**Academic Knowledge Centers (AKCs):**
**a unique concept in Swedish primary care**

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In the mid-1990s in Sweden, the care of large groups of patients, including many with chronic disorders, was transferred from hospitals to primary health care. This change made it necessary to increase clinically relevant research in primary health care. To meet this need, Lund University and Region Skåne (the county council in Skåne, the southernmost county in Sweden) jointly founded in 2008 a clinical research unit dedicated to primary health care: the Center for Primary Health Care Research (CPF). The overall goal of the CPF is to conduct ground-breaking clinical research in order to increase the quality of primary health care and thereby improve public health. The clinical research is performed in close collaboration with primary care clinicians to exploit their ideas, experiences, and expertise. In order to build bridges between academia and primary care, the CPF established a network of nine Academic Knowledge Centers (AKCs) in Skåne. At each AKC, an active clinical researcher (AKC coordinator) employed by the CPF provides on-the-job assistance with tasks including study design, implementation and applying for research funding. Each AKC supports a fixed network of primary health care centers and the nine AKCs together support all 150 primary health care centers in Skåne. The AKC network has the potential to establish Sweden at the international forefront of clinical research in primary care. Its ethos and infrastructure could serve as a template for research collaboration between academia and clinicians in primary care around the world.

**Key words : Clinical research ; Primary care ; Sweden**

**Introduction**

Sweden is a social welfare state that offers unlimited medical care to all persons with a national identification number. It has a tax-financed health care system in which county councils are responsible for providing care. There are 1,124 primary health care centers (PHCCs) in Sweden, and patients make 51,000 visits to doctors in primary care every day. In 2011, primary care accounted for 16% of the county councils’ health care costs (a total of €4.65 billion).

The Center for Primary Health Care Research (CPF) is located in Skåne, the southernmost county in Sweden (Figure 1). Skåne has a population of 1.3 million residents, of whom 18% were born outside Sweden (the overall figure for Sweden is 13%). There are
150 PHCCs in Skåne, of which 40% are private (financed by taxes and regulated by contracts). Around 1,000 primary health care physicians and 3,000 primary care nurses are employed in Skåne.

Sweden (including Skåne) has a system of tax-financed “health choices”, which allows patients to choose an accredited PHCC. Requirements are placed on health care providers in the form of conditions for accreditation. Each PHCC is paid (through taxation) according to the number of registered patients it has. 80% of the reimbursement to the PHCC is based on burden of care measurements, which are themselves based on diagnoses, i.e. Adjusted Clinical Group (ACG) [1].

The remaining 20% of the reimbursement to the PHCC is based on the Care Need Index (CNI) [2]. The CNI was developed on the basis of Swedish physicians' rating of the impact of the following factors on their workload: elderly persons living alone, children under age 5, unemployed people, low educational status, single parents, high mobility and foreign-born people.

In Skåne, patients pay €18 per PHCC consultation (a hospital consultation costs €33). A consultation at a PHCC other than the one at which the patient is registered costs the patient €25 (and results in a deduction of approximately €120 from the reimbursement to the PHCC at which the patient is registered). Patients pay a maximum of €121 per year for consultations in primary plus hospital care.

Although today’s Swedish population is in many ways healthier than earlier generations, it is ageing. As a result, it suffers from a broad range of diseases, and new solutions are therefore needed in primary health care. These include improved medical care for those with the most serious diseases; optimised use of technology; better understanding of changing patterns of illness; development of better preventive health care; and empowerment of people to lead healthy lives.

Primary health care is an important area in terms of healthcare provision to the Swed-
The Center for Primary Health Care Research (CPF)
The CPF was established in 2008 following a 2004 report from an international committee, which recommended the establishment of a new institute of Primary Health Care Research in southern Sweden. The CPF is a modern center for patient-centered primary health care research. It is a collaborative venture between Lund University and Region Skåne (the county council in Skåne). The CPF’s Board includes health care providers and representatives of Lund University and Region Skåne.

The Faculty of Medicine of Lund University has a history of medical research extending over 300 years and is one of the most research-intensive university environments in Europe. Its research covers a wide variety of subjects, ranging from basic experimental research to applied, clinical research focusing on health care science and public health issues. Research in several important areas—epidemiology, stem cells and regenerative medicine, diabetes, neuroscience and cancer—is being coordinated by researchers at the Lund University-Region Skåne Clinical Research Centre (CRC), where the CPF is physically located. Situated in Malmö in the heart of the thriving Swedish-Danish Öresund Region, the CRC is one of Europe’s most modern translational research environments. It offers unique premises where the integration of research, teaching, clinical training, and health care facilitates the development of better diagnostics and more effective treatments. An important resource at the CRC is its 40 research groups, whose members include clinical and preclinical researchers who collaborate with the CPF.

The CPF’s overall goal is to conduct ground-breaking clinical research in order to increase the quality of primary health care and thereby improve public health. Importantly, we aim to increase scientific knowledge in primary health care and to connect research and practice. This aim will be achieved by performing research in collaboration with primary care personnel to exploit their ideas, experiences and expertise. Ideas are born in practice, as we like to say. Our research reflects family medicine’s many areas of responsibility (notably issues that are particularly important for primary care patients) and exploits our multidisciplinary team of employees, which includes physicians, nurses, physiotherapists, psychologists and social workers. Researchers who are clinicians also work clinically in primary health care.

