UMEÅ UNIVERSITY

I Become Your Extended Arms

How Distance and Technology Redefine Teamwork in Rural Distributed Emergency Teams

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Abstract

In rural areas of Sweden, with limited resources and long distances between homes and services, small cottage hospitals (*Sjukstugor*) are essential for meeting the population's needs. Emergency care is provided around the clock by a team of staff members, not all of whom work from the cottage hospital during on-call hours. The team's physician operates remotely, while the registered nurse and nurse assistant are physically present with the patient. This situation is commonly referred to as a *distributed team*, in which some members carry out their duties in person at the location while others participate in team collaboration via video conferencing. Even though teamwork is crucial for patient safety, there is currently a lack of knowledge on how distributed teams perform in comparison with co-located teams. This thesis explores teamwork and taskwork in distributed teams during emergencies in rural healthcare. The research consists of four studies.

Study I is a literature review that thematically analyses relevant research to map the current knowledge of teamwork in distributed settings. Study II assesses the reliability and validity of an instrument for assessing team performance. Study III then uses this validated instrument to examine differences in team performance between distributed and co-located teams in simulation-based team training, employing statistical methods to compare these teams. Study IV uses a qualitative method to analyse focus group interviews with staff in distributed teams. It analyses their experiences in distributed teamwork and the language they use to describe their experiences.

Study I shows that distributed teams perform well when the technology is reliable and team members have received relevant training. Leadership is crucial for creating a sense of community and trust among team members, while communication via technology requires more time and clarity. The workload increases in distributed settings, and familiarity among team members plays an important role. Study II confirms the instrument's reliability and validity for measuring team performance in the distributed setting. Study III demonstrates that co-located teams perform better than distributed teams in emergencies overall. In Study IV, staff narrate their experiences in distributed settings, with registered nurses describing their expanded responsibilities as both challenging and stimulating. General practitioners value remote leadership but miss hands-on examinations, while nursing assistants note a closer patient connection with the general practitioners participating remotely.

The main findings indicate that, while there are similarities in teamwork between co-located and distributed teams, distributed teams face additional challenges in achieving effective team performance. Strategic training for staff working in distributed settings should be a key objective. This training should focus on using technology effectively to facilitate verbal and non-verbal communication. It should equip registered nurses to handle more clinical tasks and take on greater responsibility in the absence of a general practitioner. Furthermore, leadership training should focus on engaging and uniting the team towards common goals. A central challenge is how shifting roles and responsibilities in distributed teams can lead to increased workloads and potential conflicts, requiring the development of strategies to promote collaboration and minimise tension within the team.

Keywords: Rural area, cottage hospital, community hospital, distributed teams, telemedicine, teamwork, scoping review, validity, cross-over, simulations, focus groups, discourse psychology.

Enkel sammanfattning på svenska

I den här avhandling utforskas hur teamarbete och arbetsuppgifter påverkas i akuta sjukvårdsteam var medlemmar är skilda åt av geografi och som samarbetar via tekniska lösningar i glesbygdsområden.

I Sveriges glesbygdsområden, där långa avstånd och begränsade resurser utgör stora utmaningar för hälso- och sjukvården, spelar sjukstugor en viktig roll för att möta invånarnas behov. I dessa områden erbjuds akutsjukvård dygnet runt av personal som under jourtid inte arbetar på samma plats. Läkaren finns på distans medan sjuksköterska och undersköterska är på plats med patienten och samarbetet sker via videokonferens i så kallade *distribuerade team*. Trots att teamarbetets kvalitet är avgörande för patientsäkerhet, saknas idag kunskap om hur distribuerade team fungerar jämfört med samlokaliserade team, där alla teammedlemmar befinner sig på samma plats.

Avhandlingen består av fyra delstudier. Studie I är en litteraturöversikt där relevant forskning samlades in och analyserades tematiskt för att kartlägga kunskap om teamarbete i distribuerade team. I Studie II genomfördes statistiska analyser av ett instrument som mäter teamarbete för att säkerställa tillförlitlighet och giltighet även för distribuerade team. Instrumentet användes därefter i Studie III för att statistiskt jämföra skillnader i teamarbete mellan distribuerade och samlokaliserade teamarbetssituationer. I Studie IV användes en kvalitativ metod för att analysera fokusgruppsintervjuer med personal, med syfte att utforska deras erfarenheter och hur de talade om distribuerat teamarbete.

Studie I visade att distribuerade team kan samarbeta väl när tekniken är tillförlitlig och teammedlemmarna har fått relevant utbildning. Ledarskap var avgörande för att skapa en känsla av gemenskap och förtroende, medan kommunikation via synkrona tekniska lösningar krävde mer tid och tydlighet. Arbetsbelastningen ökade i distribuerade team, och om man tidigare hade arbetat med teammedlemmarna underlättade det samarbetet. Studie II bekräftade instrumentets giltighet och tillförlitlighet för att mäta teamarbete i distribuerade team. Studie III visade att samlokaliserade team överlag presterade bättre än distribuerade team i akuta situationer. I studie IV beskrev personal sina erfarenheter i distribuerade miljöer (där läkaren arbetade på distans). Resultatet visade att sjuksköterskorna fick ett ökat ansvar som uppfattades både utmanande och stimulerande. Läkarna uppskattade möjligheten att leda på distans men saknade förmågan att utföra kliniska undersökningar, medan undersköterskor noterade en närmare patientkontakt när läkaren deltog på distans.

Huvudresultatet i denna avhandling visar på många likheter i teamarbetet mellan samlokaliserade och distribuerade team, däremot möter distribuerade team fler utmaningar för att uppnå ett välfungerande samarbete. Kontinuerlig utbildning för personal som arbetar distribuerat är viktigt. Utbildningen bör fokusera på att använda tekniska lösningar effektivt för att underlätta interaktioner, både verbal och icke-verbal kommunikation samt ge sjuksköterskor träning i att hantera fler uppgifter och större ansvar i läkarnas fysiska frånvaro. Dessutom bör ledarskapsutbildningen syfta till att engagera teammedlemmarna mot gemensamma mål. En central utmaning är hur förändrade roller och ansvar kan leda till ökad arbetsbelastning och konflikter, vilket kräver strategier som främjar samarbete och minskar spänningar i teamet.

Abbreviations

A–E	Airway, breathing, circulation, disability, exposure
AI	Artificial intelligence
AR	Augmented reality
ATLS	Advanced trauma life support
CH	Cottage hospital
CRM	Crew resource management
DP	Discourse psychology
GEE	Generalised estimating equation
GP	General practitioners
ICC	Intraclass correlation
NA	Nurse assistant
NTS	Non-technical skills
PAGER	Patterns, advances, gaps, evidence for practice, research recommendations
PHTLS	Prehospital trauma life support
RN	Registered nurse
ScR	Scoping review
SBAR	Situation, background, assessment, and recommendation
SBTT	Simulation-based team training
TEAM	Team Emergency Assessment Measure
TIGER	Teamwork in Geographically Dispersed Emergency Teams in Rural Settings
UNDP	The United Nations Development Programme
VR	Virtual reality
WHO	World Health Organisation

Original Papers

I. Morian H, Creutzfeldt J, Hultin M, Härgestam M. Mapping leadership, communication, and collaboration in short-term distributed teams across various contexts: a scoping review. *BMJ Open*. 2024;14:e081878. Doi: 10.1136/bmjopen-2023-081878

II. Morian H, Härgestam M, Hultin M, Jonsson H, Jonsson K, Nordahl Amorøe T, Creutzfeldt J. Reliability and validity testing of team emergency assessment measure in a distributed team context. *Front Psychol.* 2023 Apr 20;14:1110306. Doi: 10.3389/fpsyg.2023.1110306

III. Morian H, Hultin M, Lindkvist M, Creutzfeldt J, Dubois H, Jonsson K, Nordahl Amore T, Härgestam M. Teamwork in rural emergency healthcare: a simulation-based cross-over study of co-located and distributed teams. *Simul Healthc*. 2024 Oct 17. Doi: 10.1097/SIH.0000000000000831

IV. Morian H, Hultin M, Creutzfeldt J, Dubois H, Härgestam M. 'We feel left alone out here': Dilemmas in teamwork among rural health professionals in distributed emergency settings. (In manuscript)

Preface

I have been connected to rural life for most of my life. My grandfather built a house in the roadless village of Daikanberg (*Daajkanvaerie* in Sápmi) in Lapland, where my grandmother gave birth to my mother at home. The official midwife who assisted her had to navigate the challenges of rural life, which included rowing across the lake in summer and skiing over the frozen lake in winter. As a midwife myself, stories from my family's history have always fascinated me, especially those describing how healthcare was provided under such challenging conditions. Living in a rural area does not shield you from accidents and illnesses. However, when such events occur, your distance from medical facilities and the limited resources in your area make it difficult to receive timely and adequate care. In Daikanberg, incidents with fatal outcomes have occurred, as well as those with fortunate outcomes. Examples such as falls from great heights and children getting their legs caught in snowmobiles have all been managed very efficiently, often with the involvement of local villagers.

Due to the limited resources at hand and the long distances to services, living in a rural area fosters a unique sense of community. When something breaks, you must solve the problem yourself, as the nearest plumber or electrician may be hours away and only sometimes available. Thus, people are more inclined to help one another in rural areas, using whatever resources they have.

However, even with this mentality, the need for healthcare workers with proper education and competence and a well-functioning healthcare organisation remains. My interest in patient safety and teamwork started with my work as a newly graduated nurse in an orthopaedic ward in 2004, where I quickly learned to be independent, often feeling a lack of support from my colleagues. Upon transitioning to midwifery in 2010, I discovered a new approach to teamwork. The strict boundaries between 'mine' and 'yours' were replaced with a culture that allowed for being a beginner, not knowing everything and asking for help. At the delivery ward, I was taught early on that students are our future colleagues, and we all want skilled colleagues to work with. Since then, I have carried this perspective with me: being able to learn within a supportive environment is of the utmost importance.

My involvement in patient safety and incident analysis investigations at the delivery and maternity wards deepened my understanding of the importance of teamwork, while emphasising the importance of recognising system failures rather than individual shortcomings.

Finally, although I have never been particularly fond of technology, its growing presence in healthcare is undeniable, and we must learn to handle it in the best possible way. I see how easily my children manage technology, which gives me hope for the future. Embracing these advancements can enhance our ability to provide safe and effective care, especially in distributed and rural healthcare settings.

Daikanberg, Midsummer in 2024
Hanna Morian

Introduction

As a nursing scholar, my research is grounded in evidence-based teamwork principles, which are central to nursing competence and practice and essential for patient safety (1). Each year, millions of patients worldwide suffer harm or poor outcomes due to failures within healthcare systems (2). Many of these incidents are linked to breakdowns in teamwork, including poor leadership, communication failures and inadequate collaboration between healthcare professionals (3).

In this thesis, I explore teamwork in rural healthcare. In this context, healthcare professionals are geographically separated and use technology to connect, forming what I will refer to as *distributed teams*. Within these small, interdisciplinary teams, registered nurses (RNs) collaborate with general practitioners (GPs) and nursing assistants (NAs) in highly demanding emergencies that require rapid decision-making under time pressure.

While patient safety and teamwork have been major focuses in urban and specialised healthcare centres (2), rural settings present unique challenges, such as fewer resources, longer response times and limited specialist access (4). Moreover, we know little about the specific teamwork challenges these teams encounter in rural healthcare and what is required for them to achieve effective teamwork and maintain patient safety – particularly in emergencies, when coordinated actions are critical.

Background

Rural Areas

Rural areas cover almost 50% of the world's land area (5). These regions are home to over 3 billion people and offer rich cultural and natural landscapes. However, living in rural areas presents significant challenges. Poor accessibility and infrastructure are common, and nearly 80% of rural residents live in extreme poverty (6). Globally, around 73% of Indigenous populations live in rural areas, where they face even greater socio-economic disparities, including poverty, exclusion and limited access to services compared with non-Indigenous populations (7).

Understanding and comparing rural areas is complex due to the varying definitions that exist. The United Nations Development Programme (UNDP) defines rural areas as communities with fewer than 150 inhabitants per square kilometre, while Japan sets the threshold at 500 inhabitants per square kilometre (5). This diversity makes it difficult to establish a universal understanding of rural conditions.

Rural Areas in Sweden

In this area, Sweden has challenges similar to those of the rest of the world, with a lack of a universally accepted definition of rural areas and their diverse conditions. In fact, a single national perspective may not accurately reflect all regions, necessitating flexible definitions. Rural areas in Sweden vary in population density, resource access, infrastructure and climate, making each region unique (8).

Applying the UNDP's global definition (150 inhabitants/km^2) (5) to Sweden, much of the country can be classified as rural, given that the entire country has an average population density of 25.9 inhabitants per square kilometre (9). Agencies such as the Swedish Board of Agriculture (*Jordbruksverket*) or the Swedish Agency for Economic and Regional Growth (*Tillväxtverket*) define rural areas based on service accessibility, labour market, population density and economic structure (8, 10). This thesis uses the definition provided by the National Swedish Agency for Rural Development[1] (*Glesbygdsverket*) in 1996. According to this definition, rural areas are more than a 45-minute drive from an urban centre with over 3,000 inhabitants (11). Additionally, in this thesis, communities with 'cottage hospitals' (CHs) (*Sjukstuga*) are regarded as rural, even if they do not strictly meet the official definition.

Unlike many developing countries, Sweden does not have issues regarding basic infrastructure, clean water access and food insecurity. However, rural areas – especially those in the north – present demographic challenges such as an ageing population, fewer working-age individuals and a gender imbalance, with more men than women (12). Most of Sweden's Indigenous population, the Sami, live in rural areas, particularly in the counties of Norrbotten and Västerbotten and along the mountain range. The Sami population in Sweden is estimated to be between 20,000 and 40,000. Since Sweden does not conduct censuses based on ethnicity, these figures remain approximate (13). Healthcare accessibility remains an ongoing issue in rural areas, which is explored in the following sections.

Rural Healthcare

Rural health is a pressing global concern, with populations becoming increasingly poor and less healthy than their urban counterparts. An estimated 2 billion people in rural areas lack adequate access to essential health services, significantly affecting their health outcomes (6). A major contributing factor is that most health workers live and work in cities, resulting in an imbalance in the provision of health services. In 2016, the World Health Organisation (WHO) estimated that at least 10 million health workers would be needed to achieve universal health coverage by 2030 (4). This global shortage of well-trained, skilled and motivated health workers is a core issue (6).

