foundation Professor of Clinical Nursing Research	University of Cambridge, UK	Wide clinical and research experience in acute cardiovascular patient care. Contributed to clinical practice guidelines development (European level). Participated in the COURAGE Trial.
Heather Hadjistavropoulos, PhD, Professor of Psychology	University of Regina, CA	Quality of healthcare across the continuum of care including integrated care pathways. Developed the HCCQ.[21]
Ann Dorthe Zwisler, MD, PhD, Professor of Medicine	University of Odense, DK	Experience in programs of health and morbidity, rehabilitation and palliative programs.
Rikke Søgaard, MSc, MPH, PhD, Professor of Health economics	Aarhus University, DK	Econometric modelling for policy evaluation, and preference elicitation, and use of standardised measures for costs and outcomes measurement.

Table II. The Expert Group of regional, national and international collaborators of CONCARD[PCI]

Collaborators	Institution	Expertise
Torbjørg Aasen, Patient representative	The Norwegian Heart and Lung Patient Organisation	Experience from peer support.
Bjørn Bendz, MD, PhD. Associate professor, Head ICCU, interventional cardiologist	Oslo University Hospital, and University of Oslo	Experienced interventional cardiologist with his latest research on the oldest old and PCI.[37]
Cathrine Bjorvatn, RN, MSc, PhD, Associate professor, Head Learning and Mastery Services at Bergen Health Trust	Haukeland University Hospital, and University of Bergen	Chair of Network on Learning and Mastery including all three levels of healthcare; 24 municipalities as well as Haraldsplass Deaconess Hospital, and Haukeland University Hospital.
Ellen Blom, PTH, PhD-candidate	Western Norway University of Applied Sciences, Campus Sogndal	Physiotherapist with extensive research experience from Healthy Life Centres.
Gunhild Brørs, RN, MSc, PhD-candidate	St. Olav University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing.
Anne K Drange, BSc, Radiographer	Askøy Municipality	Head, Health and Care Services, Askøy Municipality. Project on multidisciplinary team follow-up of patients with severe heart disease in primary care.
Irene Drotningsvik, RN, MSc	Haukeland University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing. Co-leader of the Cardiac Rehabilitation Unit.
Bengt Fridlund, RNT, PhD, Senior Professor	Centre of Interprofessional Collaboration within Emergency care (CISE), Linnaeus University, SE	Long experience in cardiac research, supervised >50 PhD candidates, published 400 papers. PhD in one of the earliest research studies on cardiac rehabilitation.
Stig Igland, RN, MA, Chair of Network on Learning and Mastery Services at Førde Hospital Trust	Førde Hospital Trust	Extensive leadership and project experience from interdisciplinary rehabilitation and Learning and Mastery services across administrative levels.
Alf Inge Larsen, MD, PhD. Professor and interventional cardiologist.	Stavanger University Hospital and University of Bergen	Extensive experience in interventional cardiology and research leadership.
Jan Erik Nordrehaug, MD, PhD. Professor and interventional cardiologist	Stavanger University Hospital and University of Bergen	Built PCI network and logistics in Western Norway, >200 papers & extensive supervision.
Trond Røed Pettersen, RN, MSc, PhD-candidate	Haukeland University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing.
Svein Rotevatn, MD, PhD. Chair of NORIC, and interventional cardiologist	Haukeland University Hospital	Experienced interventional cardiologist and responsible for register data in CONCARD. Will be taking the lead together with Norekvål.
Maj-Britt Råholm, RN, MNSc, PhD, Professor	Western Norway University of Applied Sciences, Campus Førde	Clinical nurse leader and researcher, experienced in both qualitative and quantitative research methods.
Jan Schjøtt, MD, PhD, Professor, and senior consultant in clinical pharmacology	Haukeland University Hospital and University of Bergen	Experience in clinical pharmacology, drug information to health care professionals and patients, and pharmacovigilance.
Marit Solheim, RN, MA, Director Center of Health Research, Førde	Førde Hospital Trust, Western Norway University of Applied Sciences, Campus Førde	Experienced in interdisciplinary collaboration across institutions, and research across primary and secondary care levels.
Rune Stiansen, Patient representative	The Norwegian Heart and Lung Patient Organisation	Experience from peer support and cardiac rehabilitation.
David Thompson, RN, PhD, Professor	Queens University, Belfast, UK	Expert in developing disease-specific PRO measures[56], and novel psychosocial interventions.
Irene Valaker, RN, MA, PhD-candidate	Western Norway University of Applied Sciences, Campus Førde	Cardiovascular clinical nurse specialist with MA in organizational models in cardiac care.
Trine Vingsnes, MD, Cardiologist and Head of Department of Medicine	Førde Hospital Trust	Extensive experience in implementation of new clinical pathways between hospitals and primary care.
Tore Wentzel-Larsen, MSc, Biostatistician	Haukeland University Hospital, and Eastern Southern Health Trust	Statistical advisor in close to 200 scientific papers.

Table III. Project administration for the cohort study in CONCARD^{PCI}

Project administration	Institution	Role
Tone M Norekvål, RN, MSc, PhD, Chair PROCARD, Professor	Haukeland University Hospital, Western Norway University of Applied Sciences and University of Bergen, NO	Principal Investigator CONCARD^{PCI}
Nina Fålun, RN, MSc	Haukeland University Hospital, and Western Norway University of Applied Sciences, NO	Main project coordinator CONCARD^{PCI} Project coordinator Norway Centre coordinator Haukeland University Hospital
Tina Birgitte Hansen, RN, MSc, PhD, Post doc	Zealand University Hospital, Roskilde, and University of Southern Denmark, DK	Project coordinator Denmark Local PI and Centre coordinator Zealand University Hospital Leader Project 4
Irene Valaker, RN, MA, PhD-candidate	Western Norway University of Applied Sciences, Campus Førde, NO	Leader Project 1
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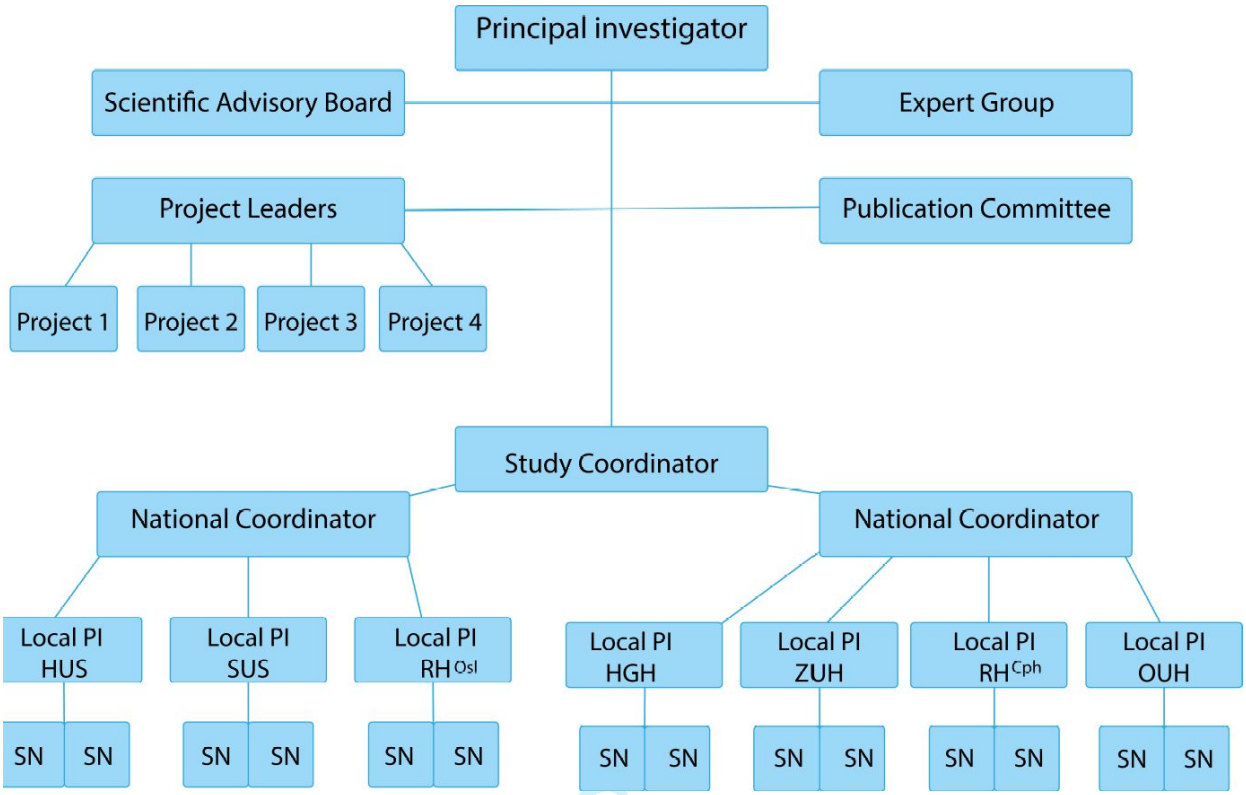

Figure I. Project organisation of the CONCARD^{PCI} cohort study

Abbreviations: HGH: Herlev and Gentofte University Hospital, Copenhagen, Denmark; HUS: Haukeland University Hospital, Bergen, Norway; OUH: Odense University Hospital, Odense, Denmark; RH^{Cph}: Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; RH^{Osl}: Oslo University Hospital, Rikshospitalet, Oslo, Norway; SUS: Stavanger University Hospital, Stavanger, Norway; ZUH: Zealand University Hospital, Roskilde, Denmark.

