Acute functional decline in older home nursing care patients

Using the Modified Early Warning Score to support clinical reasoning and decision-making in community care.
A mixed methods study

Kristin Jeppestøl

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Department of Nursing Science,

Faculty of Medicine,

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Abstract

Background: Demographic changes and transfer of tasks and responsibilities from specialist to primary health challenge community health care services. Older persons receiving home nursing care live in private or community care homes. The patients are characterized by multimorbidity and polypharmacy and with particular vulnerable health conditions that require comprehensive assessments. Community health care, represented by home nursing care registered nurses (RNs) and general practitioners (GPs), have the main responsibility of providing older home nursing care patients safe health care services. International and national initiatives has been ongoing to implement early warning scores (EWS) developed for hospitals into community care services to improve safety and to support health care personnel's clinical reasoning and decision-making processes. The modified early warning score (MEWS) tool was introduced to hospitals, home nursing care and skilled nursing homes in eight Norwegian municipalities in Eastern Agder in 2016. MEWS measure normal reference values for respiratory rate, heart rate, systolic blood pressure, temperature, and level of consciousness. MEWS generate a score from each parameter and the total score triggers standard clinical responses for when to perform new measurements and when to refer to the medical services. MEWS' and various existing early warning scores (EWS) are thoroughly validated in hospital settings. However, little is known regarding the predictive value of EWS used with older home nursing care patients with suspected acute functional decline, and only a few studies have explored the impact of EWS on health care personnel in community care settings. The evidence of EWS' clinical outcomes on older home patients in community care, and how it impacts RNs' and GP's clinical reasoning and decisions, however, are sparse, and studies indicate advantages as well as challenges with decision support tools in clinical practice in general.

Aims: The present study aimed (1) to describe the state of health and clinical trajectories of older home nursing care patients suffering from acute functional decline and factors influencing the trajectories, and (2) to explore the impact of MEWS on health care personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients.

Methods: This study used an exploratory, descriptive mixed methods design with a convergent approach. In a prospective observational study (Sub-study 1), a consecutive sampling procedure was applied between April 2018 and February 2019. Demographic,

health-related, and clinical data from older home nursing care patient's electronic patient records were collected after an initial episode in which MEWS was measured due to suspected acute functional decline (T1) and three months after (T2). The data were analyzed through descriptive statistics and Bayesian generalized mixed models. In an interview study (Sub-study 2), purposive sampling was applied to recruit RNs and GPs with experience with older home nursing care patients from the Eastern Agder municipalities. Seven semi-structured mixed focus groups were conducted from September to November 2018 to explore the participants' experiences and perceptions regarding the use of MEWS in clinical practice. The data were analyzed using a thematic content analysis with an inductive approach.

Results: A total of 135 patients participated Sub-study 1. The older patients were characterized by advanced age, multimorbidity, and polypharmacy. Habitual MEWS scores were registered for 51 patients with a median of 1 (IQR 0–1), and the median MEWS score in cases of suspected acute functional decline was 1 (IQR 1–2). Respiratory rate and heart rate (72.5% and 19.6%) were the most frequent deviating vital signs in the habitual state. In cases of suspected acute functional decline, respiratory and heart rate (88.8% and 15.3%, respectively) were the most frequently deviated vital signs.

The Wilcoxon signed ranks test showed a statistically significant difference in the scores when comparing the habitual scores with the scores in cases of acute functional decline in T1 and T2 (z -024, p 0.002). Changes from habitual state to acute functional decline predominantly leaned toward increased scores (47%), but in 35% of the cases of acute functional decline, the score did not change, and in 18% of the cases, the score was lower than the habitual score RNs adhered to MEWS trigger recommendations in 68.9% of all MEWS measurements (Paper I).

The majority of the three-month care trajectories were characterized by observation and medical treatment in the patients' home or within the levels of community care. Age, gender, and level of community care were factors associated with the care trajectories. MEWS was associated with levels of clinical responses and death throughout the care trajectories (Paper II).

A total of 36 RNs and eight GPs participated in seven focus groups in Sub-study 2. RNs and GPs considered MEWS and the new medical equipment important when assessing clinical deterioration with older patients in home nursing care. The new practice supported systematic assessments and collaboration between RNs and GPs. GPs received more systematic, concise, and relevant information from RNs, which in turn helped them to make clinical decisions

based on relevant objective information regarding the older patients. MEWS was also experienced by RNs as challenging to be used with older patients in home nursing care. MEWS' reference values were experienced as unfit to older multimorbid patients' complex state of health, and the trigger recommendations were experienced as not being adapted to the context of home nursing care (Paper III).

Conclusions: Older home nursing care patients have complex health conditions and receive comprehensive community health care services, especially related to frequent shifts between stable and unstable chronic and acute health conditions. The majority of the patients were observed or treated in the home or within the community care in cases of suspected acute functional decline. Demographic, social and clinical factors associated with higher levels of clinical responses, final level of community care and death are found in the present study, which indicates that health care personnel should be particular aware of acute functional decline in older, female home nursing care patients, living in private homes with increased MEWS scores.

MEWS have an important position as support in clinical reasoning and decision-making processes when assessing clinical deterioration in older home nursing care patients. Findings from medical records and health care personnel's experiences clearly show that MEWS and clinical judgment supported health care personnel's escalation of clinical responses to a great extent, and contribute with support for health care personnel to follow up and keep older home nursing care patients with unstable and complex health conditions at home. However, the present study's findings also clearly show that MEWS, with its' current reference values and trigger recommendations, cannot trigger safe and appropriate responses for health care personnel when assessing older patients in home nursing care.

Abstract in Norwegian

Bakgrunn: Demografiske endringer og økte overføringer av oppgaver og ansvar fra spesialisthelsetjenesten, utfordrer kommunehelsetjenesten.
Eldre som mottar hjemmesykepleie bor i private hjem eller i omsorgsboliger. Pasientene karakteriseres med multimorbiditet, polyfarmasi og skrøpelig helsetilstand som krever omfattende helsetjenester. Kommunehelsetjenesten, representert av sykepleiere og fastleger, har et spesielt ansvar for å ivareta eldre pasienters helsetilstand og gi forsvarlig helsehjelp ved akutt endring i helsetilstanden til pasienter i hjemmesykepleien.
Både internasjonalt og nasjonalt, er beslutningsstøtteverktøy som er utviklet til å bruk i sykehus for å tidlig identifisere livstruende tilstander (EWS), overført til kommunehelsetjenesten for å forbedre pasientsikkerhet ved å gi helsepersonell støtte i kliniske vurderinger og beslutninsprosesser. I 2016 ble MEWS (Modified early warning score) innført i sykehus, hjemmetjeneste og sykehjem i åtte kommuner i Østre Agder i Norge. MEWS måler normale referanseverdier for respirasjonsfrekvens, puls, systolisk blodtrykk, temperatur og bevissthetsnivå. Ved å summere poengene fra hvert parameter, utgjøres en totalscore som genererer en standard klinisk respons som innebærer forslag til hvor ofte det skal tas nye målinger og når en skal tilkalle legetjenesten.
MEWS og andre eksisterende versjoner av early warning scores er nøye validert til bruk i sykehus. Det er imidlertid forsket lite på om beslutningsstøtteverktøy kan predikere kliniske utfall hos eldre pasienter med mistenkt akutt funksjonssvikt i hjemmesykepleien. Det er også gjort begrenset forskning på hvordan verktøyene bidrar med støtte i kliniske vurderings – og beslutningsprosesser hos helsepersonell, men den eksisterende forskningen indikerer både fordeler og utfordringer knyttet til bruk av beslutningsstøtteverktøy i klinisk praksis generelt.

Hensikt: Studiens overordnede hensikt var (1) å beskrive eldre pasienter som mottar hjemmesykepleie, deres helsetilstand og kliniske forløp etter en eller flere episoder med mistenkt akutt funksjonssvikt. Og (2) å utforske hvordan MEWS bidrar i helsepersonells kliniske vurderings – og beslutningsprosesser ved mistenkt akutt funksjonssvikt hos eldre i hjemmesykepleien.

Metoder: Et utforskende, beskrivende «mixed methods» designmed samtidig kvantitativ og kvalitativ tilnærming ble valgt. I en prospektiv observasjonsstudie (Delstudie 1), ble tilgjengelige eldre pasienter i hjemmesykepleien med gitte inklusjonskriterier og hvor MEWS

ble målt ved mistenkt akutt funksjonssvikt, ble inkludert fortløpende i studien mellom april 2018 og februar 2019. Demografiske, helserelaterte og kliniske data ble samlet inn fra pasientenes pasientjournaler etter en episode med mistenkt akutt funksjonssvikt (T1) og tre måneder videre (T2). Data ble analysert med eskrivende analyser og Bayesansk generaliserte blandede modeller for å utforske faktorer assosiert med de kliniske pasientforløpene.
I en intervjustudie (Delstudie 2), ble sykepleiere og fastleger i Østre Agder-kommunene med erfaring med bruk av MEWS hos eldre pasienter i hjemmesykepleien, invitert til å dele sine meninger og erfaringer med å bruke MEWS i klinisk praksis. Syv fokusgruppeintervjuer med sykepleiere og fastleger ble gjennomført mellom september og november 2018. Tematisk innholdsanalyse med en induktiv tilnærming ble anvendt for å analysere data.

Resultat: Totalt 135 pasienter ble rekruttert i Delstudie 1. Høy alder, multimorbiditet og polyfarmasi karakteriserte pasientenes helsetilstand. Median MEWS score målt på 51 pasienter i habituell tilstand var 1 (IQR 0-1) og de hyppigste avvikende vitale tegnene var økt respirasjonsfrekvens (72.5%) og økt puls (19.6%). Median MEWS score ved mistanke om akutt funksjonssvikt var 1 (IQR1-2), og økt respirasjonsfrekvens (88%) og økt puls (15.3%) var hyppigst avvikende vitale tegnene. Wilcoxon signed ranks test viste statistisk signifikant forskjell i MEWS scorene ved sammenligning av habituell MEWS score og MEWS score ved mistanke om akutt funksjonssvikt i T1 og T2 (z -024, p 0.002).Ved sammenligning av endringer i MEWS score fra habituell tilstand og MEWS score ved mistanke om akutt funksjonssvikt var scoren høyere i 47% av målingene. I 35% av målingene med mistanke om akutt funksjonssvikt, var scorene uforandret, mens i 18% av målingene var scoren lavere enn i habituell tilstand Sykepleierne overholdt MEWS anbefaling om å kontakte legetjenesten eller ikke, i 68.9 % av alle målinger (Artikkel I).
I løpet av tre måneder ble majoriteten av de kliniske forløpene ble karakterisert med oppfølging eller medisinsk behandling i hjemmet eller innen kommunehelsetjenesten. Alder, kjønn, hvor pasientene bodde og MEWS, var faktorer som var assosiert med kliniske responser og kliniske forløp. Økning i MEWS score var assosiert med høyere nivå av klinisk respons og død gjennom hele det kliniske forløpet (Artikkel II).
Totalt 36 sykepleiere og åtte fastleger deltok i syv fokusgruppeintervju i i Delstudie 2. Sykepleierne og fastlegene erfarte at MEWS og det nye medisinsk-tekniske utstyret var et viktig verktøy for å undersøke og vurdere klinisk forverring hos eldre pasienter i hjemmesykepleien. Den nye praksisen støttet sykepleiere i arbeidet med å utføre systematiske kliniske undersøkelser, og bidro til forbedret samarbeid mellom sykepleierne og fastlegene.

Fastlegene erfarte at de mottok mer systematisk, relevant og konsis informasjon om pasienten fra sykepleierne, noe som hjalp fastlegen til å ta beslutninger for eldre pasienter i hjemmesykepleien på et bedre klinisk grunnlag. Sykepleiere erfarte også at MEWS var utfordrende å bruke hos eldre i hjemmesykepleien, fordi referanseverdiene for vitale tegn ikke var tilpasset eldre med kompleks helsetilstand, og i tillegg ble MEWS' anbefalinger for nye målinger og henvisning til legetjenesten erfart som ikke tilpasset til hjemmesykepleien (Artikkel III).

Konklusjon: Eldre pasienter som mottar hjemmesykepleie har kompleks helsetilstand som svinger mellom stabile og ustabile kroniske og akutte tilstander. De fleste pasientene ble fulgt opp i hjemmet eller innen kommunehelsetjenesten gjennom hele pasientforløpet. Demografiske, sosiale og kliniske faktorer var assossiert med høyere nivå av kliniske responser, omsorgsnivå og død. Dette indikerer at helsepersonnell bør være spesielt oppmerksom på akutt funksjonssvikt hos de eldste kvinnlige pasientene som bor i private hjem med økt MEWS score ved mistanke om akutt funksjonssvikt i hjemmesykepleien.