In Sweden, the Sami population reports a higher incidence of certain health conditions, including chronic pain, respiratory issues like asthma and challenges related to weight. Mental health concerns are also more prevalent among the Sami, with a greater proportion of individuals having considered

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[1] The National Swedish Agency for Rural Development (*Glesbygdsverket*), previously responsible for rural development issues, has been dissolved. Today, the Swedish Agency for Economic and Regional Growth (*Tillväxtverket*) has assumed its responsibilities.

or attempted suicide. Furthermore, many Sami have experienced situations in which they felt disrespected or discriminated against in healthcare settings (13). A register study by Hedman et al. found that the typical patient in rural Sweden is older, often with multiple chronic health conditions such as heart failure and pneumonia. In sum, these patients tend to have a higher burden of age-related health issues than those in urban hospitals (14).

Cottage Hospitals in Northern Rural Sweden

Globally, innovations have been necessary to provide high-quality and cost-effective healthcare in rural areas (15). In Sweden, the concept of CHs, which serve as local healthcare facilities in rural areas, is an initiative in this regard (16, 17). I use the term 'CH' because it is preferred by these institutions in northern Sweden. However, internationally, similar healthcare facilities are often referred to as 'community hospitals' (16). Four counties with vast landscapes covering half of Sweden's landmass – namely, Västerbottens, Norrbottens, Västernorrlands and Jämtlands – have a total of 15 CHs, mostly located in Västerbotten (**Figure 1**) and Norrbotten. These regions have some of the lowest population densities in Europe, sometimes fewer than one person per square kilometre (17). The number of registered inhabitants that depend on a CH for their care is roughly equivalent to the local population, such as in Tärnaby, which has around 500 inhabitants. There is a tendency for more local residents to register with a CH the further it is from an urban centre. In contrast, residents closer to urban areas have the option to register with other healthcare providers. During holiday seasons, particularly at ski resorts such as Tärnaby, the population can increase dramatically, sometimes tripling or more in size. To put this into perspective, if Stockholm, the capital of Sweden, experienced a similar influx, it would suddenly need to accommodate nearly the entire population of Sweden. While this is an extreme comparison, it highlights the considerable strain on CHs during peak times.

Although CHs function as primary healthcare centres during the day, they also take on broader responsibilities that extend their scope. They provide 24/7 emergency care, although they handle emergencies less frequently (than urban hospitals), as well as family medicine, obstetrics and gynaecology, paediatrics, minor surgery, rehabilitation and palliative care (17). Therefore, CH facilities include hospital wards, X-ray services, emergency rooms, and laboratory services (16), and their staffs comprise GPs, district nurses, RNs, NAs, physiotherapists, occupational therapists and midwives.

One of the greatest challenges for people living in rural areas is the lack of access to specialised healthcare in rural areas. For instance, the Tärnaby CH (**Figure 1**) is 350 km from the tertiary hospital in Umeå. This trip can take 4–6 hours by car, depending on the season and weather conditions. Ambulance services are typically located near CHs, but residents in need typically have long wait times, due to the extensive distances. Weather-related challenges, such as snowy roads and poor visibility, further complicate ambulance and helicopter transport. To overcome the challenges of distance and limited access to specialists, telemedicine has become a vital solution for CHs in rural areas.

Figure 1. Cottage hospitals in Västerbotten county. (1) Tärnaby, (2) Sorsele, (3) Storuman, (4) Vilhelmina, (5) Dorotea, (6) Malå and (7) Åsele. Three hospitals are also marked: two general hospitals in (8) Lycksele and (9) Skellefteå, and the University Hospital with specialised and referral care in (10) Umeå.

Telemedicine

Telemedicine, an essential e-Health component (18), refers to the provision of healthcare and the sharing of medical information over distances – in essence, 'medicine at a distance'[2] (19). The WHO defines telemedicine as follows:

> …the delivery of healthcare services where distance is a critical factor by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, all in the interests of advancing the health of individuals and their communities (20, p.2)

The word 'e-Health' is an umbrella term encompassing a range of digital solutions to improve healthcare. According to the Swedish National Board of Health and Welfare, *health* includes physical, mental and social well-being, while *e-Health* refers explicitly to the use of digital technologies and the exchange of information online to support and enhance health outcomes (21). e-Health covers telemedicine, telehealth, mobile health (m-health), electronic health records (e-journals), remote patient monitoring and digital tools for health education and preventive care (18). Unlike telemedicine, which focuses on clinical services delivered at a distance, *telehealth* encompasses broader health-related services, including public health, education and patient self-management.

Defining telemedicine can be challenging, as it lacks a single, definitive definition – much like the term 'rural areas'. Telemedicine-related terminology is often complex, with interchangeable terms, which makes it difficult for a single definition to capture its full scope. The application of telemedicine also varies, depending on the organisation implementing it (22). For example, telemedicine can involve videoconferencing for remote consultations, transmitting patient information such as medical history and lab results, and providing clinical and non-clinical services such as health monitoring and patient education (19, 22). Rather than being a specific technology or a new branch of medicine, the concept of telemedicine has

[2] 'Tele' originates from the Greek word *tele*, meaning 'far off'.

existed for decades; an early example is the two-way television system set up in 1964 between the Nebraska Psychiatric Institute and a distant hospital (19). What is relatively new about telemedicine is the digital infrastructure that now supports it. Today, high-speed Internet and broadband expansion have made telemedicine increasingly reliable and accessible. Smartphones and mobile technologies allow patients to manage their own health and communicate with healthcare professionals directly from their devices. Developments in artificial intelligence (AI) and machine learning have also led to advanced diagnostic tools, enabling more personalised treatments (23).

The COVID-19 pandemic accelerated the global adoption of telemedicine, which was seen as a critical tool for managing unforeseen catastrophes (24). However, this rise was not globally homogeneous. For instance, China experienced a high level of telemedicine implementation, while Europe saw moderate use and Africa had relatively low adoption rates (25). These disparities can be attributed to varying levels of awareness of telemedicine's significance, as well as differences in informatics literacy, the quality of existing infrastructures and strategic planning (25).

While telemedicine offers advantages such as improved access to care, cost-effectiveness and enhanced patient monitoring, it also has limitations. Poor Internet connectivity in low-income and remote areas reduces telemedicine effectiveness (25). In a review, Ftouni et al. identified several challenges associated with telemedicine during the COVID-19 pandemic (26); in particular, 18 studies noted significant concerns regarding physical examinations and diagnostic accuracy. Conducting physical examinations remotely is difficult, with many conditions still necessitating in-person evaluations. Ftouni et al. also found that poor audio-visual quality was a barrier that could cause delays in consultations. Moreover, healthcare providers and patients often lacked the technical skills to use telemedicine platforms effectively (26).

Telemedicine in Cottage Hospitals

Delivering specialist healthcare in rural areas remains a concern. The WHO suggests the employment of synchronous digital healthcare services to solve this issue by facilitating direct communication between providers and patients (20). This approach reduces mortality rates, enhances survival, improves accessibility and decreases unnecessary transfers (27-29).

In northern Sweden, Västerbotten county has pioneered the adoption of digital solutions to enhance primary healthcare services, starting with telemedicine in CHs as early as in the 1990s (17, 30). Since then, telemedicine has expanded, and the CHs in Västerbotten have invested in implementing telemedicine solutions to provide high-quality care and increase accessibility to residents (17, 30). Today, in the county of Västerbotten, all emergency rooms in CHs are equipped with videoconferencing systems, enabling connections to local physicians during on-call situations or to specialists in urban hospitals.

Although the literature uses various terms to describe telemedicine, I use the term ‘telemedicine’ in this thesis to refer to situations in which the physician is located remotely from a CH (i.e. from the patient and the rest of the team) and uses synchronous videoconferencing to participate in diagnosis and treatment and to interact with the patient and team. However, I primarily use the term ‘distributed teams’ because it explicitly highlights the geographical separation of team members – an essential aspect of medicine in rural settings, such as CHs, during on-call situations. These teams collaborate through information and communication technology during emergencies, thereby participating in telemedicine.

Teams

Teams are valuable work formations in situations where errors can have serious consequences, tasks are too complex for one person, the environment is uncertain and stressful, quick decisions are needed, or lives depend on collective expertise (31). In non-emergency medical situations, working in a team is also helpful for managing complex situations and critical healthcare tasks and ensuring patient safety (3, 32, 33). Regardless of urgency, the members of healthcare teams have high task interdependency and are usually hierarchically organised (31), as well as sometimes being geographically dispersed (34). Team members must integrate with the team, synthesise their efforts, share information, and coordinate and cooperate to achieve their goals (31). Research generally agrees that a team is a group consisting of at least two individuals who have specific roles, perform specific tasks, and collaborate to achieve a common (31). In comparison, Cooper and colleagues – the developers of the Team Emergency and Assessment Measure (TEAM) instrument used in this thesis for assessing non-technical skills (NTSs) – define a team as 'three or more individuals working together during an acute event' (35, p.376). Both definitions are important in this thesis: the broader definition captures the concept of teams and teamwork in healthcare settings, while Cooper et al.'s definition provides a focused perspective essential for assessing teamwork in emergencies in which NTSs are critical. While I acknowledge the patient as part of the context of a healthcare team that contributes to optimal outcomes and safety (36), this thesis focuses on teams comprising only healthcare staff.

Distributed Teams

Distributed teams are becoming increasingly common in complex organisations in the fields of healthcare, military and aviation (37, 38). Such teams are composed of geographically dispersed members who collaborate using information and communication technology (39). While distributed teams expand organisational flexibility, they also encounter unique challenges distinct from those of traditional co-located teams (40). In co-located teams, interactions are transparent, making it easier to assess teammates' actions and monitor visual cues for stress. Distribution, however, creates challenges, such as reduced ability to assess these cues and increased potential for communication barriers and cultural misunderstandings (41). The use of distributed teams has grown in the fields of rural healthcare and trauma care (42-45), especially in response to the COVID-19 pandemic (34, 46). However, research is lacking on how these teams maintain patient safety and effective teamwork.

Interprofessional Teams

Interprofessional teams composed of members from various professions benefit from the resulting broad knowledge base and wide range of skills. Each profession contributes unique perspectives and expertise, leading to a richer collective competence within the team (47, 48). Diverse teams tend to develop more innovative and effective solutions than homogeneous ones (48). Furthermore, in a healthcare setting, this role diversity can enhance care quality, improve communication and reduce hospital stays (47). However, Mitchell et al. have found that, while diversity can improve team effectiveness, conflicts arising from professional identity threats can negatively impact performance (48). Hierarchical structures that can hinder teamwork without clear roles and responsibilities present a challenge in interprofessional teams (47).

Interprofessional teams are used in various healthcare situations, and training for interprofessional teamwork across professional boundaries is an established part of nursing and medical undergraduate programmes (32). This type of teamwork reflects the reality of the clinical world that staff must manage.

Action and Ad-hoc Teams

The teams studied in this thesis operate in emergencies, working under time pressure and being assembled based on the personnel available during specific shifts. These types of teams can be described using various terms, with 'action teams' and '*ad-hoc* teams' being two commonly recognised classifications. Action and *ad-hoc* teams frequently operate in emergencies when timely and efficient performance is crucial (49), particularly during the 'golden hour' – that is, the first hour after a traumatic injury, when prompt medical treatment can significantly improve patient outcomes (50).

Edmondson et al. describe action teams as teams working under complex, dynamic and time-pressured conditions to perform essential patient care tasks. Such teams are often interdisciplinary, comprising members with specialised skills who must improvise and coordinate their actions in unpredictable situations (49, 51). While action teams operate in these high-pressure environments, *ad-hoc* teams are described as rapidly assembled teams whose members may have no prior experience working together. These teams often consist of well-trained staff who perform their tasks immediately upon formation, being under high stakes from the outset (52). Membership of *ad-hoc* teams often changes across shifts and rotations, with such teams comprising up to 72% of medical teams (52).

Both action and *ad-hoc* teams play vital roles in emergencies, requiring effective communication, coordination and flexibility to ensure successful outcomes in high-pressure situations (53). In this thesis, the teams are categorised as both action and *ad-hoc* teams, reflecting their roles' dynamic and high-stakes nature in emergency care settings.

Teamwork, Taskwork and Patient Safety

Understanding the concept of teamwork can be challenging due to its broad nature. Schmutz et al. discuss the definitions of teamwork and taskwork, emphasising the importance of distinguishing between them: *teamwork* refers to 'collaborative interactions among team members', while *taskwork* involves 'individual interactions with tasks, tools, machines, and systems' (54). In contrast, *team performance* is the cumulative result of teamwork and taskwork; it is not a product but rather a multilevel process (33, 54). Team performance encompasses a set of interrelated cognitions, attitudes and behaviours, and the optimisation of both technical task execution and collaborative processes is necessary in order to achieve effective team performance (31, 54).

The quality of teamwork directly influences patient safety, healthcare outcomes and the work environment. Hospitals with strong teamwork report lower rates of workplace injuries, harassment and staff turnover, with less burnout and greater job satisfaction. Thus, effective teamwork is essential for ensuring patient safety and addressing workforce challenges in healthcare (47), particularly in high-pressure and distributed environments (33).

The Swedish Patient Safety Act (*Patientsäkerhetslagen*) defines *patient safety* as 'protection against healthcare injuries' (55). The National Board of Health and Welfare (*Socialstyrelsen*) promotes good and safe care everywhere and always. No patient should have to suffer from a *healthcare injury*, which refers to any lasting physical or psychological harm, illness or death as a result of errors in healthcare (32). The report *To Err Is Human: Building a Safer Health System* underscored the importance of effective teamwork at all levels within healthcare organisations to improve patient safety and reduce instances of missed care (3). Although the report focused on the US context, its insights and recommendations have had a global impact. One of its ground-breaking insights was to shift the blame from individual caregivers to system failures, suggesting that many mistakes result from systemic issues rather than individual errors (3). Errors can occur at any stage, from diagnosis to treatment and preventive care (3). In Sweden, missed care results in extended hospital stays for approximately 50,000 patients, costing around 8 billion SEK annually. In addition, it is estimated that 2,000 patients suffer permanent damage due to medical errors in Sweden every year (32). Since many errors can be traced back to a failure in teamwork (3), the need for well-functioning teams is paramount to ensure patient safety.

Non-technical Skills

NTSs, which are needed for a healthcare team to function and perform, have been described as 'the cognitive, social and personal skills that complement workers' technical skills and contribute to safe and efficient task performance' (56, p.1). These skills typically include situation awareness, decision-making, teamwork, leadership and communication. Deficiencies in NTSs can increase the likelihood of errors and adverse events, whereas strong NTSs can significantly reduce these risks (56, 57). In contrast to NTSs, *technical skills* are the hands-on and practical abilities needed for job-specific tasks, such as the ability to perform medical procedures (e.g. safely managing medications). Such skills are crucial for professional practice and necessitate specialised training and experience (56). However, NTSs are also critical for a team to ensure effectiveness and success.