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Rethinking rehabilitation after percutaneous coronary intervention – a protocol of a multicentre cohort study on continuity of care, health literacy, adherence and costs at all care levels (the CONCARDPCI)

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Rethinking rehabilitation after percutaneous coronary intervention – a protocol of a multicentre cohort study on continuity of care, health literacy, adherence and costs at all care levels (the CONCARD^{PCI})

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ABSTRACT

Introduction: Percutaneous coronary intervention (PCI) aims to provide instant relief of symptoms, improve functional capacity and prognosis in patients with coronary artery disease. Although patients may experience a quick recovery, continuity of care from hospital to home can be challenging. Within a short time span, patients must adjust their lifestyle, incorporate medication and acquire new support. Thus, CONCARD^{PCI} will identify bottlenecks in the patient journey from a patient perspective to lay the groundwork for integrated, coherent pathways with innovative modes of healthcare delivery. The main objective of the CONCARD^{PCI} is to investigate i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment, and iv) healthcare utilization and costs, and to determine associations with future short- and long-term health outcomes in patients after PCI.

Methods and analysis: This prospective multicentre cohort study organised in four thematic projects plans to include 3000 patients. All patients undergoing PCI at seven large PCI centres based in two Nordic countries are prospectively screened for eligibility and included in a cohort with a 1-year follow-up period including data collection of patient-reported outcomes (PROs) and a further 10-year follow-up for adverse events. In addition to PROs, data are collected from patient medical records and national compulsory registries.

Ethics and dissemination: Approval has been granted by the Norwegian Regional Committee for Ethics in Medical Research in Western Norway (REK 2015/57), and the Data Protection Agency in the Zealand region (REG-145-2017). Findings will be disseminated widely through peer-reviewed publications and to patients through patient organisations.

Registration: Clinicaltrials.gov identifier: NCT03810612.

Strengths and limitations of this study

- The CONCARD[PCI] is an interdisciplinary, multicentre effort with the unique combination of data from hospital medical records, patient self-report, and national registries providing opportunities to identify novel pathways for continuity of care that contribute to outcomes.
- Although the linkage to national registers will ensure complete follow-up of the study population, potential challenges include response rate of patient self-report at follow-up.
- Non-participants will be compared to participants on a limited number of registry variables to account for potential selection bias.

INTRODUCTION

The widespread commitment to involve patients in planning and service development has become a key element of current healthcare policy. Health literacy, as the ability to access, process and comprehend health information and services, can be used to complement both individual patient care and community-level development. Understanding the varying health literacy of patients, particularly in those who experience poor access and outcomes, is thereby pivotal.[1] The American Heart Association (AHA) recently published a scientific statement[2] addressing health literacy in cardiovascular disease as of fundamental relevance to primary and secondary prevention. European leaders in secondary prevention have called for action in the post-acute aftercare of patients with coronary artery disease (CAD).[3] Although CAD is the single most common cause of death in Europe, there has been an encouraging decrease in mortality ascribed to improvements in risk-factor management, pharmacological treatment, and revascularization techniques.[4] Since, more people need to manage life with CAD as a chronic disease, modern developments in primary healthcare provision have led to increased interest in continuity of care as an essential element.[5-7] Patients' transition from hospital to home is particularly challenging because patients need to adjust their lifestyle, incorporate new medications, and acquire additional sources of support.[8] Although there is compelling evidence for secondary prevention following CAD, a large majority fail to achieve life style changes and therapeutic targets set by the ESC guidelines.[9] Therefore, adherence to treatment is also of concern. Non-adherence to medications is common for patients with cardiovascular diseases.[10] Taking prescribed antiplatelet and other secondary preventive medication after percutaneous coronary intervention (PCI) is pivotal; however, it is unknown if non-adherence also applies for patients following PCI.

This paper describes a multicentre cohort study, the CONCARD^{PCI}, that seeks to identify bottlenecks and hurdles in the patient journey and suggest the optimal timing of

services and alignment with patient preferences for patients with CAD undergoing PCI. Of special interest are challenges with continuity of care, health literacy and self-management, adherence to treatment advice, costs at all care levels, and associations with future short- and long-term health outcomes.

Uptake to cardiac rehabilitation (CR) is suboptimal[9, 11, 12], few sufficiently powered real world studies have been undertaken with the explicit purpose of investigating continuity of care and pathways of CR in patients after PCI. In addition to investigating factors associated with low referral, participation, health literacy and adherence rates among CR participants, studies are increasingly needed on evaluating alternative modes of providing CR. Follow-up of healthcare use, costs and predictors of costs following PCI in a non-clinical trial setting have been infrequently investigated.[13, 14] Thus, a large cohort of real world observations that can ascertain interventions for future clinical trials is needed.[15] The CONCARD^{PCI} responds to this challenge. In CONCARD^{PCI}, we hypothesise that continuity of care, eHealth literacy and self-management, and adherence to treatment in patients are directly associated to outcomes after PCI.

AIM OF THE RESEARCH PROGRAMME

The overall aim of CONCARD^{PCI} is to investigate i) continuity of care, ii) health literacy and self-management, iii) adherence to treatment, and iv) healthcare utilization and costs, to determine associations with future short- and long-term health outcomes in patients after PCI. CONCARD^{PCI} is organized into four thematic projects on Continuity of care; Health literacy and self-management; Adherence to treatment; and Health care use and costs (Figure 1).

METHODS

Study design and setting

CONCARD[PCI] is a large-scale multicentre cohort study with serial prospective survey data collection, clinical data and register-based follow-up. We collect data from hospital medical records, patient self-report surveys, and national registries (Figure 2). Preliminary work has been performed including in-depth interviews on patients' experiences of healthcare delivery to provide a context for the quantitative data and inform the content of the cohort survey questionnaires. Three follow-up surveys over one year are undertaken, and a 10-year follow-up for adverse events.

Seven large referral PCI centres in Norway and Denmark were selected based on the following considerations: presence of a committed research team including CONCARD[PCI] study nurses and a local principal investigator, prior research experience including research infrastructure, geographic location and size. The PCI centres perform from 900 to >2000 (mean 1668) PCI procedures annually, having 629 to 1400 beds (mean 943), and are referral centres for coronary angiography and PCI for a total of 37 local hospitals (Figure 3, Table 1). Haukeland University Hospital is the Sponsor Centre of this investigator initiated research programme. For study organisation, see online Appendix.

Study population

All patients undergoing PCI at seven large PCI centres are prospectively screened for eligibility. Screening is performed in the hospital setting by the site coordinator and trained CONCARD[PCI] study nurses. Daily admissions records and the operating programme are reviewed to identify potentially eligible patients. Electronic medical records are reviewed to confirm eligibility according to the inclusion and exclusion criteria (Table 2). When cognitive impairment is suspected by clinical or study personnel and there is no medical record of the problem, the Confusion Assessment Method[16] and 4AT[17] are used to investigate whether the patient must be excluded. Patients who are delirious or too clinically unstable to participate following PCI, who would otherwise be eligible, are re-assessed until discharge. During the

in-hospital assessment, participants provide informed consent. Because many of the questionnaires are designed for patient self-assessment, patients who need a complete proxy are ineligible. If participants need assistance in filling out the questionnaires, this is registered in the case report form (CRF). Regarding sample size and study power see *Data analysis and sample size determination.*

Measurement and data collection

In CONCARD^{PCI} a broad range of outcomes are measured and data are collected by physical assessment at baseline, review of the medical records, patient self-reported questionnaires (at baseline, 2, 6 and 12 months), and from national registries (Table 3 and Figure 2). A comprehensive data dictionary and CRF are provided to ensure standardization of abstracted data. For the Danish centres, eCRFs are used. Patients included in the study undergo a brief physical assessment and complete the self-report questionnaires at baseline after PCI (T0) (Table 3 and Figure 2). A follow-up with postal or electronic questionnaires are distributed to all patients included in the study, 2 months after discharge (T1). The time interval ensures time for follow-up care to evaluate early post-discharge continuity of care. A consecutive sub-group of patients (n=100) at the Sponsor Coordinating Center are approached for a re-test of the eHealth Literacy Scale (eHEALS)[18] and the Heart Continuity of Care Questionnaire (HCCQ)[19] as part of the validation process of the instruments. All patients are followed-up with postal or electronic questionnaires at 2 (T1), 6 (T2) and 12 (T3) months post-discharge. Non-responders receive one reminder. Vital status is identified to avoid sending questionnaires to deceased patients or their family. Patient adverse events are followed through national registers for 10 years or until death (T4) (Figure 2). Questionnaire packages are discussed with patient representatives and piloted at every measuring time point (T0-T3) before employed in the largescale cohort study.

To objectively assess adherence to therapy, serum levels of a wide panel of cardiac medications are measured. A consecutive subsample of 500 Norwegian patients from two centres will be invited to give a blood sample one year after the index procedure. The time is chosen as it corresponds to collection of patient-reported data on adherence. Moreover, adherence tends to diminish over time [20]; hence, the 1-year contact was chosen. Serum levels are submitted to an accredited clinical pharmacology laboratory, and quantified using liquid chromatography with mass spectrometry. Patients are labelled as non-adherent when serum level of at least one of the evaluated drugs is below the limit of quantification.