MEWS er et viktig beslutningsstøtteverktøy i kliniske vurderings – og beslutningsprosesser for å undersøke og vurdere forverring av helsetilstand hos eldre pasienter i hjemmesykepleien. Funn fra pasientjournaler og helsepersonells erfaringer, viser tydelig at MEWS i stor grad støtter helsepersonells nivå av kliniske responser i kombinasjon med bruk av klinisk skjønn, og MEWS bidrar også med støtte for helsepersonell til å følge opp og holde eldre pasienter med kompleks og ustabil helsetilstand hjemme. Denne studien viser også tydelig, at MEWS ikke kan brukes på samme måte som tilsvarende i sykehus fordi referanseverdiene ikke er tilpasset for å reflektere eldre pasienters kompleks helsetilstand, og den genererer heller ikke oppfølgingsintervaller eller anbefalinger om å kontakte legetjeneste som kan anvendes i hjemmesykepleien.

Terms and abbreviations

Level of community care	The lowest to highest levels of care in Norwegian municipalities: Private home, community care homes, skilled nursing homes, Municipal care units (MAU).
Clinical response	The clinical decision from lowest to the highest response; to observe the patient in the home, initiate medical treatment in the patient's home, transfer to short term skilled nursing home, MAU or hospital admission in cases of suspected acute functional decline.
Medical service in community care	General practitioner in the municipality and/or general practitioner in the out-of-hours emergency service duty or Municipal acute care unit (MAU)
Multimorbidity	The coexistence of two or more conditions and consequently, associated with more complex clinical management, worse health outcomes, and increased costs in health care services.
Polypharmacy	The use of several medications concurrently for the treatment of one or more coexisting diseases.
Habitual state	The patient's state of health in a stable health situation without acute disease.
Habitual MEWS score	The habitual vital signs and MEWS score (heart rate, respiratory rate, systolic blood pressure, temperature and level of consciousness) that reflects the patient's state of health in a stable state of health.
Trigger recommendations	The actions MEWS recommend health care personnel to perform; new measurements or contacting the medical service.

EWS	Early Warning Score
RSS	Rapid Response Systems
MEWS	Modified Early Warning Score
TILT	Acronym for early identification of life-threatening conditions
RN	Registered nurse
GP	General practitioner
MAU	Municipal acute unit
IPLOS	Acronym for individual-based nursing and care statistics
ICU	Intensive care unit
ADL	Activities of daily living

List of publications

I. Jeppestøl, K., Kirkevold, M., Bragstad, L.K. (2021) Early warning scores and trigger recommendations must be used with care in older home nursing care patients: an observational study. *Nursing Open* (in review).

II. Jeppestøl, K., Vitelli, V., Kirkevold, M. & Bragstad, L.K. (2022) Factors associated with care trajectory following acute functional decline in older home nursing care patients: a prospective observational study. *Home Health Care Management & Practice*. 2022; 34(1):42-51.

III. Jeppestøl, K., Kirkevold, M., Bragstad, L.K. (2022) Assessing acute functional decline in older patients in home nursing care settings using the Modified Early Warning Score: A qualitative study of nurses' and general practitioners' experiences. *International Journal of Older People Nursing*. 2022; 17(1)

1.0 Introduction

The demand for health care in Norway, as well as in other Western countries, is rapidly increasing (1, 2) due to demographic shifts, with an aging population and people living longer with multimorbidity. To meet these challenges, the last decade has been marked by a number of new political regulations and changes in the organization of health care services. An important political strategy has been to strengthen community care to provide safe and cost-effective health care services (3, 4).

The growing transfer of responsibility from specialist health care to primary health care has challenged the municipalities to take a more important role in providing advanced health and care services to the population at the lowest possible but safe level of care (1, 3, 4). The Norwegian coordination reform (3) encouraged early hospital discharge by providing financial incentives, such as municipal payment for patients ready for discharge who remain in hospital. Further, home nursing care and skilled nursing homes are supported to provide comprehensive and advanced health care services to increasingly sick patients. Most of these are older people. However, there is limited knowledge about what characterizes this new and growing population of community care patients with complex states of health, particularly in home nursing care, the context of this study.

Caring for patients with complex diseases in community care requires the implementation of procedures to ensure systematic and early identification of clinical deterioration to support health care personnel in clinical reasoning and decision-making. An example of a standard hospital procedure transferred from hospitals to community care is the Early Warning Scores (EWS), introduced into home nursing care and skilled nursing homes. EWS was developed and has been thoroughly evaluated for use in various hospital settings. A modified version of this instrument, the Modified Early Warning Score (MEWS), has recently been introduced (5) and has been implemented in Norwegian and international community care services with scant knowledge of how these tools work in the context of community care. Thus, it is important to elaborate on how these tools are used with various patient groups in different contexts in community care to provide insight into how these tools impact clinical practice.

1.1 Overall aim

The overall aims of the dissertation were (1) to describe the state of health and clinical trajectories of older home nursing care patients suffering from acute functional decline and factors influencing the trajectories, and (2) to explore how MEWS impacts health care

personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients.

The dissertation consists of two sub-studies. Sub-study 1 is a quantitative study, which includes two separate papers (Paper I and Paper II). Sub-study 2 is a qualitative study which consists of one paper (Paper III). Table 1 present an overview of the papers, aims and research questions of the two sub-studies.

Table 1: Aims and research questions of the three papers

Sub-study 1	
Paper I	
Title	Early warning scores and trigger recommendations must be used with care in older home nursing care patients: an observational study
Aim	Explore older home nursing care patients' MEWS scores and deviating vital signs, and determine whether RNs adhered to the MEWS' trigger recommendations.
Research questions	1. What characterizes older home nursing care patients' MEWS and vital signs in habitual state and in cases of suspected acute functional decline? 2. Is there a significant difference between MEWS in cases of suspected acute functional decline compared to the patients' habitual MEWS? 3. To what extent did RNs adhere to MEWS' trigger recommendations?
Paper II	
Title	Factors associated with care trajectory following acute functional decline in older home nursing care patients: a prospective observational study
Aim	Explore demographic, health-related, and clinical factors associated with clinical response, final level of care and death three months after the initial incidence of acute functional decline among older home nursing care patients.
Research questions	1. What characterizes the clinical care trajectories of older home nursing care patients suffering acute functional decline? 2. Which factors are associated with initial and follow-up clinical responses after an incidence of acute functional decline? 3. Which factors are associated with the final level of community care and death within a three-month period after the initial incidence of acute functional decline?
Sub-study 2	
Paper III	
Title	Assessing acute functional decline in older patients in home nursing care settings using the Modified Early Warning Score: A qualitative study of nurses' and general practitioners' experiences
Aim	Describe RNs' and GPs' experiences with the MEWS tool to support clinical reasoning and decision-making when working with older home nursing care patients who suffer from acute functional decline.

1.2 Outline of dissertation

The dissertation consists of eight chapters, including a list of references.

Chapter 2 starts with a broad overview of the research describing the typical health characterizations of older home nursing care patients, including the knowledge gap addressed in this dissertation. Then, the study's context is described by explaining the organization of Norwegian community care levels, home nursing care, and the medical service, including the collaboration between GPs and RNs and how they collaborate in situations with suspected acute functional decline in older home nursing care patients. The levels of clinical responses in cases of suspected acute functional decline in home nursing care are described. The terms clinical reasoning and decision-making are defined, followed by a presentation of reasoning strategies often used by health professionals. Lastly, the introduction of the EWS implemented in hospitals and community care in Southern Norway is described, followed by a review of research conducted prior to and since the present study was conducted on the impact of EWS in different contexts.

Chapter 3 presents the study's aims and research questions, followed by a detailed description of the design and methods used in the two sub-studies in Chapter 4, including the rationale for the mixed methods design in the present study.

Chapter 5 begins by presenting the main results from Sub-study 1. First, we present results that have not been previously published, as well as results in Paper I regarding older home nursing care patient's state of health. This is done to provide a broad picture of the state of health of the patient samples in this dissertation. Next, the results in Paper II regarding older home nursing care patients' care trajectories and the factors influencing the care trajectories are presented. Finally, the main results from Sub-study 2 are presented by describing how MEWS impacts health care personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients (Paper I and III).

In Chapter 6, the main results from Sub-studies 1 and 2 are connected, interpreted and discussed in light of the overall aim of the study and previous and recent research. Lastly, methodological considerations regarding the mixed methods design of the present study are discussed.

In the final chapter, the conclusions are presented, supplemented with implications for clinical practice and recommendations for future research.

2.0 Background

Exploring older home nursing care patients' state of health and care trajectories and how MEWS impacts health care personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients requires multiple perspectives. These include understanding the older home nursing care patient's complex state of health, the context of community care, and home nursing care. Furthermore, understanding the individual practices, as well as the collaboration between RNs and GPs, and how various EWS (including MEWS) are used in the processes of clinical reasoning and decision-making are necessary. These will be elaborated in the following.

2.1 The older home nursing care patient

Older home nursing care patients are characterized by multimorbidity, polypharmacy, and frailty (6-8). Multimorbidity is defined as the coexistence of two or more conditions and, consequently, is associated with more complex clinical management, worse health outcomes, and increased costs in health care services (9). Polypharmacy has several definitions, the most common being the use of several medications concurrently for the treatment of one or more coexisting diseases (10). Frailty in older persons develops as a consequence of age-related decline in multiple physiological systems, which collectively results in a vulnerability to changes in a habitual health status triggered by disease or trauma (11).

2.1.1 Reduced physiological reserves

Older and frail home nursing care patients need comprehensive and complex health care services (6, 11-13). Reduced resistance to external influences, reduced homeostasis and physiological reserves, and polypharmacy result in an increased risk of severe complications in relation to acute disease, and adverse outcomes (12). The combination of multimorbidity, polypharmacy, and frailty leads to older home nursing care patients having a particular risk of disease and subsequent functional decline, which in turn can result in adverse outcomes, such as increased frailty, the need for increased help from home nursing care, a higher level of community care, and mortality (14).

It is challenging for health care personnel to identify clinical deterioration in with older persons due to the presentation of atypical, uncharacteristic, and diffuse symptoms, and because older persons often have reduced ability to express changes in health state compared with habitual state. The difficulty and challenges in identifying and diagnosing acute disease with older patients have been identified through several studies (15-17), and the term acute

functional decline is used by health care personnel as a temporary diagnosis to describe an acute condition caused by disease, physical injury, or drug side effect (13).

2.1.2 Changes in vital signs

Changes in vital signs are well known to occur with increasing age and with the frail oldest in particular (18-24). Older patients are at great risk of hypotension, which is related to a reduction in the cardiovascular system's ability to respond to and compensate for stressors (18). Maximum heart rate falls with increasing age (20) and the resting heart rate is often observed to increase (21). Decreased chest wall mobility and reduced diaphragmatic efficiency result in increased respiratory rate (22) and older persons commonly have lower core body temperature and altered thermoregulatory responses (25) than younger persons. Vital signs do not appear to change as quickly in the elderly population compared to the young population with physiological deterioration (19). Due to reduced physiological and psychological reserves, the manifestation of clinical symptoms often appears before changes in vital parameters. Further, drugs commonly used by the elderly, such as drugs for cardiovascular disease, pain medication, and corticosteroids, may affect vital parameters. This means that the real state of health is not likely to be reflected early in the form of objective measurements of vital parameters in the older population (18).

Thus, the combination of physiological aging, multimorbidity, and polypharmacy affects physiological responses, and consequently challenges the interpretations of vital parameters when assessing older persons' habitual states and clinical deterioration, such as acute functional decline.

2.1.3 Acute functional decline

Acute functional decline is defined as progressive loss of capacity to perform personal activities of daily living (ADL) and instrumental activities of daily living, which develop within 1–2 days or a week (13). An observational study found 6.4% mortality within 30 days for an older patient group with acute functional decline treated in hospital settings (15), which underlines the severity of the condition.

Acute functional decline is often caused by somatic diseases common among the older population (13, 26), such as infections and cardiovascular, cerebrovascular, pulmonary, neurological, musculoskeletal, metabolic, and endocrine diseases (13, 15, 16, 26-30). It can also be caused by a psychological crisis. Psychological crises can be sudden changes in life situations, such as the sudden death of a spouse or a close family member, or major

upheavals, such as a change in residence (13). The condition is considered a medical emergency, which has been highlighted in the literature as requiring medical supervision and/or hospital admission, preferably to a geriatric hospital unit, followed by a multidisciplinary and comprehensive approach to diagnosing and treating the cause(s) (13, 31).