High-risk industries such as aviation and the military have long recognised the importance of NTSs (47). Analyses of several historical accidents[3] causing significant suffering and loss of life have revealed that failures in NTSs were often the root cause. These failures in NTSs are not unique to aviation and the military; their relevance is also increasingly acknowledged in healthcare (56).

While multiple NTSs exist, this thesis focuses on three key skills: *leadership, communication* and *collaboration*. Their meaning and use in this thesis are described below.

Leadership

Leadership in healthcare is essential to ensure that a team functions well and provides patients with the best possible care. According to the Swedish Healthcare Handbook (*Vårdhandboken*), a team consists of a leader and several team members (58), referred to as 'followers' (59). A team leader can be described as 'the person who is appointed, elected, or informally chosen to direct and coordinate the work of others in a group' (56, p.129).

[3] Notable examples include the 1977 Tenerife airport disaster, the 1979 Three Mile Island nuclear power accident and the 1986 Chernobyl nuclear power disaster.

The leader's primary role is to organise the team, distribute tasks and clarify the situation so that all team members are informed. By stepping back, the leader can gain a better overall view of the situation, reducing the risk of misjudgement. The leader must listen to the followers and delegate tasks in order to ensure the team works effectively together. Since a team is dynamic, the leadership role can shift between different individuals, depending on the situation; the most essential aspect of leadership is not who leads but rather that everyone in the team knows who it is (58).

Performance in healthcare emergencies requires effective team leadership, as poor leadership can lead to medical errors and patient harm. Most teams are hierarchically organised, and effective leaders create a safe environment for everyone to express opinions (58). Leadership also involves resolving conflicts without creating hostility (3). Rosen et al. have found that an inclusive leadership style promotes psychological safety, which enables teams to learn from mistakes and improve patient safety (47).

Power and leadership are related concepts within teams. In this context, *power* is a social phenomenon that signifies an individual's ability to influence the group (52). Teams may perform better when power hierarchies emerge because they can clarify roles and responsibilities, providing structure and direction (48). However, power does not always belong to the highest-ranking individual, especially when others have more knowledge or expertise regarding the specific task or situation (52). Also, leadership and power can negatively affect group dynamics by causing some members to be silenced or hesitant to contribute their knowledge (47).

Descriptions of effective leadership often emphasise the leader's physical presence in the room (58). Nevertheless, there is a limited understanding of leadership in distributed healthcare teams, raising the question of whether it functions similarly to leadership in co-located groups.

Communication

Communication within a team increases the likelihood of delivering high-quality, safe patient care. However, communication errors are common in healthcare, accounting for up to 70% of reported missed care. Such errors potentially lead to treatment delays, medication errors, patient falls, transfusion incidents, hospital-acquired infections and more (60).

Miscommunication is common in emergencies, as team members often encounter numerous disruptions that can easily interfere with communication and other critical factors necessary for effective teamwork. The hierarchical structure in healthcare can also hinder communication, as some individuals may hesitate to speak up or ask questions of someone in a higher position (37, 53, 54), increasing the risk of important information being lost or misunderstood.

Verbal and non-verbal communication – such as gestures or facial expressions – must be integrated into team communication in order for the latter to be effective. All team members must be clear in their communication, ensuring that information is conveyed in a way that is easily understood. Moreover, communication should be relevant, including only the necessary information and ensuring that the messages are delivered straightforwardly to the intended person. Using targeted communication, such as addressing individuals by name and making eye contact, increases the chances that the message will reach the intended person (58).

Effective communication involves not only speaking but also active listening. Active listening requires giving full attention to the speaker, understanding the message, responding thoughtfully and providing feedback. Maintaining eye contact with the speaker and paraphrasing what has been said can help avoid misunderstandings (58).

Standardised communication tools such as checklists (61), the communication technique SBAR ('situation, background, assessment, and recommendation') (62), and closed-loop communication provide structure and enhance information transfer, particularly by ensuring that information has been correctly conveyed (60, 63). SBAR originated from the US Navy in response to critical communication failures and has been shown to improve information clarity in high-stakes situations (62). In healthcare, SBAR is used in handovers: it involves providing a summary (situation), relevant information (background), an analysis of the situation (assessment) and suggested action (recommendation) (62). Closed-loop communication, also rooted in military practices, is used in emergencies to confirm that messages are received and understood. It involves three steps before the loop is considered complete: (1) the sender gives a call out, (2) the receiver acknowledges the message, and (3) the sender confirms understanding (63).

Research in other high-stakes industries, such as aviation and the oil industry, has demonstrated that information in distributed settings is often less complete, takes longer to transmit and is more challenging to interpret than that in co-localised situations (64). In aviation, for instance, pilots use technology to communicate with ground personnel; in the oil industry, offshore platforms must coordinate with teams on the mainland. Studies from the early 2000s have revealed that the communication limitations of distributed settings negatively impact other NTSs, such as situation awareness and decision-making (56). While research on communication in distributed teams within healthcare is still limited, it is known that misunderstandings, delays or incomplete information can have severe consequences, directly affecting patient safety and outcomes. Therefore, there is a critical need for more research to explore how communication technologies and strategies can be optimised to support distributed healthcare teams.

Collaboration

Collaboration is a broad aspect of teamwork that encompasses various aspects and perspectives. In this thesis, I use the TEAM instrument (**Appendix 1**) (65) as a comprehensive guide for interpreting collaboration. Within this context, I define *collaboration* as a team's capability to complete tasks and achieve goals within a reasonable timeframe, ensuring safe and correct care. The team must collaborate to prioritise care and treatment correctly, ensuring that everyone's role is clearly understood, while maintaining flexibility when needed. Even in stressful situations, the atmosphere should remain calm, with a positive team morale that includes openness to new ideas, mutual trust, tolerance for uncertainty, conflict avoidance and adaptability to changing situations (3, 58, 65). Trust and familiarity are also crucial for effective collaboration within teams, and the leader plays a key role in establishing and maintaining this trust. By fostering a culture of trust, the leader strengthens relationships within the team, leading to increased productivity and a greater commitment from team members to improve the quality of care (66). Regarding familiarity, Joshi et al. have shown that stable teams whose members had worked together before achieved better clinical outcomes and improved faster than *ad hoc* teams in which the members changed. Stable teams benefit from shared experience and knowledge of each other's work styles, strengths and weaknesses, allowing for better collaboration more quickly (67). Despite existing insights into collaboration within healthcare teams, research on how collaboration dynamics adapt in distributed healthcare settings is limited.

Simulation-based Team Training

Simulation-based team training (SBTT) effectively improves both technical skills and NTSs in healthcare (47, 68). Kohn et al. emphasise that errors in communication and shared understanding are among the most challenging areas to train, while being the most important for improving healthcare delivery (3). According to the Swedish National Board of Health and Welfare's national action plan for patient safety, the competencies of both new and experienced staff must be continuously developed through ongoing training (32). SBTT provides a structured approach for continuous competence development, especially since NTSs are identifiable and trainable competencies (47).

SBTT practice goes beyond passive lectures to current reality in clinical settings (69) and has been demonstrated to be more effective than traditional clinical education for achieving specific clinical skill goals (70). This type of training enables participants to face emergencies and uncommon conditions routinely, thereby increasing preparedness among staff who might otherwise seldom encounter such challenges (71). SBTT typically starts with an overview of objectives and environment, followed by the simulation itself. In SBTT, participants train with either a manikin or a patient actor who can display different physiological signs, conditions and diseases. The team members interact with the patient and the environment to resolve the scenario, performing as they would in real life within a representative timeframe (72).

After the simulation, the learning process begins: it starts with the 'scenario experience', followed by a 'debriefing' session in which 'new learning' is constructed. Finally, it concludes with 'applying the learning' in a clinical setting (69). The learning process typically encompasses technical skills and – even more importantly – NTSs. The scenario and its debriefing process are often run several times during an SBTT session.

Evidence suggests that teams perform better in crucial clinical actions after SBTT (73, 74). However, studies have reported conflicting results, especially regarding long-term effects (74). Criticisms of SBTT include the difficulty of maintaining skills over time without repetitive training (71). Moreover, SBTT is a resource-intensive form of training that requires significant investments in time, equipment and personnel. Some critics argue that the skills learned in SBTTs do not always transfer effectively to real clinical situations. Furthermore, participants may feel monitored and judged in a simulated environment, reducing their learning effectiveness (70).

Crew Resource Management

Inspired by team strategies in the military and aviation, healthcare has adopted similar approaches to improve patient safety. Both globally and in Sweden, crew resource management (CRM) is used in nursing and medical training for patient safety and teamwork, as well as in continuing education and team training in clinical settings (58). CRM is particularly relevant in this thesis, as the participants received CRM training during data collection.

CRM stems from the aviation field and originated from a workshop held by NASA in 1979, prompted by findings that many aviation accidents were due to human error – particularly communication errors, poor decision-making and poor leadership. Specifically, the horrific accident at Tenerife's Los Rodeos Airport in 1977 provided crucial lessons. In this tragedy, two planes collided on the runway, resulting in a loss of 583 lives (56, 75). This disaster and similar incidents led to the development of 'cockpit resource management' training procedures aimed at reducing pilot error by better utilising human resources in the cockpit. The name was later changed to 'crew resource management' to reflect the inclusion of the entire crew (59). Over several generations, CRM has evolved in aviation: initially focusing on authoritative behaviour among captains, it then expanded to include the rest of the crew and later emphasised specific skills, behaviours and decision-making processes (59).

Since the 1990s, CRM – also referred to as 'crisis resource management' – has been used in healthcare to emphasise effective and safe teamwork. In healthcare, CRM focuses on enhancing situational awareness, making and prioritising decisions, clear communication, strong leadership and followership, asking for help early and utilising all available information and resources (58, 76). As mentioned earlier, these NTS competencies are a central component of effective teamwork (56).

Structured Management

In the field of emergency medicine, structured approaches to decision-making and rapid intervention help prevent death or further disability. This medical speciality focuses on the immediate actions needed to evaluate, manage, treat and prevent unexpected illness and injury (77). In this thesis, the term *emergencies* is used to describe such events, which are also commonly described in the literature as 'acute care' or as involving the management of 'acute conditions' in a healthcare context.

A healthcare emergency can appear chaotic to an uninitiated observer. However, teams worldwide work and structure emergency healthcare work around the ABCDE (A–E) approach for managing critically ill patients. This method systematically evaluates each patient's vital systems: airway, breathing, circulation, disability and exposure (78). The primary goal of this assessment is to rapidly address and stabilise the patient's most life-threatening issues first, followed by sequential evaluation of the next vital system to achieve initial clinical improvement. This approach allows the team to buy time for treatment and diagnosis. After completing the initial A–E assessment, the team repeats these steps to reassess each vital system, monitoring for improvements or deterioration in the patient's clinical status (78, 79).

Theoretical Perspective

In this thesis, I use a variety of methods to explore teamwork in distributed teams, each of which contributes a different perspective. I have also been inspired by discourse psychology (DP) as both a method and a theoretical framework. DP is grounded in social constructionist principles that align with my ontological perspective that we create our understanding of the world through interactions (80). Moreover, my epistemological perspective is that knowledge is not an objective truth but is socially constructed and adaptable to cultural, historical and relational contexts (80). DP studies how individuals use language strategically to position themselves advantageously within social interactions and the consequences of this positioning (81, 82). Empirical studies in DP focus on language (micro-level) within a specific context (macro-level) to understand how discourses shape roles and power dynamics (82).

In this thesis, a distributed team (macro-level) comprises members from the nursing and medical professions who collectively bring a broad knowledge base and perform diverse tasks. Team members' identities are shaped by their professional roles, which are negotiated through ongoing communication to clarify responsibilities and coordinate tasks. Within the medical discourse, knowledge is central (83), and interactions in distributed teams focus on solving medical problems, assessing critically ill patients and preventing adverse events in emergencies (77). GPs typically hold the positions of leaders and experts in such teams due to their medical expertise. However, in distributed teams, traditional roles may need to be renegotiated as on-site team members collaborate with a remote GP, adapting roles, tasks, leadership and communication to meet the unique demands of the setup.

Central aspects of DP, such as interpretative repertoires, subject positions and ideological dilemmas, offer valuable tools for interpreting language use, social interactions and the negotiation of roles within distributed teams. *Interpretative repertoires* refer to the recurring ways individuals describe and make sense of the world around them. In everyday talk, individuals use interpretative repertoires to construct reality. Each repertoire gives the individual resources to construct a personal version of reality and can be contradictory and conflicting (84, 85). *Subject positions* define an individual's 'location within a conversation' (86), representing that person's roles and perspectives in specific interactions. These dynamic positions become relevant within conversations, allowing individuals to negotiate multiple subject positions. Individuals can position themselves or others in preferable (untroubled) roles aligned with norms or in non-preferable (troubled) positions that challenge norms and create tensions (84). *Ideological dilemmas* arise from conflicting values, beliefs or ideas in everyday talk, revealing the contradictory nature of ideologies. Billig et al. describe these dilemmas as interactions between different types of knowledge (87). In medical settings, tensions between scientific evidence and practical experience often emerge as team members navigate how to prioritise or integrate them. Shared cultural and societal beliefs also shape these dilemmas, which become apparent in teamwork when balancing competing demands, such as equity versus hierarchy or efficiency versus quality. These conflicts influence how roles are understood, collaboration occurs, and decisions are made.

Rationale

Rural healthcare operates under different conditions than healthcare in urban areas. However, the care provided must meet equally high standards to ensure patient safety. Limited accessibility, challenges in providing specialised care, and constrained resources have driven the adoption of technological innovations. One such innovation is the use of distributed teams in rural CHs during on-call hours; however, their impact on teamwork remains poorly understood.

This thesis is based on the assumption that teamwork failures can lead to serious patient harm, particularly in distributed environments where team members are physically separated. The lack of structured training for distributed teams in rural areas may negatively affect patient outcomes, making it crucial to understand how to optimise these teams for safer and more effective care.

Existing research on distributed teamwork in other contexts sheds light on challenges such as the absence of nonverbal cues, which can reduce team awareness, and technological barriers that complicate leadership, communication and collaboration. Still, the healthcare context – particularly in rural emergencies – presents unique complexities that require empirical exploration. This thesis addresses this gap by deepening the current understanding of distributed teamwork in emergencies, where rapid, coordinated action is crucial for patient safety.

Aims

Overall Aim

This thesis explores teamwork and taskwork in distributed teams during emergencies in rural healthcare.