Management of cohort and registry data

For the *Norwegian centres*, baseline (T0) data are transferred to the National Coordinating Centre for data entry and/or review. The forms are reviewed and queries sent to the centre for missing or incomplete items. All follow-up data are collected by postal mail and managed at the National Coordinating Centre. The paper version data are entered into electronic files by trained staff.

For *the Danish centres*, each centre registers patients who are screened, and either included or excluded in separate Microsoft Excel (version 2016) spreadsheets in a shared secure team site server hosted by the National Coordinating Centre. Data from medical records are entered into a shared SurveyXact (version 12.9) database at each study site and managed by the National Coordinating Center. Patient self-report at both baseline (T0) and follow-up are collected either electronically using a tablet via a SurveyXact-link or by paper as requested by the patient. Paper version data are entered into the SurveyXact database by trained CONCARD^{PCI} study nurses. All follow-up data are collected and managed by the National Coordinating Centre.

Every resident in Norway and Denmark has a unique personal identifier that allows datasets from national registries to be merged on an individual level. The datasets will be

released in a coded and de-identified form, but with a unique identifier common to the datasets making individual merging possible. The Heart registries, Prescription registries[21, 22], Cause of death registries[23, 24], and administrative registries on social security microdata and health care utilization[25, 26] are mandatory, and legally exempted from requirement of obtaining patient consent. Strict rules on how data can be used or linked are followed to secure privacy protection. Although these data are similar in composition, we are interested in contrasting and comparing Denmark with its high CR uptake to Norway with a lower uptake.

Data analysis and sample size determination

Descriptive statistics of the cohort by nation will be generated using proportions, means and standard deviations or medians and interquartile ranges as appropriate. Cross-sectional analysis will be used for continuity of care (Table 4) using multiple linear regression testing for a random effect for nation. For health literacy, there is a single follow-up and multiple linear regression testing for a random nation effect will be used. The cohort's longitudinal observations over one year will be modelled using generalized linear mixed models (GLMM) that account for within person correlation for adherence to medications, healthcare utilization and cost (Table 4). We will test whether patients clustered within nation is significant. If so, we will include it as a hierarchy in the GLMMs. For time to readmission, and time to major adverse cardiac event, we will use competing risk models to account for censoring by death. We will construct risk stratification models that predict the probability of each outcome for specific combinations of risk factors. We will establish internal validity by using bootstrapping techniques. We will test whether missing data is at random. If not, we will estimate the probability of missingness and include it as a weight or covariate factor in the models. For psychometric evaluation of translated instruments we evaluate the structural, discriminant and convergent validity, and reliability of the scales. For internal consistency, Cronbach's alpha is used. Test-retest reliability is evaluated by using intraclass correlation

(ICC) coefficients of patients' results obtained at a 2-week retest interval. Confirmatory factor analysis (CFA) is used for evaluating the factor structure of the original eHEALS[18] and HCCQ[19] instruments.

Power calculations for the cohort study are based on time-to-first event outcomes, as these require the most patients. To maintain at family-wise Type I error of 0.05 and 80% power using the method of Hsieh et al[27] for adjusted Cox regression models 2550 patients are needed. To adjust for losses to follow-up, we increased this estimate by 18% for a total of 3000 patients. Thus, all outcomes will have ≥80% power with alpha ≤ 0.05.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The ethical guidelines of the World Medical Association, Declaration of Helsinki and the legislation in Norway and Denmark guide the study (Declaration of Helsinki, 2008). At inclusion, a detailed letter informing the potential participant of the study, and the right to withdraw from the study at any time without any reason is underlined. The identifying key is kept in a separate file from the data. The data are kept in strict confidence in locked files at research servers to protect the participants' privacy. Approval by the Norwegian Regional Committee for Ethics in Medical Research in Western Norway has been granted (REK 2015/57), and from the Data Protection Agency in the Zealand region for the Danish centres (REG-145-2017). Written agreements between the Sponsor Coordinating Centre, and the local principal investigators and directors of the departments in each participating study centre, are signed before initiation of data collection. The study is registered at clinicaltrials.gov (NCT03810612).

PATIENT AND USER INVOLVEMENT

CONCARD[PCI] involves patients and stakeholders to target aspects of the patient journey to identify bottle-necks and carve out a user-friendly intervention. Patient involvement is carried out in several ways: Two patient representatives with a history of CAD, and trained to be patient representatives both in healthcare and research settings[28], provide input to the planning, implementing and reporting of results from the study. Representatives from all healthcare levels will be end users of knowledge from the project and are actively involved in the project through the CONCARD[PCI] Expert Group (Appendix). Reporting of patient involvement will follow the GRIPP 2 reporting checklists.[29]

COMMUNICATION OF RESULTS AND TRANSITION OF KNOWLEDGE

The CONCARD[PCI] has a close to practice and clinical approach, which will be an advantage in dissemination and communication with end users. Results will be disseminated to patients through patient organisations, and to healthcare professionals in PCI treatments teams and CR teams, as well as in primary care through seminars and scientific meetings. Due to the comprehensiveness of the outcome measures in the thematic projects (Table 4), numerous scientific papers are expected. Long-term follow-up will be reported as data becomes accessible. Authorship on publications from the study will be allocated using the guidelines for authorship defined by the International Committee of Medical Journal Editors and depends on personal involvement.

DISCUSSION

While medicine has produced large advances in cardiac treatment, there is need for more consistent patient pathways and systematic follow-up care. In order to do so, bottlenecks in the patient journey need to be identified. CONCARD[PCI] aims to close knowledge gaps related to four main areas: i) continuity of care, ii) health literacy and self-management, iii)

adherence to treatment and iv) healthcare utilization and costs of care. Although landmark cohort studies have been carried out to describe the aftercare of patients after acute MI, less is described of the patient journey, specifically after PCI, and rarely have these included extensive self-report from patients. In the past decade, an increasing number of studies using patient-reported outcomes have been performed, but in a different setting, with shorter follow-up and targeting subgroups of acute MI patients.[30-34] The US-based SILVER-AMI study focused on older adults[30], the VIRGO study[31] concentrated on younger women after acute MI, TRIUMPH[32] was designed to examine racial differences after acute MI, VICS[33] included both patients after acute MI and patients with heart failure, and NOR-COR[34] retrospectively surveyed patients below 80 years of age 2-38 months after the index event including also patients with coronary artery bypass surgery or no intervention. Age is of particular concern as it is documented that invasive strategies benefits clinically stable very old patients with non-ST-elevation acute coronary syndrome.[35] In contrast, CONCARD^{PCI} has an extended perspective by prospectively including adult patients with no age limit, engaging stakeholders throughout the study, applying a comprehensive interdisciplinary approach, and including data from national registries. One great asset of the participating Nordic countries is infrastructure in research with access to demographics and health information through the national registries. The registries include all citizens, and a personal identifying number ensures no loss to follow up. In addition to national compulsory registries on death (National Death Registry[23, 24]), readmission and use of healthcare services (National Patient Registry[25, 26]), and prescription and medication consumption (National Prescription Registry[21, 22]), the countries have disease specific national medical quality registries (e. g. NORIC). With establishing national registries, opportunities for nationwide comparisons and quality improvement of healthcare service is created.

While the aforementioned studies[30-34] also have detailed data abstracted from medical records and self-report, CONCARD[PCI] has a timely approach in the four thematic projects – one of which concerns health literacy, and specifically eHealth literacy, is of particular relevance in information technology driven societies. The AHA Scientific Statement on health literacy[2] calls for studies examining health literacy and cardiovascular outcomes beyond 30-day readmission. It is suggested that health literacy can be evaluated as part of programs aiming to improve secondary prevention in that health literacy influences drop-out rates in CR. CONCARD[PCI] responds to this challenge.

Lack of continuity of care and low health literacy are likely to carry increased healthcare utilization (e.g. readmission to hospital) and increased cost.[36] The potential need for re-thinking CR based on patient preferences and in-built economic analysis is a relevant path to follow. Moving towards a more patient-centred care aim to maximize patients' self-care abilities. Increased self-care is an overarching goal when healthcare expenditure rises to unaffordable levels. Further, in additional parameters, patient-reported outcomes can potentially identify patients at high risk of adverse outcomes and hospital readmissions[37, 38], which is of importance both to patients and society.

The importance of increased patient involvement and shared decision-making at all levels of healthcare is underlined in policy documents at a governmental and regional level.[39] Patient involvement is a unique feature of CONCARD[PCI] scarcely described in comparable large-scale studies. The use of standardized patient-reported outcome measures may provide information that can assist in this decision-making.[37, 38] In CONCARD[PCI], we include patient-reported outcome measures on a global, generic and disease-specific level,[40] and pose research questions related to patient pathways that concerns a large group of patients. We anticipate that treatment outcome (adherence), safe communication (continuity and health literacy) and self-management will prove important to future healthcare.