Acute functional decline in older persons usually presents with diffuse and non-specific symptoms, with atypical presentations with a mix of physical, functional, psychological, and social manifestations (13, 15, 16, 26-30), which deviate from the persons' habitual states. Physical changes, such as weakness, fatigue, impaired gait function, falls, loss of appetite, incontinence, or psychological changes that deviate from habitual function, such as confusion, loss of attention, loss of motivation, and initiative, could be present (15, 32, 33). Social withdrawal and neglect of the usual family and social activities can be observed.
In home nursing care, health care personnel may detect or suspect acute functional decline when a home nursing care patient's habitual state is slightly changed. Observations of functional decline can also be misinterpreted by family and health care personnel as a deterioration of chronic disease and the need for escalation of home nursing care services, or the need for a higher level of community care, such as community care homes or long-term care in skilled nursing homes (13).

It is important to diagnose and treat the cause(s) to give older patients suffering from acute functional decline the best possible treatment (12, 13, 34). Research has evaluated the effectiveness of the diagnosis and treatment of older acute ill patients in specialist health care. A comprehensive geriatric assessment (CGA) approach in hospitals is found to increase older patient's functional ability and increase the probability of returning to the level of care prior to hospital admission (31, 35, 36). However, the consequences of transferring older care facility residents to hospitals are unclear, as the benefits of hospitalizations may not outweigh potentially negative consequences, such as delirium, pressure ulcers, invasive interventions, the need for higher levels of community care, and mortality (37). Although CGA in hospitals is considered to be the gold standard for the treatment of older patients suffering from acute disease, positive effects are found regarding older patient's frailty and mortality when approached with CGA by an ambulatory team in the patient's home (38). However, regardless of whether they are managed in community care or in a hospital, the literature highlights that detection, diagnosis, and treatment of older person's complex state of health require a comprehensive approach when they suffer from suspected acute functional decline.

2.2 Norwegian community health care

The Norwegian health care service is divided into two levels: community care and specialist health care services (39, 40). The Norwegian state is responsible for specialist health care services, such as emergency services, hospitals, and outpatient services (39). The responsibility for primary health care services is placed within the Norwegian municipalities (40). Community care services typically include general practice, out-of-hours emergency services, municipal acute care units (MAU), skilled nursing homes, and home care services (40).

The present study focuses on Norwegian primary health care, and the following sections present how Norwegian community care is organized.

2.2.1 Levels of community care

Health care services are divided into three levels of care in Norwegian municipalities. The lowest level of community care is home nursing care services provided by RNs, auxiliary nurses, and nursing assistants in the patient's private home, where the patient's GP has the medical responsibility for the patient. Community care homes are considered to be a higher level of community care and typically consist of apartments owned by the municipalities with geographic proximity to the office of the home nursing care services. At this level, frequent visits or round-the-clock services by RNs, auxiliary nurses, and nursing assistants in home nursing care can be provided. A GP still has medical responsibility for the patient at this level. Skilled nursing homes represent third, and the highest level of care, providing short- and long-term comprehensive around-the-clock health care services by RNs, auxiliary nurses, and nursing assistants. At this level, nursing home physicians have medical responsibility for the patients. Figure 1 illustrates the levels of care, from lowest to highest, in Norwegian community care.

Figure 1: Community care levels in Norway

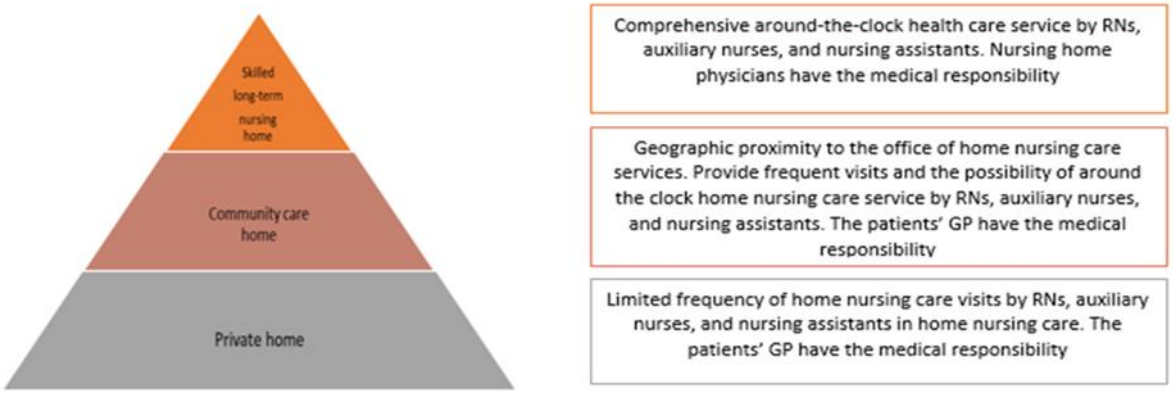


*Figure from Jeppestøl, Vitelli, Kirkevold, and Bragstad, 2021, p 4 (Paper II).

Political incentives for providing safe and cost-effective health care services imply that health care personnel in community care are expected to provide acute and long-term health care services at the lowest possible level of care as long as this can be safely handled in the municipalities (1-4). Recent research conducted in the Norwegian context (41), indicated that older persons 80 years and older receiving community care services have few transitions within the different community care levels. The most frequent trajectory was characterized as long and gradual, with up to two transitions within 180 days or more. Typically, transitions were between private home and short-term skilled nursing homes (41). A development from a generalist approach toward a more specialized care service model in Norwegian community care services has been identified (42). This may indicate that Norwegian skilled nursing homes and home care services provide increasingly specialized and differentiated health services for the various patient groups, ages, and diagnoses (43), which seem to be a result of the transfer of tasks from specialist to primary health care.

2.2.2 Home care services

Persons living at home in need of assistance with personal and instrumental activities of daily living receive help from home care services based on an assessment of their functional abilities. Persons with decreased ability to perform instrumental daily activities, such as housecleaning and grocery shopping, receive practical assistance, which in most municipalities is a service that is separate from home nursing care. Home nursing care provides assistance to address decreased ability to perform personal activities of daily living, such as maintaining personal hygiene, nutrition, and medication.

Home nursing care personnel work mostly alone in the patients' homes with limited support from other professions (44, 45). The frequencies of visits and the amount of time are assessed and determined by the municipal service offices and are adjusted as needed. The complexity of patients' state of health and care needs determines the amount of time and frequency of home nursing care visits. With increased and complex care needs, municipalities can decide to provide assistance at a higher level of care, such as community care homes or skilled nursing homes.

2.2.3 The medical service in community care

The home nursing care patients' GP collaborates with RNs mainly by electronic messages or telephone calls (46) regarding general medical treatment follow-up and in cases of acute disease, such as acute functional decline.

Weekday opening hours for GP offices are mainly set from 08:00–15:00. All GPs are required to perform out-of-hours emergency service duty, which involves a rolling on-call arrangement that GPs share. The out-of-hours emergency service ensures medical availability on evenings, nights, weekends, and public holidays. The public, including home nursing care patients, can contact the out-of-hours emergency service when the GP's office is closed if there is a need for acute medical supervision. Nursing home physicians have the medical responsibility for patients in skilled nursing homes.

2.2.4 Levels of clinical responses

When older home nursing care patients present symptoms of acute functional decline, there are several available levels of clinical responses. A typical consultation starts with a physical assessment, including EWS measurements performed by an RN. The RN either decides to continue observing the patient, or contact the patient's GP within opening hours on weekdays. If the RN decides that the patient needs to be immediately assessed by the medical service outside the GP's opening hours, the out-of-hours emergency service can be contacted. Figure 2 illustrates the levels of clinical responses, including treatment of acute disease, from the lowest to the highest level.

Figure 2: Levels of clinical responses in home nursing care

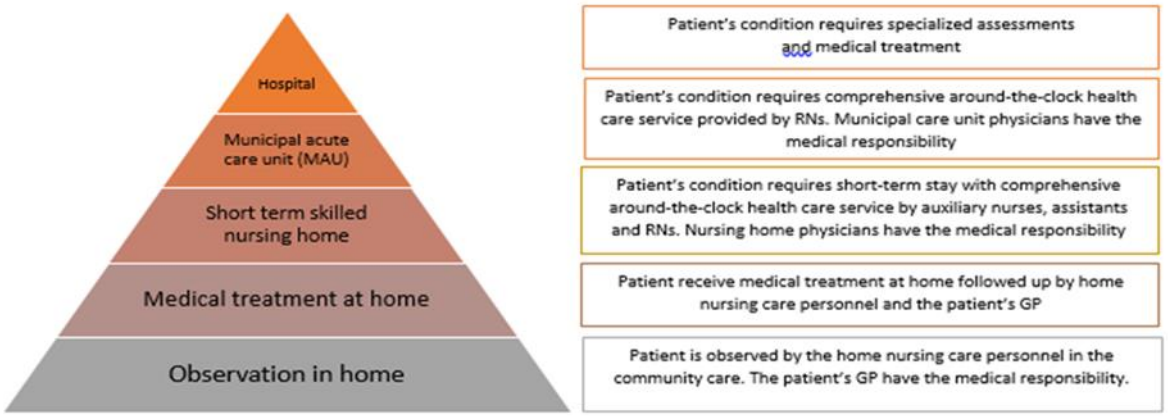


*Figure from Jeppestøl, Vitelli, Kirkevold, and Bragstad, 2021, p 4 (Paper II).

If the medical service, in collaboration with the RN, decides to start medical treatment in the patient's home, the RN and the home nursing care team organize the follow-up. The follow-up includes obtaining medication and starting the treatment, assessing whether the patient is in need of an increased number of home nursing care visits, what competence is needed. In collaboration with the GP, the RN also assesses whether it is safe for the patient to stay in the home, or if the patient needs to be transferred to a higher level of care, such as a short-time skilled nursing home, a Municipal Acute Unit (MAU), or hospital.

Home nursing care patients who live in great geographical distances from the office of home nursing care services and live alone without a social network in private homes are considered likely to be observed or treated in a higher level of care (47). Home nursing care patients living in community care homes within shorter geographical proximity to the office of home nursing care services have the possibility to stay in the home, as the home nursing care team is more flexible in observing and following up with the patient more closely. Home nursing care services can be provided around-the-clock if they are considered safe and if the home nursing care service has sufficient capacity and competency to take care of the patient. Decisions regarding safety and the capacity to observe and medically treat patients in the home or at a higher level of care are collectively decided by RNs and GPs.

2.3 Clinical reasoning and decisions

In the following section, the terms clinical reasoning, clinical judgment and clinical decision-making are defined. Then, various individual and multidisciplinary reasoning strategies,

including the advantages and challenges regarding the use of the EWS to support clinical reasoning and decisions in various clinical settings, are presented.

Comprehensive clinical reasoning regarding older home nursing care patients' complex state of health and decisions regarding the different levels of clinical responses in the context of home nursing care are complex tasks for RNs and GPs in community health care. The risk of misjudging clinical situations, overlooking important information, and making inappropriate clinical decisions in clinical practice are present in all clinical decision-making situations, as health care personnel work with various experiences and knowledge (45).

Clinical reasoning is defined as the overall process of thinking in clinical practice, on which health care personnel base their clinical judgments and decisions (48). Clinical reasoning includes both the process of identifying and defining the relevant concerns in the clinical situation and of deliberating alternative actions to address the concerns by weighing them against evidence and choosing the most appropriate decision for the patient (48, 49). Clinical judgement is referred to as the interpretation or conclusion regarding the patient's health problems and/or the decision to take action or not, by using standard approaches or improvise new options interpreted to be the most appropriate response for the patient (49). Clinical decision-making refers to the outputs of the reasoning process, where health care personnel make complex choices between several courses of action that depend on the specific focus of the situation (48). Clinical reasoning and decision-making are crucial and complex tasks in clinical practice, which depend on the health care professional's competency and experience, the specific context and situation, and the circumstances of the individual patient (48, 49). Clinical decisions can be made using a range of sources of knowledge, such as research-based knowledge, experience-based knowledge, and knowledge of the specific patient and the patient's preferences (50, 51). However, clinical reasoning and decision-making in practice are also associated with diversity, the risk of human error, and potential misjudgments (52, 53).

2.3.1 Strategies for clinical reasoning and decision-making processes

Health care professionals use a variety of reasoning patterns alone, or in combination, in clinical reasoning and decision-making processes when working with older home nursing care patients. Higgs and Jones (48) categorized research based key models, strategies, and interpretations of clinical reasoning used by health care personnel into two groups; cognitive and interactive reasoning strategies. In the following, cognitive and interactive reasoning

strategies are defined, and research showing typical reasoning strategies used in community care and hospital settings is presented.