The CPF boasts 11 research groups, four professors of family medicine and a further three university lecturers. These academics are complemented by two professors of social medicine/public health, one professor of health economics, one visiting professor from Stanford University and one visiting professor from the German Cancer Research Center. The CPF’s director, Professor Jan Sundquist, initiated a network of Academic Knowledge Centers (AKCs) in Skåne together with Professor Kristina Sundquist. In addition to their research, both Jan and Kristina Sundquist work clinically as primary care physicians.
Academic Knowledge Centers (AKCs)

Cooperation between academia and primary care empowers physicians and benefits patients. In order to foster such cooperation, the CPF established in 2008 a network of specialised PHCCs that engage in primary care research “on the ground”—so-called Academic Knowledge Centers or AKCs. The AKC network currently comprises nine AKCs in Skåne, each of which supports the research activities of other local PHCCs. Every PHCC in Skåne is linked to an AKC (Figure 1).

At the AKCs, health care professionals and students receive hands-on guidance in formulating and implementing their research ideas. Each AKC has an AKC coordinator, a clinically active researcher (PhD) who engages with health care workers who are interested in research and holds monthly research seminars at which all local health care providers are welcome to discuss their research ideas. The AKC coordinators act as research coaches, offering support with various kinds of activities, including starting up projects, quality development, establishing contacts with researchers, quantitative and qualitative research, biostatistics, scientific writing and applying for research funding.

The AKC network has conducted a number of successful projects. One AKC study published in 2012 showed that patients with type 2 diabetes and nephropathy who did not achieve a systolic blood pressure of $<140$ mmHg were at greatly increased risk of myocardial infarction, uraemia and death [3]. Another AKC study assessed renal function and use of medicines that may be harmful to patients with impaired renal function in elderly nursing home residents [4]. Further completed and ongoing projects have studied the effects of: (1) group yoga on hypertension; (2) physical activity prescriptions on hypertension; (3) kiosk-based electronic screening on physical activity levels [5]; (4) multi-professional physical activity referrals on physical activity levels [6]; and (5) group mindfulness on symptoms in patients with anxiety and depression.

The research coordinator network

To facilitate communication between PHCCs and researchers at the AKCs, and to further improve scientific competence in primary care, we have established an additional network comprising research coordinators. These research coordinators are health care providers of any profession who are responsible for scientific communication at their own PHCCs. They do not necessarily have a scientific background. Their main tasks are to know where to turn for help with scientific issues and which research facilities are available in Skåne, and to inform colleagues about research seminars and courses. The CPF and AKCs educate the research coordinators through courses and newsletters. The ultimate goal is for every PHCC to have a research coordinator who helps the AKC coordinators to disseminate important scientific discoveries and encourages the implementation of evidence-based medicine.

While it is clear that not everyone working in primary care wants to be a researcher, those who do wish to perform research should feel able to do so. In addition to providing practical help, the AKC network fosters a positive attitude towards research and a supportive atmosphere at PHCCs. The broad range of skills in primary care must be exploited, and the AKC network, together with the CPF, provides support to members of all professions in primary care and to projects of all sizes.
Teaching of research principles and practices at the CPF
The CPF is committed to teaching research principles and practice to the next generation of primary care physicians and holds a quarterly 5-day course in research methods for resident physicians. The course comprises lectures and seminars in subjects such as epidemiology, statistics, study design, scientific writing, evidence-based medicine and literature searching. The participants are able to apply the knowledge they acquire to the obligatory research project that forms part of their specialist training. Resident physicians are also given the opportunity to attend weekly seminars at the CPF, where they can discuss their research ideas and ongoing research projects with senior researchers and statisticians.

Together, the 5-day course and weekly seminars involve almost all AKC coordinators and researchers and other personnel at the CPF, and create a learning platform that attracts young researchers-to-be from the whole primary health care sector. In this way, the CPF acts as a vibrant and creative research hub that nurtures a new generation of scientifically competent health care providers.

Resources at the CPF
Experimental laboratory
The CPF's researchers and the AKC network are supported by a high-tech experimental laboratory—the first of its kind in Sweden dedicated to primary care research. The experimental laboratory team, which comprises two researchers, a doctoral student and a biomedical analyst, is currently conducting a range of studies to examine mechanisms behind chronic diseases and to identify molecular biomarker profiles that can predict disease occurrence and response to treatment. It manages a registered biobank to which CPF researchers and the AKC network have access.

Registers containing clinical and population data
The CPF manages nationwide clinical and population registers containing linked longitudinal individual-level data on the entire Swedish population, as well as geocoded information on the neighborhoods in which individuals live. Nationwide individual- and neighborhood-level sociodemographic data and nationwide data on cause of death, hospital care, cancer (from the Swedish Cancer Registry) and all in- and outpatient prescriptions for the entire Swedish population are linked using anonymous serial numbers, which protect the individual's integrity. The CPF also manages the Primary Health Care Register, which contains outpatient diagnoses from 75 PHCCs (mostly situated in Stockholm County) for 1 million unique individuals. The CPF's nationwide registers and the Primary Health Care Register allow the examination of many key research questions that are relevant for public health and primary health care patients.