However, the study has some limitations. We lack participating hospitals from northern Norway. The remoteness and distance to the PCI centre is a feature of that area and therefore of particular concern. However, travel time to the PCI centre from the most remote fjords in western Norway is also long and this catchment area is included in the study (Figure 3). Further, we exclude patients with delirium and dementia due to ethical reasons regarding informed consent and logistical difficulties. Delirious patients and patients too clinically unstable to be included following the PCI procedure, who would otherwise be eligible, are re-assessed until discharge. Non-participants will be compared to participants on a limited number of registry variables to account for potential selection bias. Extensive self-report is a feature of CONCARD^{PCI}, and we use validated questionnaires and only a few de-novo-created questions based on patient interviews. Still, the response rate of follow-up (T1-T3) may be a potential limitation. However, previous methodological work in patients with CAD showed high acceptability of comprehensive questionnaires[41] and patient representatives participating in planning of CONCARD^{PCI} ensured relevance of the questionnaires.

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AUTHOR CONTRIBUTIONS

TMN is the principal investigator of CONCARD^{PCI} and was responsible for study conception, development of the project outline, and ethical approval. HA, GB, NF, TBH, TRP, IV, and SR contributed to the development of the project outline. HA is chairing the Scientific Advisory Board with CD, HH, RS and ADZ as contributing members. NF is the coordinator of the cohort study in CONCARD^{PCI} with TBH as national coordinator in Denmark, and AIL, BBe, BBo, PP, TBH and TBR are local principal investigators. CB and IS give specific input on

transition of care. GB, TRP, TBH and IV are leaders of thematic projects. JS is a major contributor in design of studies on serum levels of cardiac medications and Project 3 in general. TMN wrote the first draft of the manuscript. All authors revised the manuscript critically, and read and approved the final manuscript. A more detailed description of the roles of all authors are in the online Appendix.

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CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors have no competing interests.

STATUS

Data collection for the cohort study commenced on 12 June 2017 and is expected to continue until July 2020, with a 10-year follow-up until July 2029. The inclusion of patients for the blood sampling for objective medication adherence measurement has not yet started.

AVAILABILITY OF DATA AND MATERIALS

Datasets used and/or analysed during the current study with a limited number of variables are available from the corresponding author upon reasonable request, provided patient privacy can be assured, and after the study database has been closed. Analysis files (R scripts, SPSS syntaxes, other) can be made publicly available from the corresponding author upon reasonable request.

AUTHOR DETAILS

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REFERENCES

1. Batterham RW, Hawkins M, Collins PA, et al. Health literacy: applying current concepts to improve health services and reduce health inequalities. Public Health. 2016 Mar;132:3-12. 2018;138:e48-e74. doi:10.1161/CIR.0000000000000579.
2. Magnani JW, Mujahid MS, Aronow HD, et al. Health Literacy and Cardiovascular Disease: Fundamental Relevance to Primary and Secondary Prevention: A Scientific Statement From the American Heart Association. Circulation 2018;**138**:e48-e74. doi:10.1161/CIR.0000000000000579.
3. Piepoli MF, Corra U, Dendale P, *et al*. Challenges in secondary prevention after acute myocardial infarction: A call for action. *Eur J Cardiovasc Nurs* 2017;**16**:369-380. doi:10.1177/2047487316663873.
4. Timmis A, Townsend N, Gale C, *et al*. European Society of Cardiology: Cardiovascular Disease Statistics 2017. *Eur Heart J* 2018;**39**:508-579. doi:10.1093/eurheartj/ehx628.
5. Haggerty R, Freeman GK, Starfield BH, Adair CE, McKendry R. Continuity of care: a multidisciplinary review. BMJ. 2003;327(7425):1219–21.
6. Riley DL, Stewart DE, Grace SL. Continuity of cardiac care: cardiac rehabilitation participation and other correlates. *Int J Cardiol* 2007;**119**:326-333. doi:10.1016/j.ijcard.2006.07.158.
7. Barker I, Steventon A, Deeny SR. Association between continuity of care in general practice and hospital admissions for ambulatory care sensitive conditions: cross sectional study of routinely collected, person level data. *BMJ* 2017;**356**:j84. doi: https://doi.org/10.1136/bmj.j84
8. Prvu Bettger J, Alexander KP, Dolor RJ, *et al.* Transitional care after hospitalization for acute stroke or myocardial infarction: a systematic review. *Ann Intern Med* 2012;157:407-16.
9. Kotseva K, Wood D, De Bacquer D, *et al.* EUROASPIRE IV: A European Society of Cardiology survey on the lifestyle, risk factor and therapeutic management of coronary patients from 24 European countries. *Eur J Prev Cardiol* 2016;**23**:636-648. doi:10.1177/2047487315569401.
10. Naderi SH, Bestwick JP, Wald DS. Adherence to drugs that prevent cardiovascular disease: meta-analysis on 376,162 patients. *Am J Med* 2012;**125**:882-887. doi:10.1016/j.amjmed.2011.12.013.
11. Resurreccion DM, Moreno-Peral P, Gomez-Herranz M, *et al*. Factors associated with non-participation in and dropout from cardiac rehabilitation programmes: a systematic review of prospective cohort studies. *Eur J Cardiovasc Nurs* 2019;**18**:38-47. doi:10.1177/1474515118783157.
12. Aragam KG, Dai D, Neely ML, *et al*. Gaps in referral to cardiac rehabilitation of patients undergoing percutaneous coronary intervention in the United States. *J Am Coll Cardiol* 2015;**65**:2079-2088. doi:10.1016/j.jacc.2015.02.063.
13. Ho PM, O'Donnell CI, Bradley SM, *et al*. 1-year risk-adjusted mortality and costs of percutaneous coronary intervention in the Veterans Health Administration: insights from the VA CART Program. *J Am Coll Cardiol* 2015;**65**:236-242. doi:10.1016/j.jacc.2014.10.048.
14. Bakhai A, Ferrieres J, Iniguez A, *et al*. Clinical outcomes, resource use, and costs at 1 year in patients with acute coronary syndrome undergoing PCI: results from the

multinational APTOR registry. *J Interven Cardiol* 2012;**25**:19-27. doi:10.1111/j.1540-8183.2011.00690.x.
15. Swieczkowski D, Mogielnicki M, Cwalina N, *et al*. Medication adherence in patients after percutaneous coronary intervention due to acute myocardial infarction: From research to clinical implications. *Cardiol J* 2016. Jul 21. doi:10.5603/CJ.a2016.0048. [Epub ahead of print].
16. Inouye SK, van Dyck CH, Alessi CA, *et al*. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. *Ann Intern Med* 1990;**113**:941-948.
17. Bellelli G, Morandi A, Davis DH, *et al*. Validation of the 4AT, a new instrument for rapid delirium screening: a study in 234 hospitalised older people. *Age Ageing* 2014;**43**:496-502. doi:10.1093/ageing/afu021.
18. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res* 2006;8:e27. doi:10.2196/jmir.8.4.e27.
19. Hadjistavropoulos HD, Biem HJ, Kowalyk KM. Measurement of continuity of care in cardiac patients: reliability and validity of an in-person questionnaire. *Can J Cardiol* 2004;**20**:883-891.
20. Ho PM, Bryson CL and Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation 2009;119:3028-35. doi: 10.1161/CIRCULATIONAHA.108.768986.
21. Furu K. Establishment of the nationwide Norwegian Prescription Database. *Nor J Epidemiol* 2008;**18**:129-136. doi:https://doi.org/10.5324/nje.v18i2.23.
22. Kildemoes HW, Sorensen HT, Hallas J. The Danish National Prescription Registry. *Scand J Public Health* 2011;**39**(7 Suppl):38-41. doi:10.1177/1403494810394717.
23. Helweg-Larsen K. The Danish Register of Causes of Death. *Scand J Public Health* 2011;**39**(7 Suppl):26-29. doi:10.1177/1403494811399958.
24. Gjertsen F. Cause of death registry-an important data source for medical research. *Tidsskr Nor Laegeforen* 2002;**122**:2551-2554.
25. Bakken IJ, Suren P, Haberg SE, *et al*. The Norwegian patient register--an important source for research. *Tidsskr Nor Laegeforen* 2014;**134**:12-13. doi:10.4045/tidsskr.13.1417.
26. Schmidt M, Schmidt SA, Sandegaard JL, et al. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol* 2015;**7**:449-490. doi:10.2147/CLEP.S91125.
27. Hsieh FY, Lavori PW. Sample-size calculations for the Cox proportional hazards regression model with nonbinary covariates. *Control Clin Trials* 2000;**21**:552-560.
28. National Institute for Health Research: Involving users in the research process. A 'how to' guide for researchers. 2010.
29. Staniszewska S, Brett J, Simera I, *et al*. GRIPP2 reporting checklists: tools to improve reporting of patient and public involvement in research. *BMJ* 2017;**358**:j3453. doi:https://doi.org/10.1136/bmj.j3453.
30. Dodson JA, Geda M, Krumholz HM, *et al.* Design and rationale of the comprehensive evaluation of risk factors in older patients with AMI (SILVER-AMI) study. *BMC Health Serv Res* 2014;**14**:506-506. doi:10.1186/s12913-014-0506-4.
31. Lichtman JH, Lorenze NP, D'Onofrio G, *et al*. Variation in recovery: Role of gender on outcomes of young AMI patients (VIRGO) study design. *Circ Cardiovasc Qual Outcomes* 2010;**3**:684-693. doi:10.1161/CIRCOUTCOMES.109.928713.
32. Arnold SV, Chan PS, Jones PG, *et al*. Translational Research Investigating Underlying Disparities in Acute Myocardial Infarction Patients' Health Status (TRIUMPH): design and rationale of a prospective multicenter registry. *Circ*

Cardiovasc Qual Outcomes 2011;**4**:467-476. doi:10.1161/CIRCOUTCOMES.110.960468.