Specific Aims

Study I aims to map knowledge on leadership, communication, and collaboration in short-term distributed teams across various fields.

Study II aims to report on the reliability and validity of TEAM for distributed teams managing acute medical conditions when the physician participates from a remote location via telemedicine.

Study III aims to explore how teamwork is affected by team situatedness in the Swedish rural context.

Study IV aims to analyse how team members position themselves while collaborating in a distributed setting during simulated emergencies.

Materials and Methods

As part of the Teamwork in Geographically Dispersed Emergency Teams in Rural Settings (TIGER) initiative, this thesis is grounded in a collaborative research programme involving Umeå University, the Karolinska Institutet and the Centre for Rural Medicine at Region Västerbotten. This thesis is based on four studies. **Study I** is systematic, explorative and descriptive in nature, while **Studies II** and **III** are quantitative, employing experimental and deductive approaches. **Study IV** is qualitative, taking an abductive approach. **Table 1** provides an overview of the studies.

Table 1. Overview of Studies I–IV.

Study	Design	Participants	Data collection	Analysis
I	Scoping review		Database searches, screening, extracting	PAGER (patterns, advancements, gaps, evidence for practice, and recommendations for future research)
II	Quantitative validation study	Students and HC staff: 27, teams: 9	Questionnaire, TEAM- assessments of SBTT	Psychometric analyses
III	Quantitative cross-over study	HC staff: 51, teams: 17	Questionnaire, TEAM- assessments of SBTT	Regression analyses
IV	Qualitative focus group interviews	HC staff: 51, focus groups: 17	Transcribed audio-recorded interviews	Discourse psychology

HC, healthcare; TEAM, Team Emergency Assessment Measure; SBTT, simulation-based team training

Setting

Study I

Since **Study I** is a scoping review (ScR), it does not focus on a specific physical setting. Instead, it explores research on teamwork in short-term distributed teams across various contexts, including the military, aviation, business and healthcare.

Study II

Study II was performed in a full-scale simulation laboratory at the Clinical Training Centre at Umeå University. This centre primarily trains nursing and medical students, offering a controlled environment where participants can practice and refine their technical skills and NTSs. The simulation laboratory is designed to replicate real-world clinical environments, allowing participants to engage in realistic scenarios within a safe and controlled setting.

Studies III and IV

Studies III and **IV** were conducted at CHs in Västerbotten county, Sweden's second-largest county, which is situated in northern Sweden. Västerbotten features seven CHs designed to serve its widespread and sparsely populated regions. In the past, each CH in Västerbotten was overseen by its own GP during on-call hours. The county then reconstructed these responsibilities; nowadays, a single GP may be responsible for several CHs – or, in some cases, for all seven within the county. Due to the considerable distances involved, it is not feasible for GPs to be physically present at the right location at the right time during an emergency. To address this issue, digitalisation has been implemented, allowing GPs to remotely participate in initial assessments and treatments via videoconferencing systems installed in each emergency room. Meanwhile, an RN and NA are physically present with the patient in the room.

Participants

Study I

As **Study I** is a ScR, no participants were recruited for the study.

Study II

The inclusion criteria were undergraduate medical students in their 10th or 11th semester at Umeå University, undergraduate nursing students in their 5th or 6th semester, and healthcare personnel – including NAs, RNs and physicians – at the emergency department at Umeå University Hospital. Recruitment took place from September to November 2021. Students were invited via email and oral announcements during their digital lectures and seminars, while healthcare personnel were recruited through their managers.

Participation was voluntary; before the study, participants were given the chance to decline participation.

Teams at three proficiency levels – beginners, intermediate and expert – were included in order to assess whether the TEAM instrument could detect performance differences across these levels. Sample size estimation was based on the research group's previous work, utilising the assumed standard deviation from that study (88). Calculations for the TEAM instrument, targeting 80% power and a significance level of 0.05, indicated that nine teams (three per proficiency level) were required.

A total of 27 individuals volunteered to participate, comprising medical students (n=3), nursing students (n=6), NAs (n=6), RNs (n=6) and physicians (n=6). They were divided into nine teams, each with three members, based on proficiency level: beginner, intermediate or expert (**Table 2**).

Participants' ages ranged from 25 to 43 years (median: 30 years), and their work experience ranged from 1.8 to 10.5 years (median: 4 years). Nearly all participants (96%) had previous experience in simulated team training. No team member in the intermediate or expert teams had prior experience in distributed team settings, while nearly half (44%) of the students at the beginner level had worked in a distributed setting. Furthermore, unlike their counterparts, the nursing and medical students had not previously collaborated with each other. All teams but one included both male and female members.

Table 2. Team compositions by proficiency level (Study II).

Team level	Participants in each team	Experience level
Beginners Teams 1–3	2 Nursing students 1 Medical student	Students
Intermediates Teams 4–6	1 Nursing assistant 1 Registered nurse 1 Physician	Less experience and less education than experts
Experts Teams 7–9	1 Nursing assistant 1 Registered nurse 1 Physician	Specialised training in emergency care and/or extensive experience

Studies III and IV
Eligible participants were NAs, RNs and GPs employed at one of the seven CHs in Västerbotten county. Recruitment took place between 2019 and 2021. Head managers at the CHs assisted in recruiting voluntary participants.

According to **Study III**'s initial sample size calculation, as outlined in the ethics application, the research team aimed to recruit approximately 12 teams to address the TIGER programme's research questions, with power calculation values being informed by prior work (89). As **Study III** progressed, the sample size was refined to align with the study's specific research objectives of comparing two independent groups (co-located vs. distributed teams). Based on detecting a difference of one standard deviation in TEAM instrument scores between the two scenarios, the final sample size was set at 17 teams, with 80% power and a significance level of 0.05.

A total of 51 participants, including NAs (n=13), RNs (n=21) and GPs (n=17), volunteered to participate in **Study III** and the subsequent **Study IV**. Teams were formed based on participant availability, considering individual schedules, work shifts for a particular day and willingness to participate. In total, 17 three-person teams were organised; of these, 13 teams comprised one NA, one RN and one GP, while four teams included two RNs and one GP. The same team members who participated in the SBTT (**Study III**) also participated in the subsequent focus group interview (**Study IV**). This sample comprised 42 (82%) females and 9 (18%) males, with ages ranging from 35 to 51 years (median: 42 years). The majority (88%) had previously collaborated with one or both of their team members. Furthermore, 14 (29%) participants had prior experience working in a distributed team environment.

Data collection

Selecting Articles
For the ScR in **Study I**, multiple databases – including PubMed, CINAHL, PsycINFO and Scopus – were searched in May 2021 to ensure comprehensive coverage of the literature. A research librarian guided the construction of search strings for each database and appropriate keywords (90). Manual searches were conducted for comprehensiveness. In addition,

in February 2023 and May 2024, the database search was updated to include the latest publications (90). The inclusion criteria are presented in **Table 3**.

In total, 6606 articles were initially reviewed against the inclusion criteria based on their title and abstract (90), in the order listed in **Table 3**. Those that met the criteria (n=379) were subjected to a full-text review in the subsequent stage (90). We used the software tools Rayyan and Covidence to facilitate the article selection (91, 92). Every article underwent independent screening by at least two researchers (90). Any discrepancies were addressed through discussion or by seeking input from a third researcher. The most common reason for exclusion was the extended time the teams worked together (n=141), followed by using the wrong type of technology (i.e. neither visual nor synchronised) (n=101). A total of 55 articles met the eligibility criteria after full-text screening.

Table 3. Inclusion criteria for the scoping review (Study I).

Number	Criteria
1	Articles available in English or Swedish
2	Focusing on key teamwork concepts of leadership, communication or collaboration
3	Involvement of at least one remotely located team member
4	Teamwork supported by synchronised audio-visual communication technology
5	Duration of collaboration within 24 hours

Questionnaires

In a questionnaire, the participants in **Studies II–IV** provided information about their background characteristics, such as age, gender, medical education and work experience. The questionnaire also included questions about their previous experience with team training and working in distributed medical teams relying on synchronised communication technology. This data was collected to describe the participants' characteristics and provide context.

Video Recordings

While **Studies II** and **III** used similar methodologies to collect audio and video recordings during SBTT, the two studies had some distinct differences; their similarities and variances are highlighted below.

Data were collected for **Study II** from September to November 2021 and for **Study III** from 2019 to 2021. In all cases, these recordings captured real-time teamwork and taskwork. The forms of communication captured included verbal and nonverbal cues and social interactions. Three iPads were installed in the emergency room to capture video footage from different angles, while the remote physicians were recorded via the live video feed. The captured data were transferred and stored on a dedicated hard drive.

Standardised Training Programme

Studies II and **III** shared the commonality of employing a standardised training programme lasting approximately 90 minutes. **Figure 2** illustrates the steps included in this programme.

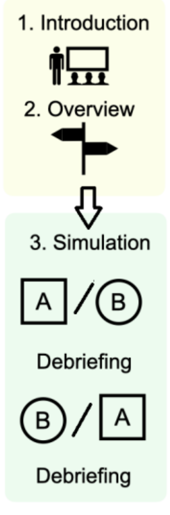

Figure 2. Flowchart of the standardised training programme for Studies II and III.
(1) Introduction: A theoretical introduction focused on patient safety and teamwork principles rooted in CRM (59) was given.
(2) Overview: Participants received an overview of the structure, including the assigned timeframe, their orientation within the environment, and an explanation of the roles of educational staff.
(3) Simulation and debriefing: After a handover from the facilitator, teams were instructed to assess and treat a patient with deteriorating vital signs. Each team participated in two scripted scenarios: *A* (the patient suffers a urosepsis) and *B* (a myocardial infarction). Team members followed standard procedures and medical guidelines to identify the condition and initiate treatment. The facilitator ended the scenario once vital signs were stabilised and a diagnosis and care plan was communicated. A facilitator-led debriefing followed, focusing on treatment and teamwork.

Scripted Scenarios and Standardised Patients

At the outset of the TIGER research programme, a team of physicians and RNs well-versed in the specific context developed the two clinical scenarios employed in **Studies II** and **III**. The scenarios were carefully designed to be comparable in complexity and to simulate a medical emergency that required immediate action. In addition, the patient diagnoses were clinically relevant and authentic to a rural CH. A standardised patient (i.e. a trained actor following a script (69)) was employed to replicate a realistic experience for the participants. This approach was chosen for **Study III** because it allowed for natural interaction between the patient and participants, in line with the broader TIGER programme, which explored patient participation using the same data material. The same setup was used for **Study II** because it ensured that the TEAM instrument would be validated in the same context in which it would later be used in **Study III.**

An RN who had extended experience in rural emergency care and was comfortable with acting portrayed the patient. She received training to follow a predetermined script, including medical and social history, in order to ensure that her responses were accurate and convincing in relation to the participants' interventions (69). Her clothing and makeup were also modified between the scenarios to represent various patient types. Two different patient diagnoses were portrayed: *Scenario A* involved a patient suffering from urosepsis, and *Scenario B* involved a myocardial infarction. The scenarios were structured so that the patient's condition deteriorated on the instructor's signal after approximately 2 minutes, which aligned with the team's completion of its first assessment of the patient's vital signs.

Team Setup

Despite their methodological similarities, **Studies II** and **III** also displayed several key differences, which are outlined as follows.

In **Study II**, the team composition remained consistent across both scenarios and used a distributed setup, as illustrated in **Figure 3**, to make it possible to validate this specific setup. In other words, the team's physician or medical student participated remotely via telemedicine, while the nurses (nursing students, NAs and RNs) were physically present with the patient in the emergency room. The case of urosepsis (*Scenario A*) always came first, followed by the myocardial infection (*Scenario B*). The research group implemented videoconferencing to facilitate remote collaboration between the physicians and proximal staff.

In contrast, **Study III** employed varied team compositions, allowing for a comparison of team performance between two different setups (co-located vs. distributed). Each team conducted one scenario with all team members co-located (i.e. in proximity to the patient), in which the patient suffered a urosepsis (*Scenario A*), and another with a distributed setting (i.e. the physician participated via telemedicine, while the RNs and NAs remained proximal to the patient), in which the patient suffered a myocardial infarction (*Scenario B*). The different setups are illustrated in **Figure 4**. Randomisation was employed to determine the flow of the scenarios, ensuring unbiased evaluation across team settings. Participants used the technical installations *in situ* at each CH for the distributed scenario. Although the screen placement in the emergency room varied across different CHs, the available resources were the same.

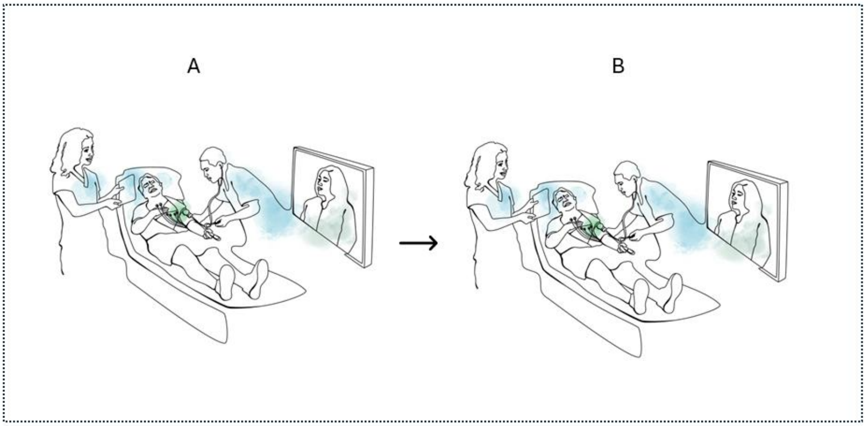

Figure 3. Team setup for Study II. All teams started with *Scenario A* (urosepsis) in a distributed setup, followed by *Scenario B* (myocardial infarction) in a distributed setup. (Illustration and copyright: Christina Heitmann)

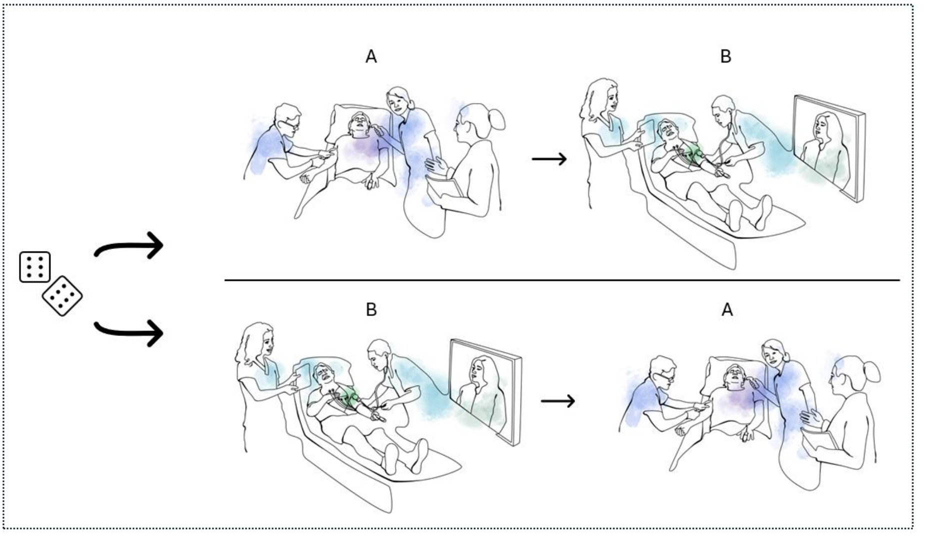

Figure 4. Team setup for Study III. Teams were randomised to start with either *Scenario A* (urosepsis) in a co-located setup or *Scenario B* (myocardial infarction) in a distributed setup. (Illustration and copyright: Christina Heitmann)

Instrument

In **Study II**, the TEAM instrument (**Appendix 1**) (65) was validated for a distributed team context; in **Study III**, it was employed to assess team performance in two distinct team compositions (co-located vs. distributed). Cooper and colleagues initially developed TEAM to assess team performance in adult resuscitation; the instrument is typically used by a trained observer or by peers following the conclusion of an event (35). Its application has evolved to include assessing NTSs in emergency teams in diverse contexts, such as emergency events managed by emergency teams and pediatric, obstetric or neonatal resuscitation teams (35). TEAM has been reported to be a valid and reliable assessment measure for NTSs in simulated and real clinical settings (88, 93) for both students and medical staff (88). Moreover, it has been translated into several languages (94, 95), including Swedish (96). We utilised the original English version for **Studies II** and **III**. Our raters' proficiency in English drove this decision, as did their familiarity and experience with teamwork and task work and the aim to reach an audience beyond Sweden.