Cognitive reasoning strategies

Cognitive strategies include health care professionals' individual thinking and characteristics for making clinical decisions (48). Hypothetical-deductive reasoning refers to formulating hypotheses based on specific features in the patient's presentation. The health care professional test the hypotheses against standardized criteria to confirm or disconfirm their clinical assumptions. Hypothetical-deductive assessment is an example of a cognitive model often used by novices and inexperienced physicians who lack sufficient knowledge and experience to recognize clinical patterns. Nursing and medicine experts may also use this strategy in complex cases in which they use data and assessments to confirm or disprove their hypothesis and base the decisions on the conclusion (48). This strategy is often related to the diagnosis of clinical conditions, and EWS for RNs in home nursing care are typical decision support tools that can confirm or exclude acute disease based on objective measurements. For RNs and GPs, objective measurements are an important part of the process of identifying the causes of acute functional decline.

In contrast to the hypothetical-deductive approach, research conducted in hospital settings shows that nurses' intuition and pattern recognition play an important part in detecting patients' clinical deterioration, and that vital signs are often used to validate intuitive findings (54, 55). Pattern recognition refers to reasoning and decisions based on the recognition of typical patterns of situations (48). Experienced RNs and GPs often identify clinical situations or symptoms based on previous experiences in combination with theoretical knowledge, and link this to similar situations, which often exclude the need for hypothesis testing, which in these situations are considered by the expert as not essential (48). Forward reasoning involves inductive reasoning, and is often used by experienced health care personnel where analysis of data results in generating hypothesis or diagnosis by the use of a sound knowledge base. Intuitive reasoning by experienced health care personnel is related to past experience with specific cases and often refer to tacit knowledge and intuition (48).

Studies conducted in home nursing care and in hospital settings have shown that health care personnel recognize changes in the patients' physical and mental condition compared with the patient's condition in habitual state, and these changes are easily recognized if the health care personnel know the patients' habitual state (45, 55, 56). Objective measures, such as vital signs, are sometimes performed to confirm or support the

findings of clinical deterioration. Detecting physical and mental changes from the older patients' habitual state in cases of acute functional decline is one example of pattern recognition and is often used by experienced health care personnel with extensive theoretical and practical knowledge of older patients' characteristics when suffering from acute disease.

In sum, RNs' and GPs' reasoning strategies are related to their experience with and knowledge of the patient. Pattern recognition is a common cognitive strategy for RNs to both identify acute functional decline and reason what causes the changes in the older home nursing care patient's state of health. For GPs, the same strategies are commonly used, although GPs must frequently integrate the RN's written descriptions of observations and measures with their clinical reasoning and decision-making processes. In this sense, experienced RNs and GPs have a solid knowledge basis for making sound clinical decisions. This is in contrast to inexperienced RNs or GPs with sparse knowledge of the individual older patient, which increases the risk of misjudgments and errors.

Interactive reasoning in situations and contexts

The interactive reasoning process involves, among several strategies, multidisciplinary reasoning and decisions made in teams, such as collaboration between RNs, auxiliary nurses, and assistant nurses in the home nursing care team and collaboration between RNs and medical services such as GP or the municipal out-of-hours emergency service (48). Common to multidisciplinary reasoning is that clinical reasoning and decisions are made based on the patient's estimated usefulness of a treatment, and decisions are made based on ethical and moral assessments in relation to economic and political guidelines or shared decision-making in cooperation with the patient (48). Research concludes that clinical reasoning and decision-making processes are influenced by several factors, such as experience and education, the culture of cooperation and collaboration with other health care personnel, and the organizational environment at the specific workplace (49, 54).

Effective and safe decision-making in teams depends on sufficient communication, common understanding of professional concepts and clinical situations (57). There are multiple sources of potential errors or delays in responses in interactive clinical decisions. To support safe reasoning and decision-making processes, standard decision support tools, are introduced in health care with the intention of facilitating consistent actions when certain criteria are present in clinical situations (58, 59). It is therefore important to explore how a standard EWS is incorporated in health care personnel's complex cognitive and interactive reasoning process, and whether EWS supports clinical reasoning and decision processes as

intended, when considering older patients' complex state of health and making decisions in the context of home nursing care.

2.4 EWS as initiative to promote patient safety in community care

The health policy goal of facilitating systematic evidence-based practice to increase the quality of care and enhance patient safety in clinical reasoning and decision-making processes has been an international trend in health care over the last two decades (52, 53, 58). According to WHO's Global Patient Safety Action Plan 2021–2030, p. 5, patient safety is "A framework of organized activities that creates cultures, processes, procedures, behaviors, technologies, and environments in health care that consistently and sustainably lower risks, reduce the occurrence of avoidable harm, make errors less likely and reduce the impact of harm when it does occur" (60).

Introducing EWS in community care is a result of political incentives to shift tasks from specialist care to community care (1, 3, 4) and to facilitate early identification and proper clinical responses with clinical deterioration, and to ensure consensus of common terminology and clinical assessments across levels of care and health professions. The orientation toward standardization in health care, that intend to enhance predictability and patient safety in practice in ongoing, and the use of EWS to ensure equal decision basis and responses across professions and contexts when assessing acute disease is an example of standardization (52, 58, 59).

In 2011, the Ministry of Health and Care Services in Norway initiated the three-year patient safety campaign "In safe hands" (53). In 2014, the Norwegian Directorate of Health followed this initiative and established a five-year national program for patient safety called "In safe hands 24-7" (61). The focus was on "early detection of life threatening conditions," and implementations of evidence-based EWS were highlighted as an important tool for improving patient safety, and many of the Norwegian municipalities followed the hospitals to introduce various EWS systems in community care settings.

2.4.1. Introducing the EWS in hospitals and community care in Southern Norway

As a result of national incentives (61, 62), the Hospital of Southern Norway developed a EWS system for the early identification of life-threatening conditions (Norwegian acronym: TILT) in 2014. TILT consists of an observational curve for vital signs registration, an e-learning system for training health care personnel, and a five-item Modified Early Warning Score (MEWS) (63).

In 2016, the eight municipalities in Southern Norway (Grimstad, Arendal, Froland, Tvedestrand, Risør, Vegårshei, Åmli, and Gjerstad) implemented MEWS. The observational curve for registration of vital signs was introduced to the municipalities but was not implemented in home nursing care due to challenges with the use of one common paper-based curve used by different health care personnel in the patient's home, which is quite different from the hospital setting. The mobile devices used to read and document patient information in home nursing care were not available for the use of an electronic observational curve. The e-learning system for training health care personnel was developed to be used by hospital health care personnel and was considered not adaptable and relevant for use in community care. However, all eight municipalities purchased the same medical-technical equipment, such as blood pressure monitors, pulse oximeters, and ear thermometers. RNs received the same training in the use of MEWS in collaboration with the Hospital of Southern Norway and the Center for Development in Nursing Homes and Home Services in the region (USHT).
The implementation of MEWS and the purchase of medical technical equipment represented an important and new opportunity to perform systematic clinical assessments in home nursing care.

2.4.2 The modified Early Warning Score

The MEWS version implemented in the Hospital of Southern Norway (and subsequently in the municipalities in Southern Norway, is presented in Figure 3. MEWS consists of five items of vital parameters: heart rate, temperature, respiratory rate, blood pressure, and level of consciousness (63).

Using this tool, the vital signs are measured, and a score is calculated based on the measurements. These measurements provide information about a person's physical condition. Vital signs that deviate from reference values generates scores in points and color codes. These points and colors trigger support concerning when to contact the medical service and when the measurements are to be repeated (63).

Figure 3: The Modified Early Warning Score (MEWS)

Score	3	2	1	0	1	2	3
Respiratory rate		<9		9-14	15-20	21-29	>30
Heart rate		<40	41-50	51-100	101-110	111-129	>130
Systolic blood pressure	<70	71-80	81-100	101-199		>200	
Temperature		<35		35-38,4		>38,5	
Level of consciousness				Alert	Voice	Pain	Unresponsive
Contact physician when MEWS score > 4, if oxygen saturation drops to <90% with oxygen treatment, or if you are concerned about the patient's condition.							

Color-code	MEWS score	Follow up/new measurements
Blue	0	24 hours
Yellow	1	8-12 hours
Orange	2	4-8 hours
Red	3-4	1-4 hours
	>4	Contact physician

A score of 0 (blue) represents normal values of respiratory rate, heart rate, systolic blood pressure, temperature, and level of consciousness and triggers new measurements every 24 hours. A score of 1 (yellow) triggers new measurements in 8–12 hours. A score of 2 (orange) triggers new measurements every 4-8 hours. A score of 3 (red) triggers new measurements every 1–4 hours, and a MEWS score of 4 or higher triggers health care personnel to contact a physician. In the MEWS version used in the Hospital of Southern Norway and the municipalities in the present study, oxygen saturation was also a part of the assessment but did not contribute to the score. However, a sudden drop of saturation (< 90%) requires the health staff to contact a physician. MEWS recommend to call for medical assistance if the health care personnel is concerned about the person's health condition (63) (Figure 3).

In 2019, after the present study was conducted, changes in line with international recommendations (64) were initiated to use the National Early Warning Score 2 (NEWS2) (65) in Norwegian hospital and municipal health services (62). NEWS2 has slightly different reference values for the same vital signs as in MEWS. NEWS also generates points for oxygen saturation, oxygen use, and emerging confusion (65). However, the present study explores MEWS, which, until 2019, was recommended by the Norwegian patient safety campaign (61) to be used in Norwegian hospitals and municipal health services.

2.5 Review of research on early warning scores (EWS) in health care prior to the present study

In the following sections, a literature review which includes research published until 2018 represents the current knowledge at the time when the present study was conducted. Reviews and quantitative and qualitative single studies concerning the effects of various EWS instruments on patient and health care personnel outcomes in hospitals and community care settings are presented. To avoid confusion about the large number of various existing versions of EWS included in previous research, the general term EWS is used in place of the particular EWS names.

The research presented from hospital settings is based on studies conducted in various hospital settings, such as emergency departments (ED), acute wards, medical and surgical wards, and intensive care units (ICU), including prehospital settings, such as patient transportation by paramedics. The research presented from community care settings are studies conducted in nursing homes and home care, and the majority research presenting EWS' impact on nurses' clinical practice is conducted in hospital settings except for one study, which was conducted in home care.

2.5.1 EWS in hospital settings

In hospital settings, the effects of EWS on predicting and improving patient outcomes have been thoroughly evaluated over the last two decades. A systematic review and narrative synthesis published in 2017 confirmed that EWS has excellent predictive value and has been found to influence patient outcomes in various patient settings (66). However, the researchers observed that EWS were effective in identifying deteriorating patients in general but that particular attention should be paid to the elderly, pregnant, pediatric, palliative, and head-injured populations, and that population specific EWS tools should continue to be used in these patients groups.

Several reviews have found that various EWS systems generally have good predictive value for timely identification and recognition of abnormal physiological parameters in deteriorating patients (66-71). More specifically, EWS systems have been shown to decrease unplanned intensive care admissions (ICU) (23, 72, 73). Regarding older patients, EWS has been found to be a powerful tool for predicting ICU admissions for geriatric patients (74) and perform well for predicting cardiac arrest (75). An observation study exploring older patients suffering from cardiac arrest showed that EWS could predict cardiac arrest, although older patients presented lower EWS scores 4 hours prior to cardiac arrest than younger patients

(19). Studies with older hospitalized patients have shown that an increased EWS is strongly associated with mortality and ICU admissions in older patients suffering from acute disease (23). Several studies have concluded that the use of EWS and early identification and responses in cases of acute disease can predict and decrease mortality (67, 72, 73, 75, 76). Collectively, extensive quantitative research conducted in hospital settings over the last decades concludes that the use of EWS systems contributes to the systematic and early identification of patients at risk of acute deterioration in the specialist health service.

2.5.2 EWS in community care settings

Internationally and in Norwegian community health care services, it is recommended that evidence-based EWS tools be implemented in home care and skilled nursing homes (62, 64). The various EWS were developed and validated to be used in hospital settings with all patient groups, except pediatric patients, who are well known to have other reference values of vital parameters (77). Despite the growing introduction of EWS in community care, specific research on the use of EWS with clinical deterioration in the older population outside hospital settings is sparse.

A study conducted in Denmark (78), explored whether EWS was appropriate for identifying and differentiating between older home nursing care patients who could be treated at home, and severely ill patients with the need for hospitalization. The study showed increased incidences of visits to the GP and hospitalization with increasing EWS scores. The study concluded that the use of EWS ensured systematic observation of the patients and improved communication between physicians and other health care personnel, and the researchers concluded that EWS was suitable for identifying acute disease in older home nursing care patients (78). Similarly, a systematic review concluded that very low and very high EWS are able to differentiate between patients who are not likely to deteriorate and those who are likely to deteriorate in pre-hospital settings, so that patients with low risk for deterioration could be safely managed at home (67).