33. Meyers AG, Salanitro A, Wallston KA, *et al*. Determinants of health after hospital discharge: rationale and design of the Vanderbilt Inpatient Cohort Study (VICS). *BMC Health Serv Res* 2014;**14**:10. doi:10.1186/1472-6963-14-10.
34. Munkhaugen J, Sverre E, Peersen K, *et al*. The role of medical and psychosocial factors for unfavourable coronary risk factor control. *Scand Cardiovasc J* 2016;**50**:1-8. doi:10.3109/14017431.2015.1111408.
35. Tegn N, Abdelnoor M, Aaberge L, et al. Invasive versus conservative strategy in patients aged 80 years or older with non-ST-elevation myocardial infarction or unstable angina pectoris (After Eighty study): an open-label randomised controlled trial. *Lancet* 2016;**387**:1057-1065. doi:https://doi.org/10.1016/S0140-6736(15)01166-6.
36. Haun JN, Patel NR, French DD, *et al*. Association between health literacy and medical care costs in an integrated healthcare system: a regional population based study. *BMC Health Serv Res* 2015;**15**:249-249. doi:https://doi.org/10.1186/s12913-015-0887-z.
37. Rumsfeld JS, Alexander KP, Goff DC, *et al*. Cardiovascular health: the importance of measuring patient-reported health status: a scientific statement from the American Heart Association. *Circulation* 2013;**127**:2233-2249. doi:10.1161/CIR.0b013e3182949a2e.
38. Anker SD, Agewall S, Borggrefe M, *et al*. The importance of patient-reported outcomes: a call for their comprehensive integration in cardiovascular clinical trials. *Eur Heart J* 2014;**35**:2001-2009. doi:10.1093/eurheartj/ehu205.
39. Barry MJ, Edgman-Levitan S. Shared decision making--pinnacle of patient-centered care. *N Engl J Med* 2012;**366**:780-781. doi:10.1056/NEJMp1109283.
40. Norekvål TM, Fålun N, Fridlund B; Patient-Reported Outcomes in Cardiology (PROCARD) research group. Patient-reported outcomes on the agenda in cardiovascular clinical practice. *Eur J Cardiovasc Nurs* 2016 Apr;15(2):108-11.
41. Peersen K, Munkhaugen J, Gullestad L, *et al*. Reproducibility of an extensive self-report questionnaire used in secondary coronary prevention. *Scand J Public Health* 2017;**45**:269-276. doi:10.1177/1403494816688375.
42. Horne R, Weinman J, Hankins M. The Beliefs about Medicines Questionnaire: The development and evaluation of a new method for assessing the cognitive representation of medication. *Psychol Health* 1999;**14**:1-24. doi:https://doi.org/10.1080/08870449908407311.
43. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. *Ann Med* 2001;**33**:337-343.
44. Osborne RH, Batterham RW, Elsworth GR, *et al*. The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ). *BMC Public Health* 2013;**13**:658. doi:10.1186/1471-2458-13-658.
45. Oldridge N, Hofer S, McGee H, *et al*. The HeartQoL: part II. Validation of a new core health-related quality of life questionnaire for patients with ischemic heart disease. *Eur J Prev Cardiol* 2014;**21**:98-106. doi:10.1177/2047487312450545.
46. Horne R, Weinman J. Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *J Psychosom Res* 1999;**47**:555-567.
47. Hellström A, Hagell P, Fagerström C, *et al*. Measurement properties of the Minimal Insomnia Symptom Scale (MISS) in an elderly population in Sweden. *BMC Geriatr* 2010;**10**:84-84. doi:https://doi.org/10.1186/1471-2318-10-84.

48. Amofah HA, Brostrom A, Fridlund B, *et al*. Sleep in octogenarians during the postoperative phase after transcatheter or surgical aortic valve replacement. *Eur J Cardiovasc Nurs* 2016;**15**:168-177. doi:10.1177/1474515115620992.
49. Hibbard JH, Mahoney ER, Stockard J, *et al*. Development and testing of a short form of the patient activation measure. *Health Serv Res* 2005;**40**:1918-1930. doi:10.1111/j.1475-6773.2005.00438.x.
50. Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996;**34**:220-233.
51. Brostrom A, Hubbert L, Jakobsson P, *et al*. Effects of long-term nocturnal oxygen treatment in patients with severe heart failure. *J Cardiovasc Nurs* 2005;**20**:385-396.
52. Ensrud KE, Ewing SK, Taylor BC, *et al*. Frailty and risk of falls, fracture, and mortality in older women: the study of osteoporotic fractures. *J Gerontol A Biol Sci Med Sci* 2007;**62**:744-751.
53. Bjelland I, Dahl A, Haug T, *et al*. The validity of the Hospital Anxiety and Depression Scale: An updated literature review. *J Psychosom Res* 2002;**52**:69-77.
54. Thompson DR, Jenkinson C, Roebuck A, *et al*. Development and validation of a short measure of health status for individuals with acute myocardial infarction: the myocardial infarction dimensional assessment scale (MIDAS). *Qual Life Res* 2002;**11**:535-543.
55. Skudal KE, Garratt AM, Eriksson B, *et al*. The Nordic Patient Experiences Questionnaire (NORPEQ): cross-national comparison of data quality, internal consistency and validity in four Nordic countries. *BMJ Open* 2012;**2**:e000864. doi:10.1136/bmjopen-2012-000864.
56. Chan PS, Jones PG, Arnold SA, *et al*. Development and validation of a short version of the Seattle angina questionnaire. *Circ Cardiovasc Qual Outcomes* 2014;**7**:640-647. doi:10.1161/CIRCOUTCOMES.114.000967.
57. Hanestad BR, Rustoen T, Knudsen O Jr, *et al*. Psychometric properties of the WHOQOL-BREF questionnaire for the Norwegian general population. *J Nurs Meas* 2004;**12**:147-159.

Table 1. Description of centres participating in CONCARD[PCI]

	Centre 1 (HUS)	**Centre 2 (SUS)**	**Centre 3 (RH^{Osl})**	**Centre 4 (HGH)**	**Centre 5 (ZUH)**	**Centre 6 (RH^{Cph})****	**Centre 7 (OUH)**
Total hospital beds	1400	482	697	949	629	1377	1064
PCI procedures per year*	1565	905	2124	1290	921	2243	2633
Catchment area of number of local hospitals	7	1	9	4	5	5	6

Centre 1 is the Sponsor Coordinating Centre.
*Figures from 2017.
** RH^{Cph} has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region.
Abbreviations: HGH: Herlev and Gentofte University Hospital, Copenhagen, Denmark; HUS: Haukeland University Hospital, Bergen, Norway; OUH: Odense University Hospital, Odense, Denmark; RH^{Cph}: Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; RH^{Osl}: Oslo University Hospital, Rikshospitalet, Oslo, Norway; SUS: Stavanger University Hospital, Stavanger, Norway; ZUH: Zealand University Hospital, Roskilde, Denmark. PCI; percutaneous coronary intervention.

Table 2. Eligibility criteria for CONCARD^{PCI}

Inclusion criteria	• Patients undergoing percutaneous coronary intervention (PCI) • ≥ 18 years of age • Living at home at the time of index hospitalization and inclusion • Informed consent
Exclusion criteria	• Patients who do not speak Norwegian/Danish • Patients who are unable to fill in the questionnaires due to reduced capacities • Patients who are institutionalized • Patients with expected lifetime less than one year • Patients undergoing PCI without stent implementation, or related to Transcatheter Aortic Valve Implantation (TAVI) or MitraClip examination • Previous enrolment in CONCARD^{PCI} (readmissions)

Table 3. Socio-demographic, clinical and patient-reported measures, and timing of assessments in the CONCARD[PCI] prospective cohort study

Measure	Details	Self-report	Hospital medical records	National Registry	Time*	Project§
Socio-demographic data	Marital status, cohabitation status, education, work status, immigration status, income, rehabilitation participation, available support system, readmission to hospital, time of first meeting with general practitioner.	X		X	T0-T3	1-4
Clinical characteristics	Clinical status at admission (blood pressure, heart rate, laboratory results (hemoglobin, creatinine, troponin, total-, high/low density lipoproteins), body weight, height, waist circumference, upper arm circumference, medical history including comorbidity and frailty, and previous hospital admissions, procedural and angiographic findings including completeness of revascularization, complications during hospital stay, additional procedures, length of hospital stay, death.	X	X	X	T0	1-4
Medication	Medication at discharge (type and dosage), consumption of prescribed medication during follow-up, side effects from medication, polypharmacy, discontinuation, serum levels of cardiac medications (quantified using liquid chromatography with mass spectrometry).	X	X	X	T0-T3	3
Lifestyle	Physical activity (frequency, duration, intensity) sexual activity, tobacco use (current, previous, never), alcohol consumption (frequency, units per week), diet (frequency and amount of intake of different foods, beverages, supplements).	X			T0-T3	1-3
Healthcare utilization	Patients' use of the healthcare system (community vs. hospital-based services, specialist vs. general provider, urban vs. rural setting).	X		X	T1-T3	4
Internet use	Patients' use of electronic equipment with internet access, use of internet to find health information, and use of the web-portal helsenorge.no	X			T0-T3	2, 3
Major life events	Comprises three items assessing major life events.	X			T1-T3	1-3
Beliefs about Medicines Questionnaire (BMQ)[42]	Comprises 11 items (the BMQ-Specific) and assesses the key psychological constructs that underpin the core beliefs influencing adherence to medicines.	X			T1-T3	3
eHealth Literacy scale (eHEALS)[18]	Comprises 10 items and assesses patients' combined knowledge, comfort, and perceived skills at finding, evaluating, and applying electronic health information to health problems.	X			T0, T3	2