TEAM is an item-based instrument with three domains: Leadership (2 items), Teamwork (7 items) and Task Management (2 items). Each domain contains several elements, with one or two items listed under each element. In the Leadership domain, the focus element for items 1 and 2 is *Leadership control*. Within the Teamwork domain, each element represents the items: *Communication* (item 3), *Cooperation and coordination* (item 4), *Team climate* (items 5 and 6), *Adaptability* (item 7), *Situational awareness: perception* (item 8), and *Situational awareness: projection* (item 9). The Task Management domain contains the elements *Prioritisation* (item 10) and *Clinical standards* (item 11) (**Appendix 1**).

Each item is evaluated on a 5-point Likert scale, reflecting the observed frequency of defined behaviours. The scale ranges from 0 (Never/hardly ever) to 4 (Always/nearly always). The maximum achievable total score is 44 (65, 97). According to Cooper et al., scores falling within the ranges of 33 or less, 34–39, and 40–44 indicate poor, good and excellent team performance, respectively (93).

In addition, item 12 is an *Overall* rating, determined on a scale of 1–10 and is provided based on the rater's overall assessment of team performance (65, 97). Scores below 7 indicate poor performance, while 9–10 indicate excellent performance (93).

Ratings

Studies II and **III** employed a similar approach when assessing the video recordings with the TEAM instrument. All three raters were involved in **Study II** from December 2021 to March 2022, and each rater assessed 18 video recordings. Raters 1 and 2 were involved in **Study III** from February to May 2023, and each rater assessed 34 video recordings. Rater 1 was a critical care RN with a PhD in nursing, while Rater 2 was a consultant physician in anaesthesia and intensive care and – at the time – a PhD student. Rater 3 was a resident physician in anaesthesia and intensive care medicine. Raters 1 and 2 had more than 12 years of experience as SBTT facilitators and raters, while Rater 3 had limited prior experience in SBTT facilitation and rating. Both genders were represented. As illustrated in **Figure 5**, the raters were trained and calibrated to achieve consensus in their assessments using the TEAM instrument in **Studies II** and **III.**

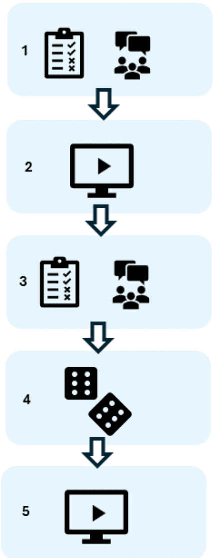

Figure 5. Calibration and assessment process for raters in Studies II and III.
(1) Raters were introduced to the TEAM instrument, and the meaning of each item was discussed to ensure a similar understanding of the behavioural markers.
(2) Raters independently practised assessment of video-recorded simulated team training; this content was not included in the studies.
(3) Raters discussed the rating procedure and established a common understanding of the instrument.
(4) Video recordings were coded and randomly assigned to the respective raters.
(5) Raters independently watched the video-recorded material and rated the teams' performance using the TEAM instrument.

Focus Groups Interviews

Qualitative data for **Study IV** were collected from 2019 to 2021. A total of 17 three-person, semi-structured focus group interviews were conducted to explore participants' perceptions of teamwork in a distributed team setting. Focus groups were chosen to generate discussions about the issue, capture interaction and discourses, and reveal diverse perspectives from different professions (98).

A focus group can be described as a small group of members who share specific characteristics or experiences. The group format allows them to discuss shared topics of interest relevant to the research objectives. This method is rooted in a social constructivist research tradition and differs from other interviews and observations by connecting to a collective understanding of the world. Participants in a focus group construct a shared frame of reference to understand their experiences. Through interaction with others, these experiences are modified, leading to the development of new knowledge. Empowering participants to express their opinions and highlighting the importance of their contributions are central to this method (99).

The interviews took place in rooms separate from the CH's regular activities. All interviews were conducted with one interviewer and one notetaker present. Participants were asked to discuss how they experienced working and collaborating in an emergency while in a distributed team composition, building on their experiences from reality and the team training. To ensure inclusivity, all participants – including those who tended to be more reserved – were specifically invited to share their perspectives in the discussion, ensuring that everyone had the opportunity to contribute. An interview guide was used that included open-ended questions such as, 'How did you perceive collaboration via telemedicine?' 'Can you tell me how you experienced communication via telemedicine?' and 'How did you perceive leadership via telemedicine?'. To clarify the answer or gain more information, follow-up questions included 'Could you please tell me more about this?'. The interviews lasted approximately 60 minutes. They were audio-recorded and transcribed verbatim for analysis, with the transcriptions being confirmed against the audio-recordings to verify accuracy.

Analysis

Charting and Extracting Articles

As an ScR, **Study I** aimed to map knowledge on leadership, communication and collaboration in short-term distributed teams across various fields. The following research questions guided this analysis:

1. What patterns related to leadership, communication and collaboration in distributed teams have been reported?
2. What progress has been made in research within the publication period of the included studies?
3. What knowledge gaps exist in the research field of distributed leadership, communication and collaboration?
4. What results from research on distributed leadership, communication, and collaboration in other contexts can be applied to the field of healthcare?

Information was extracted from the included articles by two researchers using Covidence, capturing details such as the author, title, year, country, study design, setting, and objectives and findings on leadership, communication and collaboration. I then conducted a review to ensure the accuracy and completeness of the data and to check for errors. Next, I organised the data into general characteristics (e.g. author information, study design) and three categories: leadership, communication and collaboration. Occasionally, I referred back to these characteristics to clarify or contextualise specific aspects of each category. Within each category, recurring themes were identified based on the PAGER framework (100), which encompasses the five domains of patterns, advancements, gaps, evidence for practice and recommendations for future research. The PAGER framework was chosen to enhance the quality of reporting in the ScR, as it addresses common shortcomings in presenting findings for an ScR, such as failing to identify gaps or provide research recommendations (100). **Table 4** provides an interpretation of the PAGER framework.

Table 4. Interpretation of the PAGER framework.

PAGER	Meaning
Patterns	Present the main themes arising in the analysis.
Advancements	Discuss how the field has progressed, theoretically and methodologically, within the literature.
Gaps	Discuss the areas that are lacking in research and those that have received considerable attention.
Evidence for practice	Highlight the practical implications – in this case, for health professionals and organisations working with distributed teams.
Research recommendations	Guide the direction of future inquiries.

Statistics

This section outlines the statistical methods and measurements employed in **Studies II** and **III**. **Study II** aimed to report on the reliability and validity of the TEAM instrument for distributed teams managing emergent medical conditions. By *reliability*, I refer to the instrument's ability to produce the same results consistently under similar conditions. However, reliability does not indicate what is being measured, and valid evidence is necessary. Thus, by *validity*, I refer to determining what concept(s) are accurately measured by the instrument (101). In contrast, **Study III** aimed to explore how teamwork is affected by team situatedness (co-located vs. distributed) in the Swedish rural context. SPSS versions 27 and 28 were used to perform the statistical analyses. **Table 5** provides an overview of the measures and statistical analyses used. Scorings from three raters (54 assessments) were used for calculations in

Study II, while scorings from two raters (68 assessments) were used in **Study III**, with no missing data in either study.

Table 5. Overview of the statistical analyses in Studies II and III.

Study	Measurements	Analysis
II	*Dependent variables (outcome):* TEAM: Leadership, Teamwork, Task Management and Overall *Independent variables:* Proficiency level, Scenario, Rater	Intraclass correlation (ICC) Cronbach's alpha Kruskal Wallis test Pearson's correlation
III	*Dependent variables (outcome):* TEAM: Leadership, Teamwork, Task Management and Overall *Independent variables:* Scenario, Randomisation, Rater	Cronbach's alpha Generalised estimating equation (GEE) GEE with ordinal logistic outcome

Descriptive Statistics

Descriptive statistics and measures of central tendency, including means, standard deviations, medians and quartiles, were used to describe the characteristics of the participants in **Studies II–IV**, such as gender, work experience, and previous experience in SBTT and distributed work. These measures were calculated for the entire study population and each subgroup – that is, NAs, RNs and GPs. Some missing values were found in the descriptive data and were excluded from the respective analyses.

Reliability Outcomes

Reliability, which confirms that measurements are consistently reproducible (101), was evaluated. In **Studies II** and **III**, Cronbach's alpha was calculated to explore internal consistency (i.e. the extent to which all items measure the same concept) (102). Internal consistency was calculated for the entire TEAM instrument (items 1–11) and within each TEAM domain (leadership, teamwork, and task management). In **Study II**, the intraclass correlation coefficient (ICC) was used to measure inter-rater reliability, determining the consistency or variation of measurements across different raters (103). Following a two-way random effects model for consistency and absolute agreement (103), ICC calculations were performed across each TEAM domain (leadership, teamwork and task management) and separately for each item (items 1–12).

Validity Outcomes

Validity, which ensures that the instrument accurately measures the intended concept (101), was calculated in **Study II** using parametric and non-parametric tests. Predictive validity measures how well the instrument's results forecast outcomes (101). Accordingly, the Kruskal-Wallis test was used to identify differences in TEAM scores within each TEAM domain (leadership, teamwork and task management) compared with teams' experience levels and scenario types (A and B). Concurrent validity indicates the level of agreement between two simultaneous measures or assessments (101). Using Pearson's method, correlations were calculated between item 12 (overall performance) scores and the three TEAM domains (leadership, teamwork and task management).

Generalised Estimating Equation

For **Study III**, the generalised estimating equation (GEE) was calculated to investigate the association between outcome measures: the TEAM instrument in total, its domains (leadership, teamwork and task management), and overall performance (item 12) in relation to the scenarios (A and B). A scale linear response was used to control for correlation within teams, with an exchangeable correlation matrix. The regressions were adjusted for order of randomisation and rater. In addition, the GEE with an ordinal logistic outcome was used to investigate the association between individual items and the scenario (A and B).

Data Distribution and Statistical Criteria

Before conducting the primary analyses, the distribution of the TEAM instrument scores was assessed for skewness and normality to determine the appropriateness of parametric or non-parametric testing. In the statistical analyses conducted across **Studies II** and **III**, a *p*-value of less than 0.05 was considered statistically significant. For the ICC, based on the 95% CI, values less than 0.5 indicate poor reliability, values between 0.5 and 0.75 suggest moderate reliability, values between 0.75 and 0.9 indicate good reliability and values greater than 0.90 represent excellent reliability (103). The internal consistency was considered good when the coefficient ranged between 0.7 and 0.9 (102).

Discourse Psychology Approach

In **Study IV**, the audio-recorded focus group interviews were transcribed verbatim. An iterative process was employed. I started by listening to the recordings and carefully reading all transcripts to adjust any potential errors and avoid misinterpretation. Six transcriptions were then selected for in-depth analysis, reflecting the participants' variation in age, gender, ethnicity, and experience working in distributed settings.

The analytical framework was guided by discourse psychology, which focuses on how language constructs meaning and shapes social interactions (104). The analysis began with multiple readings of the transcripts to identify recurring themes and patterns in the participants' accounts of teamwork in distributed settings. These patterns were then organised into *interpretative repertoires* that captured recurring ways in which teamwork in distributed setting had been talked about or made sense of (84). Building on these repertoires, the analysis then explored *subject positions*, identifying moments in which the participants positioned themselves or others as being aligned with expectations (i.e. untroubled) or in conflict with expectations (i.e. troubled) (86). We paid attention to how the participants positioned themselves and others within the unique context of distributed teams. Lastly, *ideological dilemmas* – that is, contradictions in value or beliefs – were analysed to uncover tensions between competing values (87). These dilemmas provided insight into the complexities of distributed teamwork and how the participants managed conflicting demands.

During this abductive approach, we iteratively shifted back and forth between the empirical material and theory to deepen our understanding of how participants talked about distributed teamwork. To ensure the robustness of the findings, the initial analysis of the six selected transcripts was extended to the remaining data, validating the identified repertoires, subject positions and dilemmas. Regular discussions among the research team further refined the interpretations and ensured coherence between the theory and empirical material.

Ethics

Students and healthcare personnel participated in **Studies II–IV**. The Swedish Ethical Review Authority evaluated our applications (Registration no: 2021-01027; date of decision: 2021-03-22; Registration no: 2019-00148; date of decision: 2019-01-08). Since no interventions specified under Swedish ethics legislation (104) were involved, the study was exempt from formal approval, and no ethical objections were raised. In adherence to the Declaration of Helsinki guidelines (105), informed consent was obtained from all participants, who were informed of their right to withdraw at any time. Participation was voluntary, and information about the studies was provided both orally and in writing. The participants were reassured that the team training would proceed regardless of their involvement in the research.