Despite the widely accepted recommendations of implementing EWS in community care (62, 64), few studies have explored EWS' appropriateness outside hospital settings in general, and the sparse number of two studies have explored the use of EWS with older patients in home nursing care in particular. Summarizing the existing research in community care settings, EWS systems are shown to be a potentially appropriate clinical and decision-making tool by structuring communication between health professions and supporting clinical reasoning and decisions regarding the escalation of levels of care. However, there is a need

for knowledge from more robust studies to more widely explore how these tools work in different contexts and with various patient groups.

2.5.3 The impact of the EWS system on nurses' clinical practice

RNs have a central role in assessing and monitoring patients' vital signs and using EWS in combination with clinical judgment, and studies have been conducted to explore how education and educational programs regarding EWS impact nurses' clinical practice. Researchers have explored how nurses' use various EWS systems, and how EWS systems impact nurses' ability to identify clinical deterioration in hospital settings. In the following section, research regarding the advantages and challenges with the use of various EWS in hospital settings is presented. This is deemed relevant as the EWS used in community care was first introduced and used in hospitals and thereby represent a reference point for experiences in community care.

Health care personnel, and nurses in particular, who have the most frequent patient contact and responsibility for monitoring patients, play a crucial role in recognizing and responding to patients' clinical deterioration. Research has identified the need to improve hospital nurses' ability to recognize and respond in a timely manner to clinically deteriorating patients (79). Educational strategies have been explored to enhance their ability to recognize and manage deteriorating patients by using EWS and rapid response teams. Most educational programs were found to be effective, and important positive impacts on health care personnel's skills were found, and studies have reported increased activation of rapid response teams, including improvement of patient outcomes, such as reduced length of stay and fewer adverse events such as cardiac arrests (80, 81).

Researchers have evaluated EWS systems when implemented in various settings inside and outside hospital settings, and found EWS to be generally beneficial to RNs' competence in identifying patients in clinical deterioration (82-85). An important advantage of EWS tools is that they are easy to use, they provide a common language across health care professionals and levels of care, and they provide support in clinical decisions as to whether and when to refer the patient to medical services (66, 82-85).

However, research shows that nurses' experiences with the use of EWS can also be challenging. Researchers have concluded with concern whether EWS could reduce a complex patient situation to a simple score, and have highlighted the risk of ignoring subjective clinical signs and slight changes in deterioration in patients (86). Similarly, researchers have found a tendency toward nurses leaning more toward medical colleagues and the escalation of EWS

rather than their own clinical judgment in situations when assessing a deteriorated patient (83). Other studies have noted that referrals to medical services due to low EWS scores in combination with RNs' general concern for the patients were ignored (82, 83, 85). The possibility that inaccurate recordings of objective measures and inappropriate reactions to abnormal scores may undermine the benefits of the systems are identified (66), and nurses experience that EWS' trigger recommendations could be ignored due to busy work days, (86) and the lack of flexibility in community care practice (45).

Regardless of the advantages and challenges of using EWS in clinical practice, a consensus understanding based on research regards EWS as a supplement to nurses' clinical judgment, used as a support in clinical reasoning and decision-making processes when assessing clinically deteriorating patients (66, 83, 86).

2.6 Review of research on EWS published during the study period (2019-2022)

Literature published since the empirical part of the present study was conducted, seems to show an increased interest in research related to vital signs and the use of EWS with the older population in both hospital and community care settings. However, the interest is still primarily directed toward the health personnel perspective and how EWS affects RNs' clinical decisions.

2.6.1 EWS used with older patients in hospital and community care settings

Studies conducted in hospital and community care settings show that older patients present generally low EWS when measuring habitual scores (87) and with clinical deterioration (87-90). Respiratory rate and heart rate were found to be the most frequently deviated vital signs associated with increased EWS in older patients suffering from acute disease. The researchers emphasized the importance of closely observing elderly patients with an EWS of 2 or 3, particularly if the increased EWS are related to tachypnea and/or tachycardia due to an increased risk of clinical deterioration and mortality (90).

Researchers worry that low EWS scores could provide false reassurance for RNs in clinical decisions (87). High habitual EWS with chronic diseases could trigger unnecessary referrals to medical services; thus, further research is suggested to explore whether EWS triggers the appropriate responses for acute ill older hospital patients (89) and care home residents (87). EWS have been shown to influence decision-making and referral processes when assessing older home nursing care residents (91). Health care personnel reported role empowerment, improved communication, and decision-making with the use of EWS. The

researchers also found a statistically significant link between older home nursing care patients' EWS and Barthel ADL scores, and concluded that EWS is a useful tool in home care. However, the complexity of older home nursing care patients' health conditions indicates that EWS cannot be used as a diagnostic tool for clinical deterioration. The researchers suggested using additional assessment tools, such as the Barthel ADL or Rockwool Frailty Scale, to support assessments of changes in health conditions (91).

2.6.2 Impact of EWS on clinical reasoning and decisions

Several studies have recently explored the effects of EWS on RNs' clinical decisions when assessing acute diseases, and highlighted both advantages and challenges related to the use of EWS in hospital settings. Researchers have found diverse benefits of EWS on RNs' professionalism, reporting that RNs find EWS to be a meaningful tool in identifying clinical deterioration (92). RNs are aware of incorporating their competence and clinical judgment in the use of EWS. However, RNs experienced EWS as less flexible and, instead, relied on their clinical judgment, disregarding the standards in many situations, which in turn became frustrating for the RNs due to disregarding the standard procedures (92). Challenges were found in several studies regarding balancing compliance with a standard tool and relying on the clinical judgement (92-95), and researchers concluded that a standard EWS could not be used to ensure patient safety alone (92, 94-96).

In sum, research has shown the positive impact of introducing EWS in nurses' practice. Improved awareness of changes in vital signs and systematic monitoring are identified positive impacts as well as improved structured communication between health care professions. EWS is shown to support RNs when referring patients for medical attention. Conversely, research also shows challenges with adherence to trigger recommendations due to time pressure and lack of response from medical services when RNs refer patients based on a general concern for patients with low scores, although several studies concluded that EWS does not overrule nurse's clinical judgment.

2.7 Summary of background and identified knowledge gap

This chapter illustrates the complexity in older home nursing care patients' state of health in general, and with recognizing clinical deterioration and acute functional decline in particular. The contexts of community care and home nursing care are differently organized than hospitals in terms of collaboration, availability of medical competence, and geographical proximity to the patient. The individual and interactive strategies in health care personnel's

clinical reasoning and decision-making processes are complex, regardless of contextual settings.

With knowledge of the increased advanced tasks and responsibilities shifted from the specialist to community care, multiple complexities regarding the older patients' state of health, the context of home nursing care, and the nature of health care personnel's clinical reasoning and decisions become important topics to explore. The research conducted over the last decades indicates the important ability of EWS to predict levels of care and death in hospital settings. Various EWS are shown to support, but also challenge, health care personnel's cognitive and interactive strategies of clinical reasoning and decision processes when assessing patients at risk of clinical deterioration. A broad agreement in research supports the use of EWS in combination with clinical judgment and that a broad set of contextual factors may influence the appropriateness of such tools in clinical practice.

Research regarding older home nursing care patients' care trajectories with specifically suspected acute functional decline has not been found. Little is known regarding the predictive value of EWS when used with this particular patient group. Only a few studies have explored the impact of EWS on health care personnel in community care settings in general, and with older patients with suspected acute functional decline in home nursing care in particular. It is therefore important to fill the identified knowledge gap by exploring the state of health of older home nursing care patients, their care trajectories, and how the use of MEWS by RNs and GPs support home nursing care when patients are suspected of acute functional decline.

3.0 Aims and research questions

3.1 Overall aim

The overall aims of the dissertation were (1) to describe the state of health and clinical trajectories of older home nursing care patients suffering from acute functional decline and factors influencing the trajectories, and (2) to explore how MEWS impacts health care personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients.

3.1 Aims and research questions of Paper I

Paper 1 presents a study exploring the MEWS of older home nursing care patients and their deviating vital signs and to determine whether RNs adhered to the MEWS trigger recommendations.

The research questions were:

1. What characterizes older home nursing care patients' MEWS and vital signs in the habitual state and in cases of suspected acute functional decline?

2. Is there a significant difference between MEWS in cases of suspected acute functional decline compared to the patients' habitual MEWS?

3. To what extent did RNs adhere to MEWS' trigger recommendations?

3.2 Aims and research questions of Paper II

In Paper II, we explored the demographic, health-related, and clinical factors associated with clinical response, final level of community care, and death three months after an initial incidence of acute functional decline among older home nursing care patients.

The research questions were:

1. What characterizes the clinical care trajectories of older home nursing care patients suffering acute functional decline?

2. Which factors are associated with initial and follow-up clinical responses after an incidence of acute functional decline?

3. Which factors were associated with the final level of community care and death within a three-month period after the initial incidence of acute functional decline?

3.3 Aims of Paper III

The study presented in Paper III aimed to describe RNs' and GPs' experiences with the MEWS tool to support clinical reasoning and decision-making when working with older home nursing care patients who suffer from acute functional decline.

4.0 Materials and methods

This study consisted of two sub-studies that used both quantitative and qualitative methods to collect and analyze data.

In the following sections, the study design, setting, and sampling strategies are described. Lastly, data collection and data analyses for the quantitative and qualitative studies are presented.

4.1 Mixed methods design

Mixed methods design facilitates a greater understanding of complex processes from different perspectives in health care (97). To address the aims in the present study, aspects of patients and health care personnel were needed to be explored with a mixed methods design (97, 98). A quantitative approach was most appropriate for exploring older home nursing care patients' state of health, care trajectories, and factors associated with the trajectories. This study required the collection of measurable data on a number of variables from patient records. A qualitative approach was most appropriate to explore how MEWS impacts RNs' and GPs' clinical reasoning and decision-making processes.

To enable exploration of both perspectives at the same time provided a broad understanding (97, 98) of how MEWS impact on RNs' and GP's cognitive and interactive clinical reasoning and decision-making processes when assessing suspected acute functional decline with older patients in home nursing care. Table 2 gives an overview of the two sub-studies design and sampling procedure.

Table 2: Mixed methods design with a convergent approach

	Sub-study 1	**Sub-study 2**
Study design	Prospective observational study	Interview study
Sampling procedure	Consecutive April 2018–February 2019	Purposive September 2018
Sample	Home nursing care patients (n = 135)	RNs and GPs (n = 44)
Data collection	Structured web-based data collection from electronic patient records from April 2018, to May 2019	Seven semi-structured focus groups GPs (n = 8) and RNs (n = 36) September to November 2018

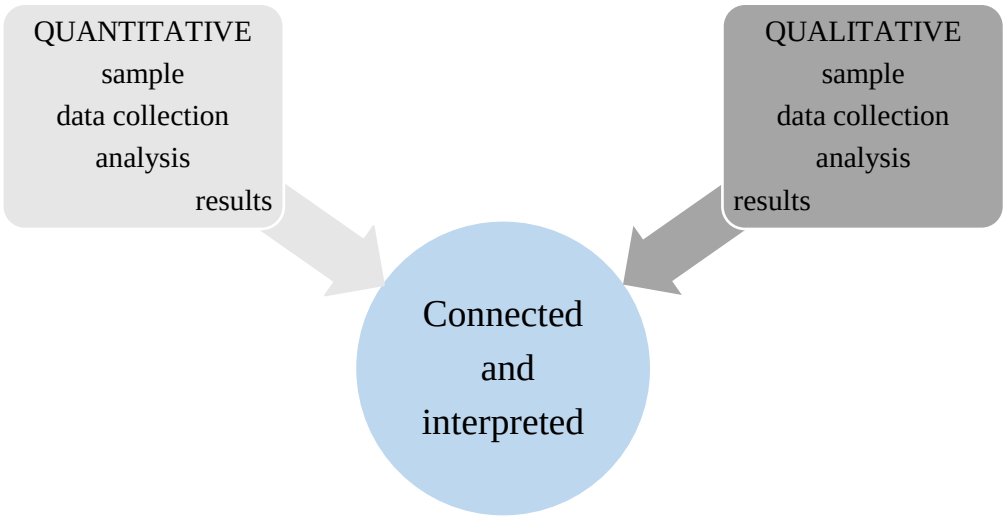
4.1.1 Convergent approach

The purpose of the convergent approach was to obtain different but complementary data on the same topic and to address the overall aim of the study (97). A convergent approach involves collecting qualitative and quantitative data concurrently but separately. Equal

priority was assigned to quantitative and qualitative data, and the findings of one phase were not dependent on the results of the other.

The integration of the results occurred during the interpretation phase to assess congruence and explore contrasts and complementarity (97). In the present study, a connection occurred in the presentation of the results and in the discussion in the present study is illustrated in Figure 4.

Figure 4: Convergent mixed methods design (99)



4.2 Setting and sample

In this section, the setting of the present study, and the recruitment strategies for the two sub-studies are described.