EQ-5D-5L[43]	Comprises 5 items and is widely used for measuring economic preferences for health states.	X			T0-T3	4
Health literacy questionnaire (HLQ)[44]	Comprises 20 items measuring four levels of health literacy: Appraisal of health information (5 items); social support for health (5 items); Ability to find good information (5 items); and Understanding health information (5 items).	X			T0,T3	2
Heart Continuity of Care Questionnaire (HCCQ)[19]	Comprises 33 items covering eight topic areas: heart condition explained, communication among providers, preparation for discharge, post-hospital review of treatment, receipt of conflicting information, information on medications and on physical and dietary needs.	X			T1	1
HeartQol[45]	Comprises 14 items with 10-item physical and 4-item emotional subscales.	X			T3	1-4
Medication Adherence Report Scale (MARS-5)[46]	Comprises 5 items and measures self-reported adherence to medicines, and assesses both intentional and unintentional non-adherence.	X			T1-T3	3
Minimal Insomnia Symptom Scale (MISS)[47, 48]	Comprises 3 items assessing major features of insomnia, i.e. difficulties initiating sleep, waking at night and not feeling refreshed by sleep.	X			T0-T3	1-3
Patient Activation Measure (PAM)[49]	Comprises 13 items assessing patient knowledge, skill and confidence for self-management.	X			T2	2
RAND-12[50]	Comprises 12 items with 3 to 5 response levels. It generates two health indices: mental and physical health.	X			T0-T3	1-4
Sleep Sufficient Index (SSI)[48, 51]	Comprises 2 items assessing amount of actual and desired sleep	X			T0-T3	1-3
Study of Osteoporotic Fractures (SOF index)[52]	Comprises 3 items and assess weight loss, inability to rise from a chair five times without using the arms and self-reported poor energy.	X			T0, T3	1-3
The Hospital Anxiety and Depression Scale (HADS)[53]	Comprises 14 items and determine the levels of anxiety and depression that a patient is experiencing, and generates 2 sub-scales; HADS-D and HADS-A.	X			T0-T3	1-4
The Myocardial Infarction Dimensional Assessment Scale (MIDAS)[54]	Comprises 35 items specifically measuring seven different domains of health status and daily life challenges in individuals who have suffered a myocardial infarction: physical activity (12 items), insecurity (9 items), emotional reaction (4 items), dependency (3 items), diet (3 items), concerns over medication (2 items) and side effects (2 items).	X			T1-T3	1-3
The Nordic Patient Experiences Questionnaire (NORPEQ)[55]	Comprises 8 items and gives a brief measure of patient experiences in evaluation of the quality of healthcare delivery.	X			T1	1

The Seattle Angina Questionnaire (SAQ-7)[56]	Comprises 7 dimensions of coronary artery disease: physical limitation, angina frequency and quality of life.	X			T0-T3	1-3
WHOQOL-BREF[57]	Comprises one global item on overall quality of life.	X			T0-T3	1-4

* T0: Baseline, T1: 2-month follow-up, T2: 6-month follow-up, T3: 12-month follow-up
§ Project 1: Continuity of care, Project 2: Health literacy and self-management, Project 3: Adherence to treatment, Project 4: Health care use and costs

Table 4. Definition of outcomes in CONCARD[PCI]

Outcome	Definition
Continuity of care	As measured by the Heart Continuity of Care Questionnaire (HCCQ).[19]
Health literacy and eHealth literacy	As measured by the Health Literacy Questionnaire (HLQ)[44] and eHealth Literacy Questionnaire (eHEALS).[18]
Adherence to medication	As measured by the Medication Adherence Report Scale (MARS-5)[46], Beliefs about Medicines Questionnaire (BMQ)[42] and data related to consumption of prescribed medication identified through national prescription registries, and serum levels of cardiac medication.
Healthcare utilization	As measured by patients' use of primary care services (general practitioner visits) and secondary care services (inpatient admissions and outpatient visits).
Healthcare (associated) costs	As measured by the tariffs of national agreements between the professional associations of medical specialists and the National Health Services, and the tariffs of the national case-mix system of the diagnosis-related groupings (DRG) and the ambulatory grouping system (DAGS).
Time to readmission	Cardiac and all-cause readmissions.
Time to death	Cardiac and all-cause mortality.
Time to major adverse cardiac events (MACE)	A composite of cardiac mortality and hospitalization for cardiovascular disease or chest pain.

FIGURE LEGENDS

Figure 1: Projects in CONCARD^{PCI} researching bottle necks for good and efficient patient pathways across levels of health care

Figure 2: Measuring time points and data collection in the cohort study in CONCARD^{PCI}

Figure 3. Study sites in cohort study in CONCARD^{PCI}

H= PCI centres including the local hospitals in their catchment area.
Copenhagen University Hospital, RH has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region.

ADDITIONAL FILES

Additional file: Scientific environment, collaboration and organisation of the project.

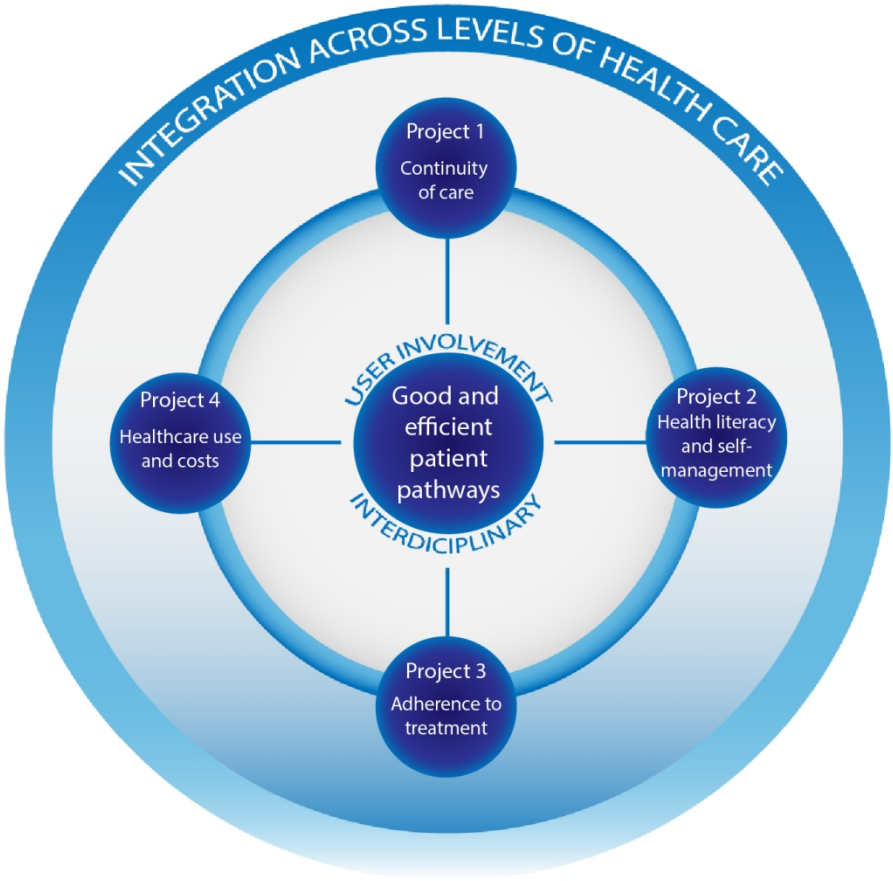

Figure 1: Projects in CONCARDPCI researching bottle necks for good and efficient patient pathways across levels of health care

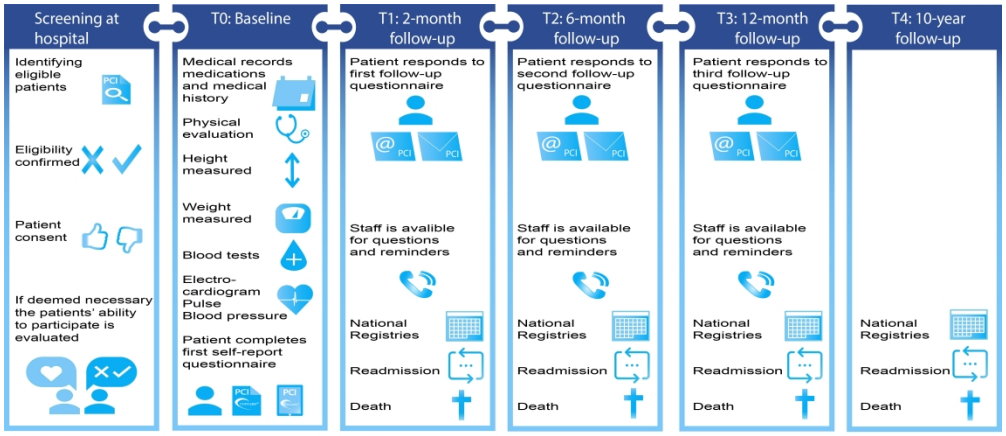

Figure 2: Measuring time points and data collection in the cohort study in CONCARDPCI