Particular consideration was given to the sensitivity of the video recordings, which could not be anonymised or pseudonymised. These recordings were stored on a secure, dedicated hard drive, locked and accessible only to authorised personnel. Furthermore, while participating in SBTT, participants might be exposed to stressful situations and feel anxious about being monitored, which could cause further nervousness if they felt that their shortcomings were becoming visible. Therefore, creating a supportive environment during the SBTT was essential to minimise stress. Their participation in **Studies II** and **III** provided the healthcare staff with valuable team training, which was considered an ethical benefit, as it helped enhance the participants' teamwork and taskwork skills and contributed to their overall competency within the healthcare organisation. Moreover, **Study IV** promoted reflection on distributed teamwork, supporting self-awareness and helping participants identify potential areas for improvement.

Results

Distributed Teamwork Across Fields

In **Study I**, an ScR, we aimed to map knowledge on leadership, communication and collaboration in short-term distributed teams across various fields. The results included 55 publications from 2001 to 2023, encompassing different types of literature, such as journal articles, book chapters, conference papers, systematic reviews and theses. In this thesis, I use the term 'article' to refer to any literature included in the study. These articles explored a range of contexts, including healthcare, the military and business. The diversity of these contexts sometimes led to heterogeneous findings. Moreover, the findings related to leadership, communication and collaboration were not always separated but tended to overlap, as evidenced by the fact that the articles often simultaneously addressed more than one of these teamwork aspects. The findings are presented below in a narrative summary. For a detailed result of the PAGER framework, please see **Appendix 2**.

Terminology

The term 'virtual team' was the most frequently used term for distributed teamwork (n=39) in the articles that described the researched team setting. However, in this thesis, I continue to use the term 'distributed teams' because of its clear definition and its emphasis on geographical distance. The team structures in the included articles ranged from fully distributed to partially co-located, with a focus on technological collaboration. The effectiveness of these teams appeared to be influenced by contextual factors such as team size, the nature of the task and the team's level of experience (106, 107).

Teamwork in a Distributed Medical Context

A subset of the included articles (n=9), published between 2008 and 2021, specifically examined distributed teamwork in healthcare settings. These studies often focused on simulations, experiments or randomised trials involving healthcare professionals, exploring themes such as remote leadership in trauma teams and the impact of distributed teams during crises such as the COVID-19 pandemic. Some articles also reviewed existing research on distributed teamwork in healthcare.

These studies revealed that remote leaders in trauma teams often maintained a hierarchical structure, mainly communicating with senior members who, in turn, informed junior staff. During urgent situations, the leaders increased their communication and gave more direct instructions (45). The geographical distribution of team members did not seem to affect care delivery or teamwork in mass casualty and trauma care studies (43, 44, 108). However, a notably heightened workload was observed in distributed teams. Despite this increased workload, effective teamwork was critical to maintaining the quality of care (43). A study by Butler et al. concluded that the successful implementation of telemedicine requires strong teamwork. In a study by Fang et al., videoconferencing between a neonatologist and a bedside care provider improved efficiency and adherence to protocols in neonatal resuscitation. The care providers followed the guidelines more precisely and achieved adequate ventilation faster than those who performed their tasks without remote neonatal support (109). Moreover, videoconferencing in medical settings proved beneficial compared to telephones by fostering interaction among team members. This technology also supported better multitasking and the development of a shared mental model (42). When visual contact was available, the physicians engaged in the intervention more actively, resulting in more effective interventions and improved patient outcomes (42).

The COVID-19 pandemic further accelerated the need for telemedicine and videoconferencing. Both Kennel et al. and White et al. emphasised that these distributed setups enabled healthcare teams to manage increased workloads and communication challenges, improving coordination and patient care during the crisis (34, 46).

Teamwork in Other Distributed Contexts

The importance of using an appropriate leadership style in distributed teams was evident across all contexts. The best leadership approach was different for different teams, depending on the team's specific tasks and urgency (45, 46, 110-122). Inclusive leaders who actively engaged team members at different locations were more successful in fostering a sense of community. Effective leadership often requires a combination of hierarchical and supportive behaviours (45, 112, 115, 117). However, a strictly hierarchical style was found to be challenging in distributed teamwork settings due to the lack of social cues in such settings (123). Therefore, a leadership style with adaptability was crucial, with effective communication playing a pivotal role. Team members who communicated more frequently were often perceived as leaders (112, 115, 117, 123, 124).

Communication delays and misunderstandings were common in distributed teams (120, 125). Over time, communication difficulties diminished, but this improvement was more pronounced in long-term, established teams than in short-term ones (126). Studies showed mixed results regarding communication via videoconferencing: such communication was perceived as more polite and less disruptive than face-to-face communication, yet videoconferencing could also slow down the communication process (126). Additionally, some studies found that videoconferencing led to less frequent communication episodes in comparison with co-located teams (119). Specific individuals dominating the conversation in a distributed setting could marginalise other team members, who became invisible. This created an imbalance in communication within the team and reduced the benefits of having a larger team (127, 128).

In collaboration within a distributed team, 'team opacity' occurs, in which the lack of nonverbal cues and awareness of colleagues' actions increases workloads and hinders coordination and adaptability (41, 119, 121, 127, 129-131). Familiarity among team members enhances effectiveness, as it is more challenging to build trust and shared mental models in distributed teams than in co-located teams (110, 117, 132-137). One practical suggestion was to overcome this lack of trust using Swift Trust theory, which assumes that trust is present from the start of a collaboration and can be effective for distributed teams (132). Although pre-meetings to foster familiarity and trust are recommended for distributed teams, these are often impractical for teams that work together only briefly (128, 138).

Progress in Research

The material showed a trend of increasing research on distributed teams over the past 20 years. Earlier studies highlighted challenges such as the lack of nonverbal cues, low cohesion and difficulty building relationships (111, 139, 140). In more recent studies, the focus shifted to adapting leadership styles to fit distributed environments, such as fostering inclusivity, enhancing communication and improving team coordination (46, 112, 124, 141). Advances in communication technology – such as high-quality videoconferencing – have mitigated early problems with mistrust and coordination to some degree (64, 129, 142, 143), promoting richer interactions and more balanced participation among all team members (128, 138, 140, 144). Consequently, recent research has indicated that distributed teams can achieve communication quality and collaboration on par with those of co-located teams by using appropriate strategies and technologies (42, 43, 145-148).

Gaps in Research

The need for specialist training for leaders of distributed teams was emphasised in many studies (45, 115, 133, 134, 149-152). However, a gap in research was observed regarding such training programmes, especially in healthcare. Factors affecting communication quality remain unclear, and inconsistent findings about communication technologies indicate a need for further studies. Short-term distributed teams face unique challenges, such as the need to build trust and construct shared mental models (110, 117, 132-136); these challenges are little studied, particularly in high-pressure healthcare environments.

Findings related to evidence for practice and future research directions are incorporated later in this thesis under 'Implications for Practice' and 'Future Research', where specific recommendations are partially based on the analysis using the PAGER framework.

Validity and Reliability of the TEAM Instrument

To compare the team performance of co-located versus distributed teams in **Study III**, it was essential to validate the TEAM instrument first. Therefore, **Study II** aimed to test the validity and reliability of the TEAM instrument in distributed healthcare teams working in emergencies.

Reliability

The *inter-rater reliability* (i.e. exploring the variation between raters when assessing the same group of subjects (103)) of the TEAM domains of

Leadership, Teamwork and Task management was strong. Leadership showed moderate reliability, Teamwork exhibited excellent reliability and Task management had good reliability (**Table 6**). Although some variation may still exist, these results suggest that the raters generally agreed and were consistent in their evaluation of these aspects of team performance.

The TEAM instrument's *internal consistency* (i.e. exploring the extent to which all items in the instrument and its domains measure the same concept (102)) revealed high reliability across all three domains of Leadership, Teamwork and Task management (**Table 6**). This result can be interpreted as the items within each domain being well-aligned to measure the respective team performance aspects.

Table 6. Inter-rater reliability and internal consistency of the TEAM instrument in Study II.

TEAM domains	**Inter-rater reliability** ICC (95%) *Consistency*	ICC (95%) *Absolute agreement*	**Internal consistency** Cronbach's alpha
Leadership (items 1–2)	0.74 (0.42–0.89)	0.59 (0.10–0.83)	0.94
Teamwork (items 3–9)	0.92 (0.81–0.97)	0.82 (0.36–0.94)	0.97
Task management (items 10–11)	0.85 (0.67–0.94)	0.78 (0.46–0.92)	0.89
Overall (item 12)	0.91 (0.81–0.97)	0.80 (0.30–0.94)	
Total (items 1–11)			0.97

Validity

The *predictive validity* (i.e. exploring to what extent the instrument's results predict the outcome (101)) analyses underscored significant differences in performance scores among teams with varying experience levels. Beginners consistently performed lower than intermediate and expert teams, demonstrating that the TEAM domains can distinguish between different skill levels (**Figure 7**). Interestingly, the results were consistent across different scenarios (i.e. urosepsis vs. myocardial infarction) (**Table 7**), suggesting that the instrument's ability to predict performance is stable across varying medical conditions.

Regarding *concurrent validity* (i.e. exploring the extent of the agreement between two measures or assessments taken at the same time (101)), there was a strong positive correlation between the scores in the three domains of Leadership, Teamwork and Task management domains when correlated to the overall team performance (i.e. the 12th item of the TEAM instrument) (**Table 7**). This result can be interpreted as indicating that, if teams exhibit high performance in specific domains, they are generally a well-functioning team.

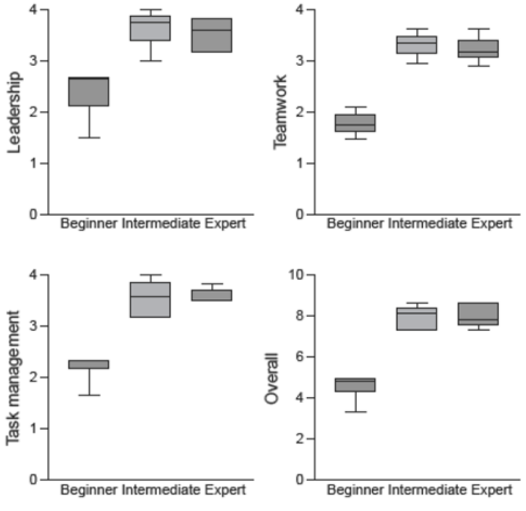

Figure 7. Boxplots illustrating team performance across the Leadership, Teamwork, Task management and Overall performance domains across the proficiency levels in **Study II.** Beginners consistently scored lower, while intermediate and expert groups performed similarly across most domains.

Table 7. Predictive and concurrent validity of the TEAM instrument in **Study II**.

TEAM domains	**Predictive validity**		**Concurrent validity**
	Kruskal Wallis *Proficiency level*	**Kruskal Wallis** *Scenarios*	**Pearson** *Overall performance*
Leadership (items 1–2)	*p*<0.001	0.79	r=0.92
Teamwork (items 3–9)	*p*<0.001	0.43	r=0.98
Task management (items 10–11)	*p*<0.001	0.50	r=0.96
Overall (item 12)		0.96	

Distributed vs. Co-located Teamwork

Study III explored how teamwork is affected by team situatedness in the Swedish rural context (co-located vs. distributed). The results are clarified through the three distinct levels of detail defined by the TEAM instrument. The distribution of scores on the TEAM instrument and its domains showed a slight negative skewness (ranging from -0.44 to -0.92), indicating a tendency towards higher scores. However, the skewness values were close enough to normality to justify using linear regression.

Level 1: Team Performance in Total

Initially, the reliability of the TEAM instrument was confirmed with a good Cronbach's alpha (0.94) for the Total (items 1–11). The distributed and co-located teams were compared across the three domains of the TEAM instrument (i.e. Leadership, Teamwork and Task management) and analysed together. In this comparison, the co-located teams outperformed the distributed teams, showing better overall scores in Total (items 1–11), with a mean difference of 0.22 units (*p*-value: 0.005). In addition, Item 12, Overall Performance, received significantly higher ratings for the co-located setup, with a mean difference of 0.50 units (*p*-value: 0.025). Scenario randomisation was controlled, and the second scenario scored higher in Total (items 1–11) and Overall Performance (item 12), indicating a potential learning effect.

However, no significant differences were noted between raters for the Total Score (items 1-11) and Overall Performance (item 12), suggesting minimal rater bias (**Table 8**).

Table 8. Regression coefficients (β), standard errors (SE), and p-values for the effects of Scenario, Order and Rater on Total items (1–11) and Overall (Item 12), with Cronbach's alpha for internal consistency of the Total.

Independent variables	**Total, items 1–11** β (SE) *p-value*	**Overall, item 12** β (SE) *p-value*
Scenario		
Co-located	**0.22** (0.08) *0.005*	**0.50** (0.22) *0.025*
Distributed	-	**-**
Order		
1st	**-0.23** (0.08) *0.004*	**-0.44** (0.22) *0.046*
2nd	-	-
Rater		
Rater 1	0.09 (0.18) *0.620*	0.76 (0.50) 0.130
Rater 2	-	-
Cronbach's alpha	0.94	

Level 2: Team Performance of Domains

A more focused comparison was made between the two team setups within the three domains of Leadership, Teamwork and Task management. While no significant differences were found in Leadership and Task management (*p*-values: 0.61 and 0.15, respectively), co-located teams performed better in the Teamwork domain (*p*-value <0.001). The Teamwork domain encompasses several key aspects, including effective communication, timely task completion, composure and control, positive team morale, adaptability to changing situations, monitoring and reassessing the situation, and anticipating potential actions. Regarding the randomisation of scenarios, teams in the second scenario scored significantly higher in Leadership and Teamwork, though the difference in Task management was not significant. Additionally, no significant differences were noted between raters on this level. The internal consistency for these domains was confirmed with Cronbach's alpha values of 0.82–0.91, indicating good reliability. (**Table 9**).

Table 9. Regression coefficients (β), standard errors (SE), and p-values for the effects of Scenario, Order and Rater on the domains of Leadership (items 1–2), Teamwork (items 3–9), and Task management (items 10–11), with Cronbach's alpha for internal consistency.