As the only clinical specialists who work and take care of their patients in the patients' own neighborhoods, primary health care clinicians are able to develop hypotheses concerning environmental influences on chronic diseases. The nationwide registers allow for the assessment of cumulative environmental exposures from 1975 onwards and follow-up for health-related outcomes until 2010.

In order to achieve key research objectives, the CPF is also involved in the development of a new Family Medicine Quality Register in Skåne. The Family Medicine Quality Register will be established to safeguard and improve the quality of primary care; in-
crease the availability of medical data to health care providers; increase knowledge about chronic diseases that are usually treated in primary care; study, at the PHCC level, treatment outcomes and health economics related to diagnostic procedures and treatment; and facilitate primary health care research on somatic and mental disorders in Skåne. In this context, it is noteworthy that a search for all diagnoses of depression and anxiety in Sweden for the period 2001-2007 revealed that ~95% of such diagnoses were made in primary care (unpublished observation).

Development of the Family Medicine Quality Register coincided with the introduction of a new medical record system for all primary care in Skåne. Data in the register are collected automatically from all public and private PHCCs in Skåne without disrupting doctors’ work and include the following: age, sex, diagnoses (all types of diseases), laboratory data, sick leave, drug prescriptions, diagnostic procedures, height, weight and blood pressure. Future data collection could cover lifestyle habits (physical activity, diet, tobacco, alcohol), self-rated health and health-related quality of life, scales for mental symptoms, and scales for stress and pain.

The CPF’s registers are handled by three database managers. Researchers at the CPF and in the AKC network are able to use the registers for studies relevant to primary health care and receive support from highly skilled statisticians.

**Research conducted at the CPF**

The research conducted at the CPF covers a broad range of topics with clinical relevance to primary health care patients. For example, some CPF researchers are studying infectious diseases in primary care. Other CPF researchers are studying familial risks of cancers and thromboembolic diseases in order to develop prediction models that can be used in primary health care. Some of the studies Jan and Kristina Sundquist perform make use of the nationwide data registers described above; others are clinical projects with patients or participants recruited from primary health care settings. Some such projects use detailed data on patients’/participants’ lifestyles and analyse blood samples.

Jan Sundquist’s research currently focuses on the effects of socioeconomic status, migration, family environment and neighborhood on psychiatric health, while the primary research interest of Kristina Sundquist (who contributed to the development of the CNI [2]) is the influence of heredity, lifestyle, migration and neighborhood on cardiovascular health.

The CPF’s researchers are highly productive [7-19]. Between them they had 135 articles published by peer-reviewed journals in 2011 (including *JAMA* [20] and *Circulation* [21]) and 137 articles in 2012 (including *The Lancet* [22], *Archives of General Psychiatry* [23], *Circulation* [24] and *Lancet Oncology* [25]. A number of these articles are based on studies performed in collaboration with leading international researchers, including Professor Kenneth Kendler at Virginia Commonwealth University, USA [26-28]; Professor Kari Hemminki at the German Cancer Research Center in Heidelberg [29-31]; and Professor Marilyn Winkleby at Stanford University, USA [7, 32].

Identifying risk factors for diseases is a prerequisite to preventing their occurrence. Senior CPF researchers are committed to identifying the factors that influence the risk of diseases and other health outcomes affecting primary care patients, and have con-
ducted a number of studies with this general goal in mind. Some of our most recent studies are described below.

Risk of coronary heart disease and stroke among spousal caregivers of cancer patients [24]
Individuals diagnosed with cancer between 1987 and 2008 were identified in the Swedish Cancer Registry, a cancer database with nationwide coverage. Spousal caregivers of cancer patients were followed up for hospitalisation for coronary heart disease and stroke from the date their spouse was diagnosed with cancer until the end of 2008, and were found to be at increased risk of both coronary heart disease and stroke. This indicates that clinical attention should be paid to such caregivers, who may experience high levels of stress in their daily lives.

Increased risk of mortality in early childhood and young adulthood in individuals born prematurely [20]
674,820 individuals born as singletons in Sweden between 1973 and 1979 were followed up until December 2008 for death from all causes. 7,095 deaths occurred in this cohort during follow-up (a total of 20.8 million person-years). Low gestational age at birth was independently associated with increased all-cause mortality in early childhood and young adulthood.

Conclusions
Research networks in primary health care, such as the AKC network, build bridges between academia and clinics. This increases scientific skills at PHCCs and facilitates the conduct of patient-centered research in primary health care. Dedicated centers for primary health care research, such as the CPF, can conduct a range of studies that provide an immediate benefit to patients, including clinical, epidemiological and experimental studies. The establishment of centers similar to the CPF and of networks similar to the AKC network in other countries would be expected to contribute to the advancement of primary care research and local improvements in patient care.

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