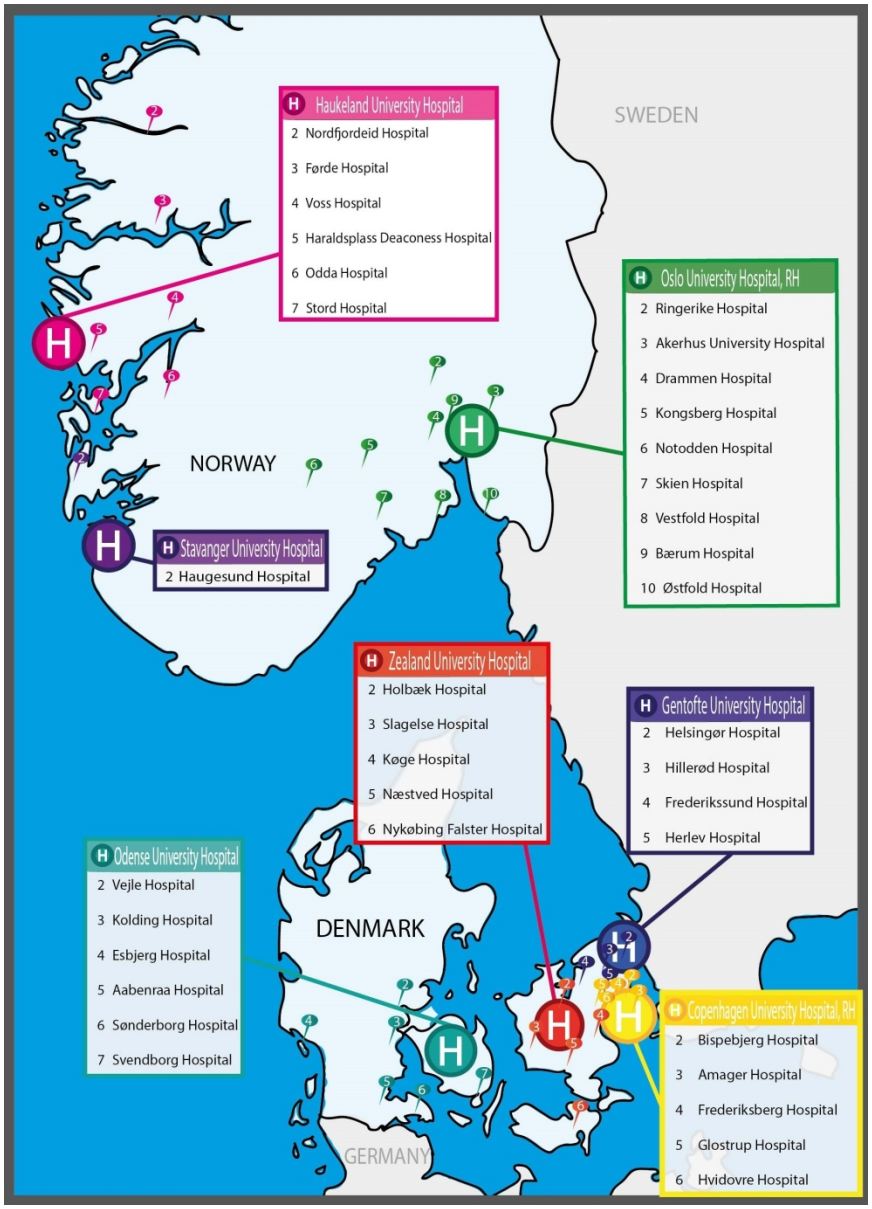

Figure 3. Study sites in cohort study in CONCARDPCI
H= PCI centres including the local hospitals in their catchment area.
Copenhagen University Hospital, RH has regional function for all ST-elevation myocardial infarction patients affiliated to the capital region and Zealand region

495x686mm (96 x 96 DPI)

APPENDIX

SCIENTIFIC ENVIRONMENT, COLLABORATION AND ORGANISATION OF CONCARD[PCI]

We have built a research team with a broad interdisciplinary profile involving local, regional, national and international collaborators. Collaborators range from emerging leaders as thematic project leaders to world-renowned senior scientists in the Scientific Advisory Board. Each member is a specialist in her/his field providing expert knowledge into the research project. An Expert Group who will be pivotal in translating evidence into healthcare has been established including representatives from Learning and Mastery Networks, Healthy Life Centres, health trusts, cardiac rehabilitation services, and patient organisations. Two patient representatives identified through the Norwegian Heart and Lung Patient Organisation are providing input to the planning, implementing and reporting of results from the programme. As these groups join forces, we will be especially well suited to undertake this large-scale registry-based multimethod multicentre study on patient pathways after percutaneous coronary intervention.

Table I. The Scientific Advisory Board of CONCARD[PCI]

Scientific Advisory Board	Institution	Expertise
Heather Allore, PhD, Professor of Medicine (Geriatrics) and of Public Health (Biostatistics), and Director of the Yale Program on Aging Biostatistics Core	Yale University, USA	Design and analysis of studies of multi-component interventions and observational studies of multifactorial health conditions.
Christi Deaton, PhD, RN, FAHA, FESC, Florence Nightingale Foundation Professor of Clinical Nursing Research	University of Cambridge, UK	Wide clinical and research experience in acute cardiovascular patient care. Contributed to clinical practice guidelines development (European level). Participated in the COURAGE Trial.
Heather Hadjistavropoulos, PhD, Professor of Psychology	University of Regina, CA	Quality of healthcare across the continuum of care including integrated care pathways. Developed the HCCQ.[19]
Ann Dorthe Zwisler, MD, PhD, Professor of Medicine	University of Odense, DK	Experience in programs of health and morbidity, rehabilitation and palliative programs.
Rikke Søgaard, MSc, MPH, PhD, Professor of Health economics	Aarhus University, DK	Econometric modelling for policy evaluation, and preference elicitation, and use of standardised measures for costs and outcomes measurement.

Table II. The Expert Group of regional, national and international collaborators of CONCARD[PCI]

Collaborators	Institution	Expertise
Torbjørg Aasen, Patient representative	The Norwegian Heart and Lung Patient Organisation	Experience from peer support.
Bjørn Bendz, MD, PhD. Associate professor, Head ICCU, interventional cardiologist	Oslo University Hospital, and University of Oslo	Experienced interventional cardiologist with his latest research on the oldest old and PCI.[35]
Cathrine Bjorvatn, RN, MSc, PhD, Associate professor, Head Learning and Mastery Services at Bergen Health Trust	Haukeland University Hospital, and University of Bergen	Chair of Network on Learning and Mastery including all three levels of healthcare; 24 municipalities as well as Haraldsplass Deaconess Hospital, and Haukeland University Hospital.
Ellen Blom, PTH, PhD-candidate	Western Norway University of Applied Sciences, Campus Sogndal	Physiotherapist with extensive research experience from Healthy Life Centres.
Gunhild Brørs, RN, MSc, PhD-candidate	St. Olav University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing.
Anne K Drange, BSc, Radiographer	Askøy Municipality	Head, Health and Care Services, Askøy Municipality. Project on multidisciplinary team follow-up of patients with severe heart disease in primary care.
Irene Drotningsvik, RN, MSc	Haukeland University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing. Co-leader of the Cardiac Rehabilitation Unit.
Bengt Fridlund, RNT, PhD, Senior Professor	Centre of Interprofessional Collaboration within Emergency care (CISE), Linnaeus University, SE	Long experience in cardiac research, supervised >50 PhD candidates, published 400 papers. PhD in one of the earliest research studies on cardiac rehabilitation.
Stig Igland, RN, MA, Chair of Network on Learning and Mastery Services at Førde Hospital Trust	Førde Hospital Trust	Extensive leadership and project experience from interdisciplinary rehabilitation and Learning and Mastery services across administrative levels.
Alf Inge Larsen, MD, PhD. Professor and interventional cardiologist.	Stavanger University Hospital and University of Bergen	Extensive experience in interventional cardiology and research leadership.
Jan Erik Nordrehaug, MD, PhD. Professor and interventional cardiologist	Stavanger University Hospital and University of Bergen	Built PCI network and logistics in Western Norway, >200 papers & extensive supervision.
Trond Røed Pettersen, RN, MSc, PhD-candidate	Haukeland University Hospital	Cardiovascular clinical nurse specialist with MSc in clinical nursing.
Svein Rotevatn, MD, PhD. Chair of NORIC, and interventional cardiologist	Haukeland University Hospital	Experienced interventional cardiologist and responsible for register data in CONCARD. Will be taking the lead together with Norekvål.
Maj-Britt Råholm, RN, MNSc, PhD, Professor	Western Norway University of Applied Sciences, Campus Førde	Clinical nurse leader and researcher, experienced in both qualitative and quantitative research methods.
Jan Schjøtt, MD, PhD, Professor, and senior consultant in clinical pharmacology	Haukeland University Hospital and University of Bergen	Experience in clinical pharmacology, drug information to health care professionals and patients, and pharmacovigilance.
Marit Solheim, RN, MA, Director Center of Health Research, Førde	Førde Hospital Trust, Western Norway University of Applied Sciences, Campus Førde	Experienced in interdisciplinary collaboration across institutions, and research across primary and secondary care levels.
Rune Stiansen, Patient representative	The Norwegian Heart and Lung Patient Organisation	Experience from peer support and cardiac rehabilitation.
David Thompson, RN, PhD, Professor	Queens University, Belfast, UK	Expert in developing disease-specific PRO measures[54], and novel psychosocial interventions.
Irene Valaker, RN, MA, PhD-candidate	Western Norway University of Applied Sciences, Campus Førde	Cardiovascular clinical nurse specialist with MA in organizational models in cardiac care.
Trine Vingsnes, MD, Cardiologist and Head of Department of Medicine	Førde Hospital Trust	Extensive experience in implementation of new clinical pathways between hospitals and primary care.
Tore Wentzel-Larsen, MSc, Biostatistician	Haukeland University Hospital, and Eastern Southern Health Trust	Statistical advisor in close to 200 scientific papers.