Independent variables	Leadership items 1–2 β (SE) *p-value*	Teamwork items 3–9 β (SE) *p-value*	Task management items 10–11 β (SE) *p-value*
Scenario			
Co-located	0.06 (0.12) *0.614*	**0.28** (0.07) *<0.001*	0.19 (0.13) *0.154*
Distributed	-	-	-
Order			
1st	**-0.28** (0.12) *0.019*	**-0.22** (0.07) *0.002*	-0.25 (0.13) *0.066*
2nd	-	-	-
Rater			
Rater 1	0.25 (0.20) *0.213*	-0.02 (0.18) *0.927*	0.29 (0.21) *0.158*
Rater 2	-	-	-
Cronbach's alpha	0.83	0.91	0.82

Level 3: Team Performance on Item Level

To understand these differences further, each item in the TEAM domain was compared between the distributed and co-located team settings. This analysis revealed that the co-located teams outperformed the distributed teams in only two specific items, with no significant differences in the other nine items. The two items where co-located teams scored higher were in the Teamwork domain and included item 4, which assessed the team's ability to work together to complete tasks in a timely manner, and item 7, which assessed the team's ability to adapt to changing situations.

Narratives on Distributed Teamwork

Study IV explored how team members described their experiences collaborating in distributed teams during emergencies, drawing on narratives from recent training and real-world scenarios. The findings are described in three repertoires: *involvement, uncertainty* and *risks*. These repertoires sometimes overlap due to the interconnected nature of teamwork; for instance, responsibility, leadership, tasks, roles and communication continually influence one another. Dilemmas in distributed teams is also represented. Excerpts from the transcripts are given to contextualise the subject positions and are labelled with their corresponding focus group (FG A–Q) and the participant's professional role (NA, RN or GP).

Involvement

In the *repertoire of involvement*, participants in an untroubled position described how the distributed setup enabled the team members to engage and contribute actively during emergencies. RNs described taking on additional responsibilities and performing tasks beyond their usual scope, which contributed to their sense of autonomy and professional growth. Many RNs – particularly experienced ones – were accustomed to working independently during on-call hours and felt confident managing tasks without a physician at the CHs, as illustrated by this RN's comment,

> We are so used to not having a physician here during on-call hours. I have built a sense of security through experience, so I'm not nervous. I don't think I work worse when I don't have a physician present; I still do the same things in many ways. Sometimes, I find it stimulating to have the physician at a distance so that I can do more things. (FG D, RN1)

Also, having the GP on the screen throughout the entire emergency provided a sense of support and collaboration that differed from the traditional setup, where the GP might step in and out of the room. For the RNs, the GP's constant presence – even remotely – contributed to a sense of inclusion and engagement in managing the emergency together. GPs shared similar views, appreciating how the videoconferencing allowed to stay engaged from start to finish. They also noted that the distributed setup let them maintain a calm focus on leadership and task delegation while overseeing the team without needing to be directly involved in hands-on care. Although NAs were less outspoken during the interviews and frequently aligned with the perspectives of GPs and RNs, one NA noted that the distributed setup offered a more direct role in patient care. The absence of the GP in the room allowed them to remain closer to the patient and take on greater responsibility – a shift from their typical involvement in co-located settings. An NA described this in the following way,

> It's like I take a bit of a step back when the doctor is in the room because then you [nodding to the GP] are usually by the patient. However, when we were doing telemedicine, it felt like I was closer to the patient. (FG G, NA)

Uncertainty

The *repertoire of uncertainty* focused on the challenges and worries team members experienced when working remotely, which placed them in a troubled position. For RNs, the absence of the GP's physical presence created a sense of heightened responsibility, as they became the most medically trained professional on-site. This shift required them to make tasks and decisions that typically fell within the GP's domain, leading to feelings of doubt and hesitation. Although the GP was digitally accessible, the lack of immediate physical support added pressure, particularly during complex cases. Similarly, GPs found themselves in a troubled position due to their inability to perform hands-on clinical assessments, which they considered a vital part of their role. The absence of this essential component was described as making it more challenging to complete a clinical picture. As one GP commented,

> I'm sceptical about assessing people remotely … simply because you might miss the patient's skin colour, and you miss the feeling of stress or panic if it's there, you miss … well, smells and several senses: sight, hearing and smell. (FG P, GP)

Sensory information was viewed as crucial for understanding a patient's condition. Without it, GPs felt they were missing 'tools in their toolbox', which made it harder to piece together a diagnosis. This limitation also forced them to rely on evaluations conducted by RNs. In some cases, unfamiliarity with the on-site staff further complicated the process, leading to additional uncertainty in making critical decisions.

Risks

The *repertoire of risks* described the team members' voices of concern about the potential negative consequences and risks of the distributed setup for themselves and their patients. In a troubled position, both GPs and RNs experienced unease with the reduced control and increased personal responsibility that came with this way of working, which they perceived as being imposed by organisational and political decisions. GPs were troubled by their increasing reliance on information technology systems, which they viewed as unreliable and insufficient to replace traditional on-call services. This dependency left them unable to fully assume responsibility for patient outcomes, as they believed technological failures could jeopardise safety. In describing this situation, one GP commented,

> I mean … the enormous distances we have here … am I supposed to bring some equipment in the car when I am out [on a call]? And then I'm standing there with the police and a guy with an axe, and suddenly I'm supposed to jump into the car, connect to the system, and … I mean, it's unreasonable, right? It's just not possible. But, I don't think people understand this, and that's what I'm worried about with this – how good this is … this little part [distributed setup] cannot be taken as a reason to remove the on-call service entirely. That's the risk I see. (FG H, GP)

In turn, the RNs found themselves in a similarly troubled position, often feeling alone in being the first point of contact for patients. Without the immediate support of a GP, they carried the bulk of the responsibility during critical situations, managing patient care alongside NAs while waiting for the GP to connect via videoconferencing. The uncertainty about when (or if) they could reach the GP added to their sense of vulnerability and compromised patient safety.

Dilemmas in Distributed Teams

In the distributed setup, there were challenges regarding the team member playing the role of 'contact person' between the on-site members and the online GP. These challenges revealed an ideological dilemma, as the team members grappled with competing priorities and expectations. On the one hand, GPs expressed frustration with the lack of a clear contact person and the difficulty establishing effective communication with the on-site team. They described feeling that their instructions were not being heard or acknowledged, which created uncertainty regarding whether their input was reaching the on-site team. Even though the GPs had an overview of the emergency room through the screen, they felt excluded from the on-site team without a designated contact person. One GP explained,

> I think it felt strange. I was not … how should I put it … part of it. You're supposed to be part of the team, but you're on the outside. You're just watching, not participating. (FG L, GP)

The role of contact person primarily fell on the RN, who was expected to bridge the gap between the patient and the GP. This created a strain, as the RNs felt that their attention was divided between repeating information to the GP on the screen and addressing the patient's immediate needs. Some RNs felt they were failing the patient when they focused too much on relaying information to the GP. One RN described feeling like a 'yo-yo', constantly moving back and forth between the GP and the patient, which disrupted the workflow, created strange communication and left the on-site colleagues feeling excluded. NAs also noted that constantly shifting their attention between the GP on the screen and the patient fragmented the interaction, making it harder to convey nonverbal communication. This back-and-forth movement disrupted the flow of communication and added to the sense of disconnection between the GP, the patient and the on-site team.

Discussion

Summary of the Main Results

Study I revealed that many of the teamwork challenges encountered by co-located teams are mirrored in distributed teams. However, achieving the same level of team performance as a co-located team demands more effort from the members of a distributed team, often leading to an increased workload. **Study II** confirmed that the TEAM instrument could robustly measure team performance in distributed settings, so this instrument was later applied in **Study III**. **Study III** showed that distributed teams did not perform at the same level as co-located teams, with collaboration and adaptability being particularly challenging for distributed teams. Finally, in **Study IV**, participants described a redistribution of tasks and roles and a shift in responsibilities. RNs described an increased workload, taking on greater responsibility and additional tasks.

Leadership Style

Leadership in distributed teams is shaped not only by assigned roles but also by interaction and communication. **Study I** showed that vocal team members often took on leadership, especially during high-stakes tasks. While **Study I** showed that medical teams in distributed settings often remained in hierarchical structures, **Studies III** and **IV** showed a tendency towards shared leadership within the Swedish context. GPs continued to hold leadership roles while RNs assumed greater responsibilities. Shared leadership, in which team members jointly take responsibility and influence one another to achieve goals, has been linked to improved team performance and adaptability in complex healthcare environments (153). However, it is often described as evolving over time, with leadership roles shifting among members based on the needs of the team' and context's needs (154). This is not typically the case in *ad-hoc* teams in rural areas, where RNs are required to immediately assume greater responsibility and share leadership, often without the opportunity to adapt to the role gradually.

Study III found no significant differences in leadership between distributed and co-located teams. However, in distributed settings, the 'hands-off' approach (i.e., where the GP cannot perform hands-on tasks due to physical distance and reliance on digital communication) may explain this as TEAM item 2 evaluates the leader's ability to avoid direct involvement in practical tasks and instead focus on the overall situation (97). The physical distance in distributed teams naturally promotes this leadership style, which could be seen as an advantage rather than a limitation. In the 'Big Five' model by Salas (155), leaders are encouraged to focus on strategic oversight, team coordination and motivation, rather than on direct involvement in practical tasks. While physical proximity in co-located teams can make this balance more challenging, distributed settings naturally support this leadership style.

The higher leadership scores in the more experienced groups observed in **Study II** suggest that leadership skills naturally develop with experience. However, these scores may also indicate that experienced leaders are better equipped to adapt to distributed setups. West et al. consider practical experience to be essential for developing effective leaders and have noted limited evidence for the direct impact of specific leadership training programmes on healthcare outcomes (154). In contrast, McAlearney argues that well-planned leadership programmes can enhance quality and reduce turnover (156). It is likely that the most effective approach combines these perspectives, balancing the benefits of experience with targeted training that is tailored to the context and specific needs of the healthcare setting.

Trust and Familiarity

Trust and familiarity were identified in this thesis as critical for efficiency in distributed teamwork. Trust is the willingness to be vulnerable to others' actions (157). It was found to be crucial in distributed settings, where GPs must rely on RNs' hands-on assessments, as they cannot perform these evaluations themselves (**Studies III** and **IV**). However, trust can be difficult to establish immediately in newly formed teams. Evidence suggests that teams often rely on formal roles and hierarchies to provide structure in the initial phase (158). This was evident in **Study IV**, where GPs described relying on the professional role of the RNs, trusting their competence and training as RNs rather than their abilities or experience. This reliance on roles helped the team establish trust and enabled effective collaboration in the early stages, before personal familiarity could develop (159). Jarvenpaa et al. similarly found that trust within new teams is often based on whether team members do what they say they will and follow the rules, rather than on relational factors such as kindness or care (158). While this reliance on structure can initially help teams function, it can limit autonomy (157), since individuals may hesitate to take the initiative or make independent decisions until deeper trust is established over time.

Familiarity, defined as knowledge about a person's job, environment and colleagues (160), is essential within a team because higher levels of familiarity are linked to increased productivity. Also, familiarity often lays the foundation for trust: the more team members know about each other, the easier it is for them to build trust (160, 161). In **Study II**, characteristic responses indicated that the emergency department staff were familiar with each other, unlike the students, who did not know each other. While this familiarity may have influenced the team dynamics, other factors such as experience and education level are more likely to have played an essential role. While the team members at CHs (**Studies II** and **IV**) usually know each other well, GPs expressed concerns regarding connecting with a CH whose staff they were unfamiliar with, and CH staff were similarly concerned regarding working with an unfamiliar GP. In such cases, a lack of familiarity can decrease productivity, as more time and effort are required for coordination (160, 161). In teams where the members know each other well, it is possible for power structures to be more negotiable and informal. However, when a remote GP is unfamiliar with the on-site team, a knowledge gap may arise (83), potentially leading to different perceptions about who holds the authority in patient assessment.

Adapting to New Tasks and Roles

Just as familiarity with other team members is essential, 'task familiarity' – that is, an individual's knowledge of and experience with specific tasks (161) – is crucial. In distributed teams, tasks were often redistributed, with the RNs taking on new roles and responsibilities they were unaccustomed to; this often required them to handle a broader range of roles and tasks. The title of this thesis, *I Become Your Extended Arms*, was stated by an RN in **Study IV**; it captures how RNs act as the GP's proxy in the emergency room, performing tasks that the GP would typically handle if physically present. This expression may also underscore the power dynamics (83) embedded in task delegation. The GP retains the overall decision-making authority, while the RNs act as an extension of the GP's authority through their actions.

When RNs are familiar with tasks, coordination may become smoother and more efficient. In contrast, low task familiarity leads to uncertainty and a greater need for guidance (162). Espinosa et al. note that a lack of task familiarity increases learning time and workload (161). The concept of 'task-shifting' – that is, transferring specific tasks from highly qualified workers to those with shorter training – was initially implemented by the WHO to ease the burden of HIV and has become relevant in rural and other resource-limited areas (163). At a CH, in an ideal situation, task-shifting could involve RNs receiving additional training and thus being better prepared for hands-on clinical examinations, for which they were often untrained. In fact, the WHO stresses that task-shifting requires proper implementation and training. If not managed well, it may result in insufficient training, increased workload, burnout and decreased quality of care. In some cases, changes to laws and regulations might be necessary to ensure a national strategy is in place (163). It has also been discussed whether task-shifting should be based on the benefit for the patient – for example, does it allow the patient to receive a better examination? – and not solely on resource limitations (164). Even if task-shifting in CHs is primarily motivated by resource limitations, such as a lack of available GPs, it can still benefit patients by ensuring access to on-site personnel who can perform necessary examinations, provide timely care and prevent delays that otherwise might leave patients without adequate assessment or treatment.

Listening and Communication

Communication emerged as a crucial leadership tool in **Study I**, where 'speaking up' was found to be more important than listening; those who talked more were perceived as more suitable leaders. This finding contrasts somewhat with the situation in co-located teams, where listening to and considering others' opinions are just as important as speaking up (58, 155). In a distributed setting, communication becomes more than a way of speaking; it is also a means of positioning oneself within the team. Those who speak more reinforce their role and position in the team, illustrating how power can be manifested through language and discourse (83).

Due to the use of technology, communication in distributed teams was reported to be slower (**Study I**) and needed to be more precise (**Study IV**). Conversations became more polite and drawn-out, with fewer interruptions, allowing each person to speak fully (**Study I**). Although the type of communication changed, this did not necessarily result in poorer communication (**Study IV**). The change in communication also affected how the conversational space was occupied by the team members and who felt comfortable speaking.