4.2.1 Setting

The present study was conducted in a Norwegian community care setting. A total of two large (more than 20,000 inhabitants), three medium (5,000–20,000 inhabitants), and three small (fewer than 5,000 inhabitants) municipalities were represented.

4.2.2 Recruitment for Sub-study 1

Home nursing care personnel from the eight participating municipalities were asked to recruit patients for the study. Consent forms were distributed to the home nursing care offices to ensure the availability of consent forms in the MEWS equipment bags carried by the home nursing care personnel. A consecutive sampling procedure was used to recruit eligible older home nursing care patients with suspected acute functional decline according to the given

inclusion and exclusion criteria over a set period of time (100). Between April 2018 and February 2019, all eligible patients were approached and asked to participate by home nursing care personnel, and the inclusion criteria were:

- 65 years and older
- Living in private homes or in community care homes
- Receiving home nursing care
- Presenting acute loss of activities of daily living (ADL)
- Assessed with MEWS

Terminally ill patients, or patients with severe cognitive diseases precluding consent were not recruited for this study.

4.2.3 Recruitment for Sub-study 2

A purposive sampling was applied in this sub-study to recruit RNs and GPs with experience with older home nursing care patients in collaboration with RNs in home nursing care (101). The inclusion criteria were:

- RNs working in home care
- GPs working with older home nursing care patients
- Experience with using MEWS in clinical settings with older home nursing care patients.

The administrative leaders and district medical officers of the eight municipalities approved the study and gave access to invite RNs and GPs to participate in focus groups.

4.3 Data collection

In the following sections, the quantitative data collection methods used in Sub-study 1 and the qualitative data collection methods used in Sub-study 2 are presented.

4.3.1. Development of a structured web-based data collection form

A structured web-based data collection form using the "Nettskjema" interface from the University of Oslo was developed by the research team for the purpose of this study.

4.3.2 Data collection for Sub-study 1

Data from older home nursing care patients' electronic patient records (Gerica and Profil) were collected from April 2018 to May 2019.

At the time of inclusion, T1, demographic, health-related, and care trajectory data following the initial MEWS measurement were collected. At the time of three-month follow-

up, T2, demographic and health-related data were collected. An overview of data collected in Sub-study 1 is presented in Table 3.

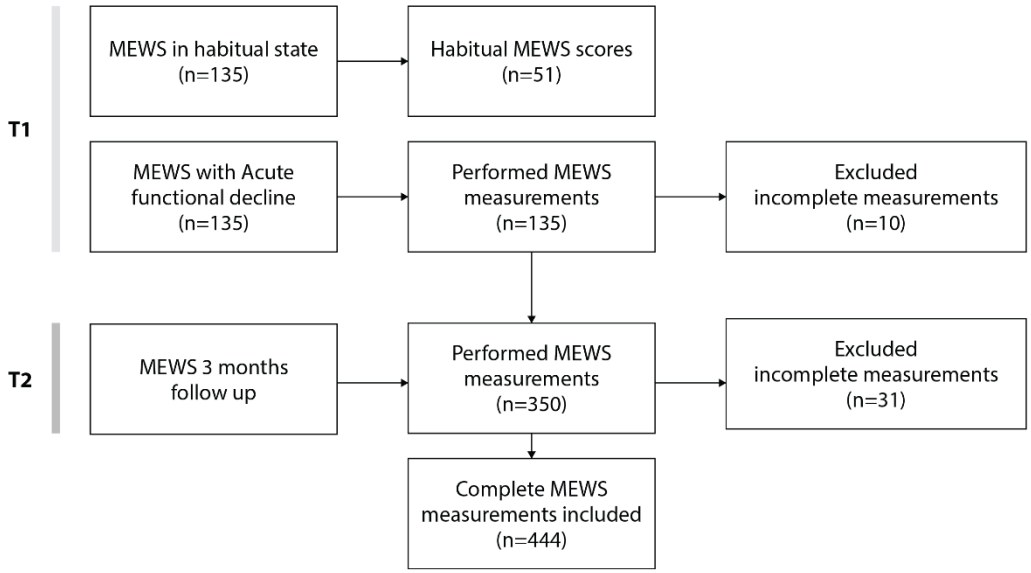
Table 3: Demographic, health-related, clinical, and care trajectory data

Type of data	Variables	T1	T2
Demographic, health-related, and clinical data	*Independent variables/Covariates*		
	Age	x	x
	Sex	x	
	Municipality	x	x
	Level of community care	x	x
	Number of daily medications	x	x
	*Diagnose groups	x	x
	**IPLOS score	x	x
	Number of home nursing care visits pr. day.	x	x
	***Type of home care assistance	x	x
	Duration of symptoms	x	x
	MEWS with acute functional decline	x	x
Care trajectory data	*Dependent variables*		
	Referrals to medical service	x	x
	Hospital admission	x	x
	Municipal acute care unit (MAU) admission	x	x
	Skilled nursing home admission	x	x
	Death		x

*Classified by the International Statistical Classification of Diseases and Related Health Problems (ICD), ICD-10.
**The patient's functional ability in daily life activities: 1–2 = Dependent in all ADL activities, 3 = medium need for personal assistance, 4 = extensive need for personal assistance, 5 = full need for all personal assistance.
*** Assistance with instrumental activities of daily living and personal activities of daily living
****MEWS consists of the following vital parameters: heart rate, temperature, respiratory rate, blood pressure, and level of consciousness. Oxygen saturation is part of the assessment but does not contribute to the score.

Habitual MEWS and the MEWS score at the initial episode of suspected acute decline were collected in T1. Up to 10 MEWS measurements for each were collected in T2. The collection of MEWS measurements are presented in Figure 5.

Figure 5: Flow chart of MEWS measurements collected in Sub-study 1



An electronic data collection form (Nettskjema.no), directly connected to the University of Oslo's server, Services for Sensitive Data (TSD) (102), was used to collect the data. Data were collected from the home nursing care offices of the eight municipalities during the first 5 months of the data collection period (May 2018–October 2018). When a patient from one of the municipalities gave consent, a mail was sent to the PhD candidate, referring to the patient with an anonymized serial number, which authorized the PhD candidate to look up the patient in the electronic journal.

All data were collected by the PhD candidate, who had broad experience with the two systems of municipal electronic journals. An RN from each municipality was always available to resolve any questions regarding the data in the patient records before these were recorded in the data collection form.

4.3.3 Preparation of the data material for analyses

Preparation of data from patient records

All collected data were stored in a dedicated database in the services for sensitive data (TSD). The data were transferred to the statistical software SPSS (103) and R (104) for further analyses. The database was inspected for missing data in the primary quality assurance. The original patient records were consulted to restore any missing values.

For the Bayesian generalized linear mixed model (Paper I), we fitted models at baseline and T2 with different covariates for the models at different timings and for several outcomes. The model was prepared and processed by a statistician (third author of Paper II) in close collaboration with the PhD candidate and the main supervisor. The T1 model had 0.55% missing entries in the covariates, whereas models at T2 showed 10.86% missing in the outcome variables, and 1.32% missing among covariates. The missing data were assumed to be missing randomly, as no specific structure could be detected. Single imputation of missing data was performed using the k-nearest neighbors (k-NN) method, implemented using the R package VIM.37 (105) The distance computation for defining the nearest neighbors was based on an extension of the Gower distance (106) We chose k = 5 neighbors to impute after trial and-error tests. A sensitivity analysis of the chosen imputation method was performed by comparing the k-NN results with the other simple imputation methods available in the VIM. No significant change resulted in the output when varying the imputation method; therefore, k-NN was chosen as the most established and reliable approach.

4.3.4 Development of the interview guide for Sub-study 2

An interview guide with topics and a small number of open questions (101) were developed to explore RNs' and GPs' experiences and perceptions regarding the use of the MEWS in the clinical practice of home nursing care (Appendix 1).

The topics in the focus groups contained topics related to the following:

- Experiences and perceptions related to the usefulness of MEWS in clinical reasoning and decision-making.
- Communication and collaboration between RNs in home nursing care and GPs.
- Whether MEWS is experienced as a tool that contributes to the detection of acute disease and whether MEWS contributes to clinical response and follow-up response in older home nursing care patients with acute functional decline.

- Organizational issues that could inhibit and promote the use of MEWS in the care trajectory followed an episode with acute functional decline.
- Need for adjustments in the use of MEWS to ensure efficient use of the tool
- Need for further training on the use of MEWS in clinical practice.

4.3.5 Data collection for Sub-study 2

In Sub-study 2, focus groups were used to collect data. All focus group interviews were conducted in a meeting room in the home nursing care office of each participating municipality. One large municipality did not participate in Sub-study 2 because capacity restrictions. Table 4 presents the various sizes of the participating municipalities, the time period of the interviews, the number of participants, and the duration of the interviews.

Table 4: The participating municipalities

*Size and municipality		Month - year	**Number of health care personnel (n=44)	Duration
Large	Arendal	October 2018	5	1h:18min
Medium	Tvedestrand	September 2018	9	1h:10min
	Froland	October 2018	8	1h:7min
	Risør	November 2018	7	1h:13min
Small	Vegårshei	September 2018	6	1h:13min
	Gjerstad	October 2018	5	1h:6min
	Åmli	November 2018	4	53min

*Large: inhabitants < 20.000, Medium: inhabitants >20.000, Small: inhabitants >5000
** A total of 35 RNs and 8 GPs participated

Preparation of the qualitative interview data

All interviews were transcribed verbatim with transcript software (f4transkript) (107) within a few days of the interviews. Field notes were conducted from each interview, and an abstract containing tentative findings was constructed when all interviews were transcribed.

4.4 Quantitative analyses

4.4.1 Paper I

Descriptive statistics

Descriptive data analyses, including frequency distributions of categorical variables, median, and interquartile ranges (IQR) of continuous variables, were conducted. To compare habitual MEWS scores with MEWS scores in cases of acute functional decline, the Wilcoxon signed-ranks test, with a significance level of $\alpha = 0.05$, was used. The SPSS software package (version 26.0) was used for the analyses (103).

4.4.2 Paper II

Descriptive statistics

Explorative analyses were conducted to understand the characteristics of the MEWS used in the home care setting with older home nursing care patients with suspected acute functional decline. A descriptive data analysis was conducted on all variables to obtain frequency distributions, median, and IQR. Incomplete MEWS measurements were excluded. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version 26.0 (103).

Bayesian generalized mixed model

Prediction models for the three outcomes of interest (death, type of living arrangement, and final level of clinical care) were fitted using Bayesian generalized mixed models, as implemented in the R package MCMCglmm (108). Generalized models were needed since the outcomes were all categorical, binary (death), and multinomial (type of living and clinical condition). In the former case, we fitted a logistic model, while in the latter, we fitted a multinomial model. The municipality covariate is included via a random effect, since its variability is external to the patient's condition, and thus, we needed to accommodate for the possible over-dispersion. Therefore, the model included mixed effects, with all other covariates included as fixed effects. Two different models were fitted and are explained in the following sections.

The baseline model

The first model was a baseline model, with the outcome being the initial clinical response at T1. This was a 4-level categorical variable, with the reference category "observation at home," and three other levels being "medical treated at home," "admission to municipal emergency unit (MAU)," and "admission to hospital." We selected clinically relevant

covariates at T1 using the following variables: age, sex, the MEWS score at T1, diagnoses, number of medications, number of homecare visits per week, types of home health care and rehabilitation services received, and the average of the 13 IPLOS measurements.

The second model

The second model was a model at T2 to describe what happened to the patients later in time compared to baseline (T1) for a more precise description of the evolution of the older home nursing care patient's condition and the following three-month care trajectory.

Outcomes

We used the three outcomes specified above, specifically:

- Death was a binary 0-1 variable, with the reference category being 0 (alive).
- Type of living arrangement at T2 was a categorical 3-level variable, with the reference category "community care homes," and two further levels being "private home" and "skilled nursing home."
- The outcome related to the patients' final level of clinical care at T2 was a 5-level categorical variable, with reference category "Continued observation at home," and four further levels being "treated medically at home," "admitted to municipal acute care units (MAU), "hospitalized (or re-hospitalized)," and "admitted to skilled nursing home."

Since all outcomes were time-dependent variables in the data, we used the patient-specific measurement closest in time to T2 as the outcome at T2. Municipality was included as a random effect, while all covariates were included as fixed effects in all 3 T2 models.

Covariates

The covariates used in these models at T2 were the random effect given by the municipality, and the same fixed effects covariates at T1 as used in the baseline model.
Moreover, we added four fixed-effects covariates at T2:
1. The MEWS score at T2, estimated as the patient-specific MEWS measurement closest in time to T2 (if available), or with the habitual MEWS (when follow-up MEWS measurements were unavailable).

2. A functional decline variable at T2, namely a binary categorical covariate measuring whether the patient had had new episodes with symptoms of acute functional decline during the last three months.