Table III. Project administration for the cohort study in CONCARD^{PCI}

Project administration	Institution	Role
Tone M Norekvål, RN, MSc, PhD, Chair PROCARD, Professor	Haukeland University Hospital, Western Norway University of Applied Sciences and University of Bergen, NO	Principal Investigator CONCARD^{PCI}
Nina Fålun, RN, MSc	Haukeland University Hospital, and Western Norway University of Applied Sciences, NO	Main project coordinator CONCARD^{PCI} Project coordinator Norway Centre coordinator Haukeland University Hospital
Tina Birgitte Hansen, RN, MSc, PhD, Post doc	Zealand University Hospital, Roskilde, and University of Southern Denmark, DK	Project coordinator Denmark Local PI and Centre coordinator Zealand University Hospital Leader Project 4
Irene Valaker, RN, MA, PhD-candidate	Western Norway University of Applied Sciences, Campus Førde, NO	Leader Project 1
Gunhild Brørs, RN, MSc, PhD-candidate	St. Olav University Hospital, NO	Leader Project 2
Trond Røed Pettersen, RN, MSc, PhD-candidate	Haukeland University Hospital, NO	Leader Project 3
Svein Rotevatn, MD, PhD, Chair NORIC, interventional cardiologist	Haukeland University Hospital, NO	Co-Investigator CONCARD^{PCI} NORIC data
Kristin Rykkje, RN **Kristin J Ramstad,** RN, MSc-student **Irene Instenes**, RN, MSc **Tom Jakobsen**, RN **Lisbeth Moldestad**, RN **Marie TN Hayes**, BA, MA	Haukeland University Hospital, NO	Study nurses Haukeland University Hospital Data management, Haukeland University Hospital
Alf Inge Larsen, MD, PhD. Professor, interventional cardiologist.	Stavanger University Hospital and University of Bergen, NO	Local PI, Stavanger University Hospital.
Mari Espedal, RN, ICN **Peggy Elin Bjørheim**, RN **Ulrika Eva Kulling Johnsson**, RN **Karen Stødle**, RN	Stavanger University Hospital, NO	Study nurses Stavanger University Hospital
Bjørn Bendz, MD, PhD. Assoc. professor, interventional cardiologist, Head ICCU.	Oslo University Hospital, and University of Oslo, NO	Local PI, Oslo University Hospital, Rikshospitalet
Rønnaug Dahlviken, RN, MSc **Tuva Grønsund**, RN **Liv Marit Torbjørnsen**, RN **Maren Leifson**, RN	Oslo University Hospital, NO	Study nurses Oslo University Hospital, Rikshospitalet
Trine Bernholdt Rasmussen, RN, MSc, PhD, Post-doc	Herlev and Gentofte University Hospital, DK	Local PI, Herlev and Gentofte University Hospital
Sofie-Amalie Kristensen, RN-student **Margrethe Herning,** CNS **Anne Kirstine Vinther,** RN **Kristina Brejnholt Jacobsen,** RN	Herlev and Gentofte University Hospital, DK	Study nurses Herlev and Gentofte University Hospital
Pernille Palm, RN, MSc, PhD	Copenhagen University Hospital, Rigshospitalet, DK	Local PI, Copenhagen University Hospital, Rigshospitalet
Signe West Christensen, MSc **Hanne Møller Kongshavn,** RN	Copenhagen University Hospital, Rigshospitalet, DK	Study nurses Copenhagen University Hospital, Rigshospitalet
Kirsten Charlotte Helmark, RN, MSc **Trine Schier Morsing**, RN **Ulla Werner Hansen**, RN **Mette Busk Hansen**, RN **Helle Back Schønemann**, RN	Zealand University Hospital, Roskilde, DK	Study nurses Zealand University Hospital, Roskilde
Carsten Toftager Larsen, MD, PhD, Head of the cardiac invasive laboratory	Zealand University Hospital, Roskilde, DK	Registry data
Britt Borregaard, RN, MSc, PhD-candidate	Odense University Hospital, DK	Local PI, Odense University Hospital
Astrid Trangbæk, RN	Odense University Hospital, DK	Study nurse Odense University Hospital

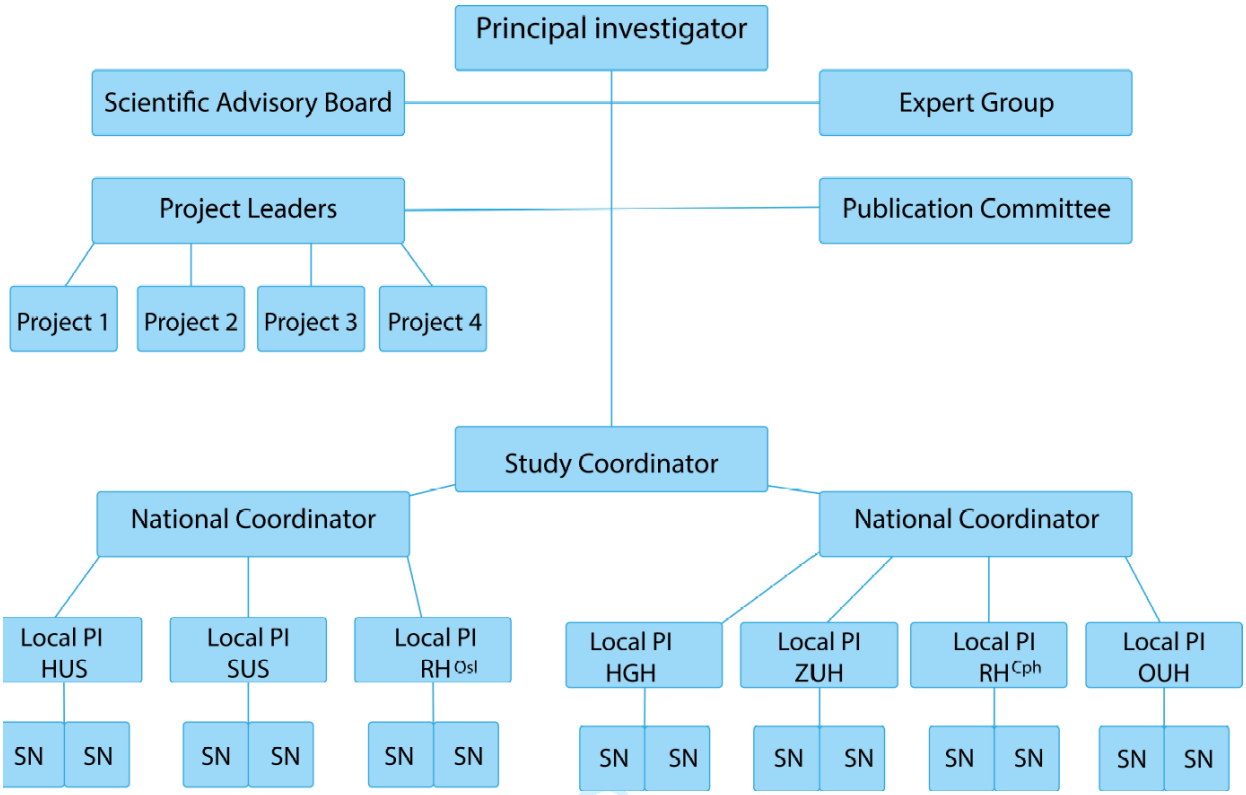

Figure I. Project organisation of the CONCARD^{PCI} cohort study

Abbreviations: HGH: Herlev and Gentofte University Hospital, Copenhagen, Denmark; HUS: Haukeland University Hospital, Bergen, Norway; OUH: Odense University Hospital, Odense, Denmark; RH^{Cph}: Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; RH^{Osl}: Oslo University Hospital, Rikshospitalet, Oslo, Norway; SUS: Stavanger University Hospital, Stavanger, Norway; ZUH: Zealand University Hospital, Roskilde, Denmark.