One aspect of communication discussed in **Study IV** was in relation to the dilemma about the 'contact person role'. The GPs described a sense of exclusion when they did not have a designated person in the emergency room to communicate with them through the screen, make sure to listen to their instructions and ensure their directions were carried out. On the other hand, this role created problems for the RNs who were called to play it in the room, as it made them responsible for communicating with both the GP and the patient while managing their tasks. This could lead to stress and the exclusion of the third person in the team (an RN or NA), by limiting communication to an exchange between the GP and one RN. Thus, the 'contact person role' created a communication that both included and excluded, benefiting some while burdening others. The challenge of maintaining a sense of unity and balanced communication (**Study I**) becomes apparent here, especially as physical separation could lead to feelings of exclusion across different sites.

Another important observation from **Study IV** was that the NAs spoke the least in the focus groups. This withdrawal from communication can be viewed as a result of the medical discourse that prioritises education and professional status (i.e. GPs > RNs > NAs). These norms shape communication flow, determining who is given space to speak and whose voices are minimised. One NA pointed out the key role played by non-verbal communication in co-located teams – such as gaze, gestures and tone of voice – in asserting authority and guiding interactions, which has also been noted by Härgestam et al. (165). However, in distributed teams, technological issues such as poor camera angles can limit non-verbal cues and make them more difficult to perceive. This finding further emphasises the importance of clear verbal communication in distributed teams.

Impact of Technologies

The technology in use must be well-suited to the task in order to be effective for a distributed team (**Study I**). According to media richness theory, rich media is preferable in settings where information can be interpreted in various ways, resulting in ambiguity and a lack of clarity (166). Thus, a distributed team with access to few non-verbal cues will perform better with richer communication technology. However, the findings from this thesis reveal that even synchronous visual tools such as videoconferencing present challenges in conveying non-verbal cues such as body language and facial expressions (**Studies I** and **IV**). While text-based tools may supplement and reduce misunderstandings, they further limit the transmission of non-verbal communication (166).

The remote GPs, for instance, expressed frustration over being unable to monitor the patients' vital cues and signs directly; they had to rely on staff in the room to read these values aloud. Even though high-quality video technology improves some of these issues, recent technological advancements such as virtual reality (VR), augmented reality (AR) and artificial intelligence (AI) could offer more comprehensive solutions (167, 168). VR would allow realistic training in emergencies, AR could display vital signs directly to the GP and AI could be used to analyse non-verbal cues in real-time video. These technologies could become particularly valuable in rural areas, where innovative solutions are often necessary to meet healthcare challenges.

However, the idea of using technological advancements in this context is linked to the power of knowledge, as discussed in **Study IV**, and – more specifically – to a lack of knowledge about the technology in use. The participants described being encouraged to use the technology and the distributed way of working without being given training on how to use it. A lack of training in technology use is not unique to this study. In a systematic review, Ftounis et al. identified 12 studies that discussed a lack of training for healthcare professionals and patients, noting deficiencies in technical skills and appropriate usage of technology (26). This lack of technological knowledge can lead to misdiagnoses and delayed treatments (26); it can also create new dynamics within the team. Some participants in **Study IV** spoke about the technology as something natural, while others found this way of working frightening and challenging. There were differences in how the teams handled the technology in practice (**Studies II** and **III**): some teams adapted more efficiently, with members who seemed more confident and knowledgeable about the technology, while other teams were more hesitant.

Some participants (**Study IV**) viewed the technology used in their distributed team as innovative and positive, while others felt forced and uncomfortable.

Patient Experiences

Although this thesis focuses on healthcare teams, the main character – namely, the patient in the room – should not be forgotten. It is necessary to consider how patients feel about the use of technology in their care and whether team members' knowledge of this technology affects how they can involve the patient and the care they provide. In a recent study by Ärlebrandt et al., patients described the success of healthcare treatment in a rural distributed setting as partly dependent on their expectations and partly on the healthcare professionals' competence in using the technology (169). Similarly, in a study by Dubois et al., healthcare professionals described how a distributed setup can both facilitate and challenge patient participation, depending on the healthcare team's ability to manage the technology and maintain effective communication (170). These considerations are essential as healthcare continues to evolve.

Methodological Considerations

Recruitment Challenges

While the project for this thesis was conceived prior to the COVID-19 pandemic, the societal crisis caused by the pandemic emerged midway through the data collection for **Studies III** and **IV**. In **Study II**, all data collection occurred during the pandemic, at a time when the emergency department and educational institutes for healthcare were under particular strain. The pandemic significantly burdened the healthcare system, requiring healthcare professionals to prioritise patient care over participating in research. Thus, it was challenging to recruit participants for this study. A CH in Norrbotten County withdrew its participation before the planned data collection in **Studies III** and **IV**, as it could not maintain patient safety while allocating staff for professional training and research participation. In addition, since the second half of the data collection for **Studies III** and **IV** occurred during the pandemic, the global shift towards increased digitalisation in primary care – along with the resulting widespread awareness and increased knowledge of technology and remote work – may have influenced the results.

For practical reasons, we enlisted the help of healthcare centre managers to recruit participants in **Studies II–IV**. Removing staff from their duties without their managers' involvement would not have been feasible. Given the managers' position of authority, the research team were careful to inform participants that their participation was voluntary and they had the right to withdraw from the study before the start of data collection. No one chose to withdraw. However, it remains unknown whether others declined participation when approached by the manager, as this information was not disclosed to the research team.

Potential Bias

Bias can affect results in various ways. In **Studies II** and **III**, the risk of false positives (Type I errors) due to e.g. analyses from different raters must be acknowledged. To address this possibility, potential confounders such as scenario order and rater effects were controlled to minimise the impact of random variations. Moreover, the raters were trained using the TEAM instrument and calibrated after scoring videos with varying performance levels. Discussions were held to raise awareness of potential rating errors and emphasise that the behaviour of the team as a whole, not individual behaviours, should influence the scoring. Several potential errors were addressed, such as central tendency bias, in which raters consistently give midpoint scores, and in the end, effects on the overall performance scoring, such as raters being influenced by either the first or the last observed behaviours and thereby skewing their assessments (56).

Regarding randomisation in **Study III**, participants were randomly trained in two setups: urosepsis in the distributed setting and myocardial infarction in the co-located setting. Although the scenarios were designed to be comparable in difficulty, participants may have perceived one as more severe than the other, potentially introducing perceptual bias and influencing their performance and responses.

A standardised patient is helpful when teamwork and interaction are in primary focus, as in parts of the TIGER programme. However, there are limitations to using a standardised patient, as they are usually healthy and unable to simulate specific physical symptoms, such as lung crackles. Another challenge lies in ensuring that the patient does not blend roles when quickly switching between two different scenarios. The standardised patients received training beforehand to address this issue, and clothing and makeup were changed to mark the shift in different situations.

Trustworthiness

Study IV used small (three-person) focus groups of healthcare personnel to stimulate interactions. Small focus groups are recommended when participants are highly knowledgeable or emotionally engaged with the subject (99), as in this study. While some variations in participation were observed, such as GPs and male participants contributing more frequently, we, as interviewers, actively worked to create an open and inclusive environment to ensure all participants could share their perspectives. As interviewers, we were aware of our roles as RNs within this professional structure, recognising that this could also influence the dynamics of the discussions. I conducted interviews with half of the focus groups, which required me to listen to the material repeatedly to familiarise myself with the interviews collected by another researcher. The time gap between data collection and analysis necessitated additional efforts to engage with the material. The analysis process was reflexive throughout, with continuous back-and-forth engagement with the data and discussions in the research group.

Transferability Across Contexts

Study I provided a comprehensive and systematic mapping of the research area. A ScR can identify research gaps; however, it cannot address whether the available research is of good or poor quality, since quality assessments are not included in the methodology (90). Moreover, the quantity of the generated data made it difficult to decide whether breath or depth was most important. Several included studies contained discussions of their findings in general terms, without specifying the team's technology or task. This made it difficult to determine the transferability of the research to distributed teams in healthcare. Also, most of the settings in the included studies did not consider the patient factor or what the patient might contribute to the workload or teamwork.

Studies II and **III** involved the use of a simulated environment, which may not have fully captured the complexity of real-world settings. However, the scenarios were scripted based on commonly occurring emergencies within the context of a rural primary healthcare centre relying on a distributed team. The unique conditions of the CHs in rural areas of Sweden may somewhat limit the transferability of the findings of these studies to other contexts.

In **Study II**, only a few participants had previous experience in distributed settings, and all of them were students. This meant that the medical staff, experts in their medical field, were not necessarily experienced in distributed teamwork. Still, the overall skills and general expertise of the intermediate and expert groups seemed to play a greater role than their specific contextual experience in a distributed setting, as the students – as expected – performed the least well. Similarly, the proportion of staff in **Study III** who had previously worked in a distributed context was relatively low, at 29%, further limiting the transferability of the results. Although the technology and its implementation had occurred several years earlier, many of the participants felt uncomfortable working with the technology, which likely stemmed from the fact that the participants did not feel adequately trained to use the technology in a distributed setting. While they understood that they were expected to utilise it, they lacked the knowledge to do so effectively and instead chosed the telephone consultations.

Finally, for **Study IV**, the detailed description of the context and participants' characteristics that were provided makes it possible for readers to assess the findings' applicability to similar settings.

Implications for Practice

Adapting to a distributed team approach in emergency care may require a period of adjustment as staff members become familiar with distributed workflows. Organisations should involve staff in designing and refining distributed workflows to establish practical solutions that meet both clinical needs and patient safety and to adapt workflows to fit the specific context. Simulation-based training offers valuable practice in teamwork for distributed settings. Key areas for ongoing training could include the following:

- Inclusive training that supports all team members with a focus on clarifying roles to ensure everyone understands their responsibilities;
- Leadership training that emphasises trust-building and unity across sites;
- Communication training focused on overcoming limitations, such as the lack of non-verbal cues,
- Preparations for RNs to handle extended responsibilities and tasks;
- Acknowledging that some staff members may adapt to technology more easily than others, with training designed to help all team members develop confidence and skills; and
- Open discussions on team hierarchies to clarify expectations and responsibilities as roles evolve.

Finally, it is vital to consider the patient's experience within a distributed setting. Gathering patient feedback can provide valuable insights into how telemedicine impacts patients' perception of care and overall satisfaction with distributed team interactions.

Future Research

During this research journey, several challenges were observed in the studied distributed teams that require further investigation to understand better and address. Beyond technical innovations, future research should consider the NTSs of distributed teams, including how team members navigate trust and role clarity, and how they can lead in distributed settings. In future research, advanced technologies such as AI-driven tools or wearable devices could be used to measure communication and interaction patterns. However, it is crucial to understand how such tools affect the NTSs of team members, in order to ensure that technology serves as an enabler – rather than a barrier – to effective collaboration. Furthermore, understanding the patient's perspective in distributed team care remains essential. Future studies can explore how patients perceive distributed team care, including communication, trust and overall care quality. This feedback will guide improvements in distributed settings, ensuring that patient-centred values are maintained.

Conclusion

This thesis has shown that distributed teamwork in healthcare brings new challenges and opportunities, especially in providing round-the-clock care to rural populations despite geographic distances. While distributed teams may achieve performance levels comparable to those of co-located teams, managing leadership, communication and collaboration remotely is complex and increases the workload for some team members. Their new tasks and expanded responsibilities place RNs in distributed teams in a vulnerable position, as they often find themselves handling additional duties and being at the centre of team interactions. Thus, RNs require support and training to navigate these role shifts confidently. In a distributed setting, GPs must adapt their leadership to function at a distance, while NAs encounter increased patient interaction. Tailored training programmes for all professions are therefore needed to address technological competencies, new roles, remote leadership and effective communication strategies.

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Appendix

Appendix 1 Team Emergency Assessment Measure

Scoring in the first 11 items; 0 Never/Hardly ever; 1 Seldom; 2 About as often as not; 3 Often; 4 Always/Nearly always. Scoring item 12; Using 1-10, 1 being poor performance and 10 being the top. Ratings should include the team as a whole i.e. the leader and the individual team members as a collective, bearing in mind that some will have a greater role than others.

Categories	Elements	Items	Score
Leadership: It is assumed that the leader is either designated, has emerged or is the most senior.	Leadership control	1.The team leader let the team know what was expected of them through direction and command	0 – 4
		2. The team leader maintained a global perspective	0 – 4
Teamwork: Elements that cover communication, timely action, composure, morale, adaptation, monitoring of the situation and anticipation of future events	Communication	3.The team communicated effectively	0 – 4
	Co-operation and co-ordination	4.The team worked together to complete the tasks in a timely manner	0 – 4
	Team climate	5.The team acted with composure and control	0 – 4
	Adaptability	6.The team morale was positive	0 – 4
		7.The team adapted to changing situations	0 – 4
	Situation awareness (perception)	8.The team monitored and reassessed the situation	0 – 4
	Situation awareness (projection)	9.The team anticipated potential actions	0 – 4
Task Management: Cover task prioritisation and the use of applicable standards and guidelines.	Prioritisation	10.The team prioritised tasks	0 – 4
	Clinical standards	11.The team followed approved standards and guidelines	0 – 4
Global Overall Rating		12. On a scale of 1– 10 give your global rating of the team's non-technical performance	1 – 10

Adopted from Cooper et al., 2010.

Appendix 2 PAGER Study I

Patterns	**Advances**	**Gaps**	**Evidence for practice**	**Research recommendations**
Distributed leadership The role of inclusive leadership in mitigating exclusion within distributed teams, where frequent contributors often emerge as leaders.	*Earlier studies* highlighted challenges in distributed leadership. *Recent research* explores various leadership styles and strategies for effective distributed leadership.	Research on the effectiveness of different leadership training programs for distributed teams is notably lacking.	Training programs for distributed leaders address the unique aspects of the distributed setting, including leadership skills and technology proficiency.	Research is needed on the healthcare sector's distributed leadership challenges, particularly those related to managing urgent tasks while upholding patient care standards.
Distributed communication The importance of clear communication and achieving balance between sites.	*Earlier studies* suggested that distributed teams face communication issues. *Recent research* shows no significant difference in communication quality.	There is a lack of clarity regarding the factors that influence communication quality within distributed teams.	Richer technology is recommended, as it enables social cues. This is particularly important when dealing with urgent and complex tasks.	Research is needed on communication strategies in short-term teams and different communication technologies, as studies have shown inconsistent results.
Distributed collaboration The challenges that short-term teams face in building familiarity and trust, compared to experienced ongoing teams.	*Earlier studies* addressed the impact of missing nonverbal cues on team awareness. *Recent research* indicates technology has no significant effect on collaboration.	There is a paucity of research on how to address the disadvantages faced by short-term distributed teams.	For short-term teams, the "swift trust model" recommends acting as if trust is already present from the start of the collaboration. This approach helps build trust quickly and achieve outcomes.	Research is needed on effective approaches for fostering trust and creating a shared understanding among short-term teams.