3. An “admission to hospital” variable at T2, namely a binary categorical covariate measuring whether the patient had been admitted to hospital/ MAU/ skilled nursing home or other institutions during the last three months.

4. A “contact with medical service” variable at T2, measuring the proportion of times the follow-up in time of the patient required contact with a physician during the last three months.

All models were estimated via Bayesian inference to propagate uncertainty in the data (109, 110).

Uninformative priors were used, unless a default conjugate prior was available (111), for several reasons: the dataset was rich enough to allow the data to inform the inference, the complexity in the data structure made it difficult to elicit meaningful priors in this context, and keeping the prior uninformative allowed direct interpretation of estimates in classical frequentist terms.

4.5 Qualitative analyses

4.5.1 Paper III

Thematic content analysis

The data were analyzed using a basic inductive thematic content analysis in an iterative process that moved between text, codes, categories, and themes, inspired by Green and Thorogood (101). All transcripts were read to obtain an overview of the interviews. All transcripts were imported into the qualitative analysis software NVivo12 (112), which was used to organize the codes from all transcripts.

Coding procedure

The coding was performed and approached close to the text, with a focus on letting the data determine the themes rather than approaching them with specific topics or questions in mind (101). The PhD candidate and the main supervisor coded the first interview together to identify codes and ensure consensus. Subsequently, the second interview was coded separately. New and similar codes were then discussed and agreed upon, and the degree of agreement was assessed using NVivo12, resulting in 95%–98% agreement. The PhD candidate coded the remaining five interviews. The coding process of the whole dataset resulted in 114 codes that were identified as suitable for sorting the material to obtain an overview of the interview content.

Categorization and development of themes

All interviews were re-read after the coding process. The codes were then grouped into 24 categories based on similarity of content and by asking, “What is this segment about?” and “How is it like, and not like, the other segments?” (101). The categories were then discussed by the PhD candidate and the main supervisor before subsequent analysis commenced. In the ensuing analysis, two main themes emerged from nine categories and were found to be relevant for Paper I.

Several codes were included in the main categories, and examples of how we arrived at the main themes are presented in Table 5.

Table 5: Examples of codes, categories, and main themes of the qualitative analysis

Transcribed text	Code	Category	Main theme
It gives a certain reassurance that there may not be anything seriously wrong with the patient if the MEWS score has not changed much from what is normal. They do not suffer from sepsis when the pulse and everything are fine. (RN-27) "Really, before MEWS... I could ask the nurse, "What is the respiratory rate?" It really didn´t happen. It didn´t happen before… or… I didn´t get the answer to these questions. It´s something that has happened after implementing MEWS. I don´t think the nurses measured the respiratory rate. They would say 'shortness of breath' or 'no shortness of breath' or 'the patient is breathing fast"." (GP-3)	MEWS provides specific information	Change of practice after the introduction of MEWS	**MEWS as a support in clinical decision-making**
"A lot of our patients have dementia, and they are often unable to express symptoms; you just really have to know your patients in order to assess if it's normal or not". (RN-3) "I think it's something about that continuity and that home nursing care nurses know the care recipients very well, and that is important. It is as important as well as an instrument like MEWS". (GP-6)	Nurses must be in contact with the patients to identify changes	Nurses and GPs have to know their patients to make proper clinical decisions	
"We work a lot with geriatric patients, and I think that MEWS is not adapted to geriatric patients. It's kind of more like it would be suitable for me if I were hospitalized." (RN-4) I think that the respiratory rate score is very low; it's for a healthy person, and we really have none of those. (RN-2)	Patients have parameters outside MEWS' normal range in habitual state.	MEWS is not an appropriate tool for all patient groups	**Adjusting the use of MEWS to older patients in community-based settings**
"It should be said that we are not that structured when it comes to the MEWS follow-up intervals. But sure, we do our own reasoning, even if it's a score of three [red] or two" [yellow]. (RN-44) "Really, to leave the patient at home and to come back again for new measurements in one to two hours… that is really not how we work in home nursing care". (RN-20)	MEWS trigger recommendations are not always relevant nor feasible		

*Table from Jeppestøl, Kirkevold & Bragstad, 2021, p. 6 (Paper III).

4.6 Ethical considerations

The study was designed in accordance with the ethical principles for medical research stated in the World Medical Association's Declaration of Helsinki (113). Approval for the study was obtained from the South East Norway Regional Ethics Committee for Medical Research (Reference number: 2018/469). All administrative leaders of home nursing care in the eight municipalities involved in the study signed written approval for participation in Sub-study 1 and Sub-study 2.

4.6.1 Sub-study 1

The researcher is responsible for ensuring that principles for participation, information, and consent are complied with and handled in an acceptable manner (113). All participating municipalities therefore received in-depth oral and written information about the study. Considering the advanced age, comorbidity, and the current suspicion of acute functional decline in this patient group, several issues were taken into consideration prior to recruitment. As a PhD candidate, I had the responsibility of ensuring that the RNs and the nurse's assistants assured that the respondents understood what they consented to (113, 114). The respondents were asked to participate in the study by RNs or nursing assistants when a MEWS measurement was used to assess suspected acute functional decline. This meant that every participant's competence to consent had to be assessed prior to the request. Older home nursing care patients may be unable to make sound decisions due to acute disease, and dementia or other chronic cognitive diseases could potentially limit and challenge parts of the competence of consent, and it is therefore important that RNs and nursing assistants who know the home nursing care patients are familiar with this challenge and assessment.
If the RNs or nursing assistants were unsure of whether the respondents were able to give their consent at the given time, we agreed that they awaited the request for a few days to assess whether their state of health had improved.

In health care, there will always be an unbalanced relationship of power between health care personnel and patients (115). Patients often want to be polite and comply with the health care system, and in such situations, patients may say yes to participate in the study because they may be anxious to disappoint or be disloyal to the RNs or nurse's assistants. Health care personnel who asked older patients with suspected acute functional decline in general, and additional chronic diseases such as dementia and cognitive impairment in particular, had to be careful, due to the possibility of leading to insecurity for the patients, if they did not understand the information provided and thus become restless, suspicious, or confused. The possible recruitment challenges were presented as possible risks in the

application for approval for the research project by the Regional Committees for Medical and Health Research Ethics (REK) (116). However, the potential burdens for older home nursing care patients in the sub-study were considered minimal. The respondents were not directly affected after signing the consent form, and their sensitive data were DE identified and stored in the University of Oslo's services for sensitive data. However, the ethical challenges and issues identified during data collection were not handled by health care professionals or the researcher alone. The research team was always involved in various questions and issues during the study, but it was my responsibility as a PhD candidate to ensure that the study complied with the legislation and guidelines.

4.6.2 Sub-study 2

When the RNs and GPs were approached for the focus groups, they were informed that their anonymity would be secured throughout the project. Since only 1or 2 GPs participated in the focus groups, we chose not to specify the GPs' municipalities throughout the entire study. At the beginning of all focus groups, the informants were notified about the research team's' commitment to confidentiality, and they were informed of the opportunity to withdraw from the study at any time without any negative consequences. This was done to ensure anonymity, as many of the municipalities had employed a few GPs.

Lastly, the informants were asked to consent to audio recording the interview. All 44 informants signed a consent form, assuring voluntary participation and confidentiality, and all consented to audiotape the focus groups. No informants withdrew from the study.

The consent was safely stored in a locked and fireproof cabinet. Each RN's and GP's anonymity was maintained by giving each individual RN and GP an identification number in Paper III and this dissertation. The forms containing information on RNs' and GPs' education and experience and the transcribed interviews were safely stored and could only be collected by the research team in this study. All data related to the study and article were securely stored in the University of Oslo's Services for Sensitive Data (TSD) (102).

5.0 Results

In the following sections, the main results from each of the two sub-studies will be presented. In addition to the published results presented in Papers I and II, unpublished results that further describe the patient group are presented. The unpublished results characterized the older patients' frequently recorded disease groups, frequently used medications, and symptoms recorded in the cases of suspected acute functional decline. These additional results, presented initially, are important for describing the complexity of older patients' state of health.

The main results in Paper I addressed the state of health of older home nursing care patients, whereas those in Paper II addressed their clinical trajectories and factors influencing the trajectories in cases with suspected acute functional decline.

In Sub-study 2, the main results in Paper III primarily responded to how MEWS affects health care personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients. Paper I adds quantitative results regarding how RNs adhere to MEWS trigger recommendations regarding referrals of the patients to the medical service.

Sub-study 1

5.1 Characteristics of the sample

The sample consisted of 135 home nursing care patients from eight municipalities with a median age of 85 years (IQR 79–89.25) and consisted of 34.8% (47) males and 65.2% females (88). Demographic and health-related characteristics are presented in Table 6.

Table 6: Demographic and health-related characteristics of older the home nursing care patients

Demographic and health-related data	N = 135 (%)	Median (IQR)
Age		85 (79–89.25)
Gender		
Male	47 (34.8)	
Female	88 (65.2)	
Diagnosis groups*	3	(2–4)
Daily medications		8 (5–11)
Living arrangements		
Private	76 (56.3)	
Community care home	59 (43.7)	
Home nursing care	135 (100.0)	
Number of visits pr. day		2 (1–4)

*Classified by the International Statistical Classification of Diseases and Related Health Problems (ICD), ICD-10.

5.2. Older home nursing care patients' state of health

5.2.1 Recorded diseases and daily medications

A total of 16 different disease groups were represented within this patient group at T1 and T2. Each patient presented with a median of three disease groups (IQR 2–4) (117). Frequently recorded disease groups were diseases of the circulatory, respiratory, musculoskeletal system connective tissue, and endocrine systems; nutritional diseases, and metabolic, mental, behavioral, neurodevelopmental disorders (Unpublished data). The patients used a median of eight daily medications (IQR 5–11) (Paper I). The most frequently used medications (111) were related to the nervous system, alimentary tract and metabolism system, cardiovascular system, blood, and blood forming organs system (Unpublished data).

5.2.2 Symptoms of suspected acute functional decline

The most frequent reasons for suspecting acute functional decline were diffuse and vague symptoms deviating from habitual conditions, infections, pain, and falls (Table 7). Diffuse and vague symptoms were recorded in the patient records with a range of different statements, for example, "*The patient expresses that he is feeling unwell*" or "*The patient is unusually quiet today and seems a bit confused.*" Examples of more specific symptoms could be "*The patient walks slower than usual*" (to indicate reduced ADL function*)* and "*The patient is pale and does not want anything to eat*" (indicating nutritional deficiencies) (Unpublished).

Table 7: Recorded symptoms and reasons for performing MEWS measurements

Reasons for performing MEWS measurements/symptoms of suspected acute functional decline documented in patients' medical records*	**N = 228 (%)**
Diffuse and vague symptoms that deviated from the patient's habitual condition	81 (35.5)
Infection symptoms	44 (19.3)
Pain	26 (11.4)
Falls	20 (8.8)
Reduced ADL functions	17 (7.5)
Dizziness	11 (4.8)
Dyspnea	10 (4.4)
Anxiety	5 (2.2)
Relatives' concern	4 (1.8)
Vomiting and diarrhea	3 (1.3)
Nutritional deficiencies	3 (1.3)
Suspected incorrect drug use	2 (0.9)
Syncope	1 (0.4)
Incontinence	1 (0.4)

*Several symptoms of MEWS measurement/patient were registered.

5.2.3 MEWS scores and frequently deviated vital signs

The habitual MEWS scores were registered for 51 patients (37.8%), and the median MEWS score was 1 (IQR 0−1). The median MEWS score in case of acute functional decline (T1) was 1 (IQR 1−2), and the median MEWS score in T2 was 1 (IQR 1−2). The majority of all scores in T1 (97.6%) and in T2 (97.2%) were low (0−4). Although the majority of the scores were low, we found a statistically significant difference in the scores when we compared the habitual scores with the scores in cases of acute functional decline in T1 and T2 (z-3.024, p 0.002). Changes from habitual state to acute functional decline predominantly leaned toward increased scores (47%). However, in 35% of the cases of acute functional decline, the score did not change, and in 18% of the cases, the score was lower than the habitual score (Paper I). Respiratory rate was the most frequently deviating vital sign in the habitual state (72.5%), and in cases of acute functional decline at T1 and T2 (88.8%). Heart rate also frequently deviated in the habitual state (19.6%) and in cases of acute functional decline at T1 and T2 (15.3%). Blood pressure, temperature, and level of consciousness rarely generated elevated MEWS scores in habitual state (5.9%, 5.9%, and 2.0%). Similarly, blood pressure, temperature, and level of consciousness seldom generated elevated scores in T1 or T2 (9.8%, 4.9%, and 0.4%) (Paper I).

In sum, the sample consisted of a patient group characterized by advanced age, multimorbidity, and polypharmacy. The patients presented a wide range of symptoms after one or several incidences of acute functional decline and generally low MEWS scores, frequently increased by elevated respiratory rate and heart rate in both habitual state and in cases of suspected acute functional decline within the three-month study period. In 47% of the cases, the MEWS scores did not show the expected increase, and 53% of the scores were stable or lower than the habitual score.

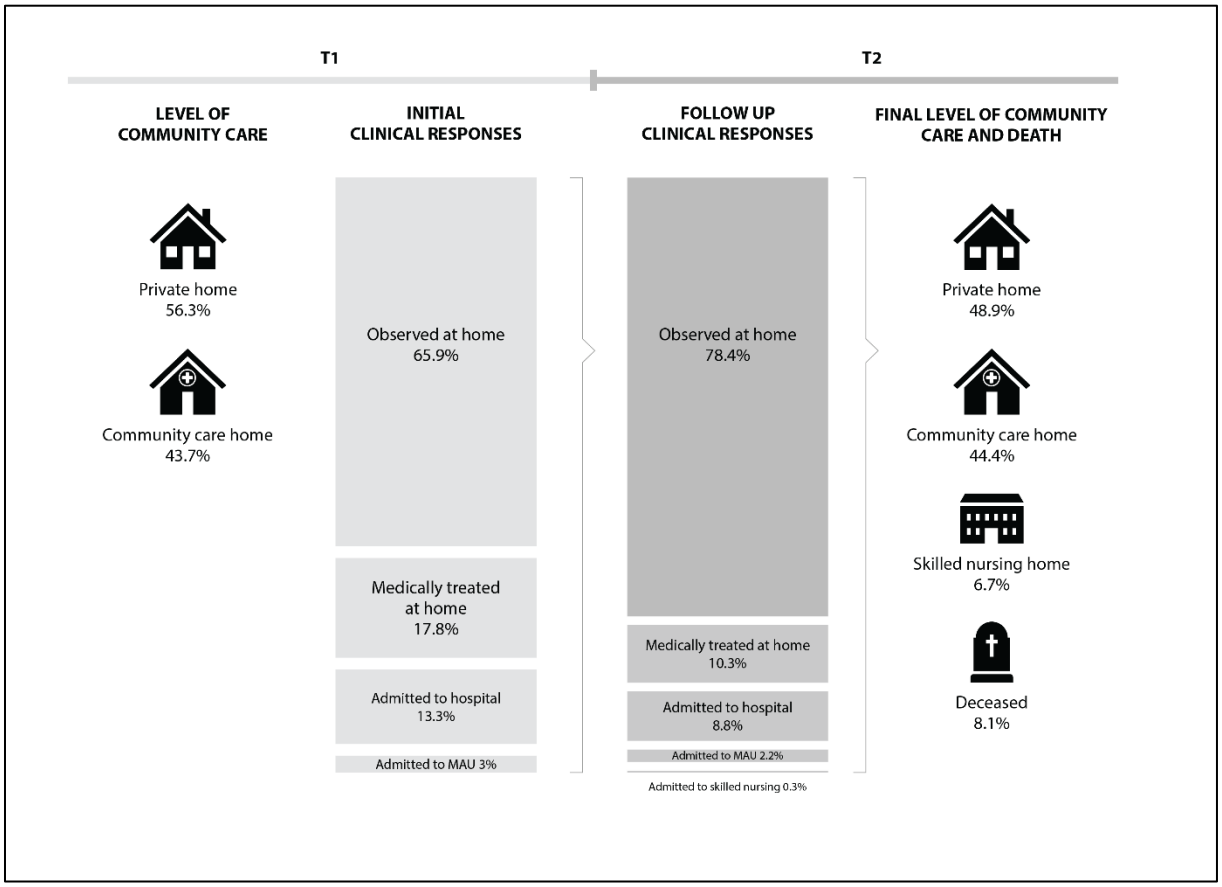
5.3. Older home nursing care patients' care trajectories

The older patients' care trajectories started when home nursing care identified symptoms of acute functional decline that deviated from the patients' habitual state, and MEWS was performed with one of the following clinical responses: observed at home, medically treated at home, and admitted to MAU or hospital. At inclusion in the study, 56.3% lived in private homes, and the remaining patients lived in community care homes. With the initial episode of suspected acute functional decline, the majority of the patients were observed (65.9%) or medically treated at home (17.8%). A total of 3% were admitted to MAU, and 13.3% were admitted to the hospital.

Within the three-month period, 65.2% of the patients experienced new incidents of acute functional decline. However, all 135 patients were followed up with MEWS measurements after the initial episode (T1). After new MEWS measurements in the following three-month period, the patients were observed (78.4%) or medically treated at home (10.3%). The remaining patients (2.2%) were admitted to MAU, hospital (8.8%), or skilled nursing homes (0.3%). At the end of the study period (T2), 48.9% lived in private homes, 44.4% lived in community care homes, and 6.7% of the patients were transferred to skilled long-term nursing homes. Within the three-month study period, two patients died in private and community care homes, and nine patients died in skilled long-term nursing homes (8.1%) (Paper II).

These results indicate that older home nursing care patients were observed and treated in their homes or within the levels of community care in the majority of the cases of suspected acute functional decline. Figure 6 presents the levels of care and clinical responses in older home nursing care patients' care trajectories in cases of suspected acute functional decline.

Figure 6: Older home nursing care patients' levels of care, clinical responses, and care trajectories



5.3.1 Factors influencing clinical care trajectories

The Bayesian generalized mixed linear mixed models showed that several factors were associated with clinical responses at a level of statistical significance (Table 9 in this dissertation and Paper II). Age, gender, level of community care, duration of symptoms, and previous hospital admission were factors that influenced clinical responses throughout the care trajectories. Factors associated with clinical responses, final level of community care, and death throughout the older home nursing care patient's care trajectories are presented in Table 8. Throughout the care trajectories, the MEWS was a factor that influenced the care trajectories by predicting levels of clinical response and a possible increased risk of death. Low MEWS scores did not exclude the possibility of acute disease, the need for a higher level of clinical responses, and a possible increased risk of death. These results indicate that health care personnel must use MEWS with care for older patients in home nursing care and in combination with clinical judgment (Paper II).

Table 8: Factors associated with clinical responses, final level of community care, and death

	Outcomes	Age	Gender	Level of community care T1	Duration of symptoms	MEWS T1	MEWS T2	Admitted to hospital
T1	Initial clinical response	x	x	x	x	x		
T2	Follow up clinical response	x					x	
	Final level of community care			x				
	Death		x			x		x

Statistical significant factors are presented. Significant borderline factors are excluded from this table.

Sub-study 2

In the following sections, the results in Paper I are presented regarding the extent to which RNs adhered to the MEWS trigger recommendations regarding referrals to the medical service. The results in Paper III are presented, which reported the advantages and challenges RNs and GPs experienced with using MEWS to assess older home nursing care patients in cases of suspected acute functional decline.

5.4 Characteristics of the sample

The sample consisted of 44 health care personnel representing seven municipalities. A total of 36 RNs (81.8%) and 8 GPs (18.2%) had mean ages of 43.9 and 43.3 years, respectively (Paper III). The characteristics of the RNs and GPs, including their age and clinical experience, are presented in Table 9.

Table 9: Characteristics of the health care personnel

Variable	GP (n = 8) (18.2%)	RN (n = 36) (81.8%)	Total (n = 44) (100%)
Age (mean (SD))[§]	43.25 (5.94)	43.92 (13.26)	43.8 (12.2)
20–29			9 (20.5)
30–39			6 (13.6)
40–49			13 (29.5)
50–59			12 (27.3)
60–69			4 (9.1)
Clinical experience (mean (SD))	15.13 (6.33)	15.81 (10.89)	15.69 (10.16)
0–5	0	6 (17.14)	7 (15.9)
6–10	3 (37.5)	6 (17.14)	9 (20.5)
11–20	5 (62.5)	11 (31.42)	15 (34.1)
21–30	0	8 (22.85)	9 (20.5)
31–40	0	4 (11.42)	4 (9.1)

All values are n (%) unless otherwise specified.

[§] The individual age of the participants is not presented due to data protection restrictions to protect the identity of the participants.

5.5 MEWS impacts on health care personnel's clinical reasoning and decision-making processes

5.5.1 Adherence of MEWS trigger recommendations

RNs adhered to MEWS trigger recommendations in 68.9% of all MEWS measurements. In a total of 99.3% of the remaining MEWS measurements in which RNs did not adhere to MEWS trigger recommendations, the scores were low (score 0–4). Regardless, patients were referred to the medical service despite the low scores in these cases. The findings indicate that clinical judgment was used in combination with MEWS in clinical decisions, and sometimes the clinical judgment outweighed the trigger recommendations (Paper I). Although RNs and GPs considered that MEWS could not be used alone, MEWS was considered an important tool to systematize objective observations, and to supplement subjective observations, knowledge of the individual patient, and clinical judgment (Paper III). To a great extent, MEWS supported the majority of the RNs' clinical decisions (Paper I).

5.5.2 Advantages and challenges of using MEWS in clinical practice

Supporting collaboration and systematic assessments

The results in Paper III indicated that MEWS was potentially useful to support GPs' and RN's clinical reasoning and decisions-making. MEWS was considered an important and indispensable tool in home nursing care, which improved both RNs' and GPs' collaboration in assessing suspected acute functional decline. In addition to the introduction of the MEWS tool, new medical-technical equipment was provided to the home nursing care teams to allow them to conduct the MEWS assessments. The new equipment led to a new and extended opportunity for RNs to measure relevant vital signs and combine these measurements with the clinical judgment and knowledge of older home nursing care patients. GPs experienced receiving more systematic, concise, and relevant information from RNs, which in turn helped them to make clinical decisions based on relevant objective information regarding older patients (Paper III).

Challenges of using MEWS with older patients in home nursing care

Although a general positive attitude toward MEWS was expressed by RNs and GPs, several challenges related to the use of MEWS with the older patient group and the use of MEWS in the home nursing care context were repeated topics through the interviews. MEWS' usefulness was experienced as limited, because it was not perceived as sufficiently adjusted to the older home nursing care patients nor to the context of home nursing care. RNs highlighted that MEWS was a tool used to support the overall clinical assessment, but not to be used alone. RNs were aware of the possibility of making incorrect decisions about the older patients by solely relying on MEWS, and they underlined the importance of combining habitual MEWS with the development of MEWS in the situation along with knowledge of the patient. Low scores, such as scores below 3, were considered challenging to assess. Conversely, scores above 3 were considered easier to assess and to make decisions (Paper III).

RNs experienced that they constantly had to adjust their interpretation of MEWS' normal range to fit the patients, which could lead to uncertainty and ambiguity rather than support in their clinical judgments. A significant limitation with MEWS was that it was not experienced to fit the older multimorbid patients' typical health conditions, typically characterized by deviated vital signs in habitual state, and atypical and diffuse presentation of symptoms and vital signs with acute functional decline. Respiratory rate and heart rate were

often referred to as frequently deviated in habitual state as well as with acute disease in older patients. Furthermore, the normal ranges for blood pressure and temperature were referred to as too broad for older patients. Many older patients used medications that could camouflage changes in blood pressure, and this would not generate elevated scores in MEWS. The complexity in older patients' health conditions and clinical presentations in cases of acute functional decline resulted in challenges of using MEWS as a decision support tool, which resulted in RNs often trusting their clinical judgment over MEWS when making clinical decisions in practice (Paper III).

RNs' experiences of challenging situations in evaluating MEWS trigger recommendations for new measurements or contacting medical services were discussed in all interviews. MEWS trigger recommendations for new measurements were often disregarded due to great geographical distances and limited flexibility with work lists. The RNs made it clear that it was often unfeasible and even impossible to adhere to MEWS recommendations in the context of home nursing care. If the MEWS score were elevated and triggered frequent measurements, and the RNs considered the patient to be clinically unstable, the situation would be discussed with other colleagues in the team and with the medical service. The GP or the emergency out-of-hour service would then be contacted, and RNs would argue for admission to a higher level of care, such as the municipal acute unit (MAU) or hospital, to ensure patient safety (Paper III).

6.0 Discussion

In this chapter, the main results are interpreted, discussed and connected in light of the overall aims, drawing on previous and recent research. In the first section, the older home nursing care patients' state of health, care trajectories, and factors that influenced the care trajectories are discussed (Papers I and II). In the second section, the impact of MEWS on health care personnel's clinical reasoning and decision making in cases with suspected acute functional decline in older home nursing care patients is discussed (Papers I and III). Methodological considerations are presented at the end of this chapter.

6.1 Older home nursing care patients' state of health and care trajectories

By combining the findings in the present study, it has become clear that the older home nursing care patients' state of health was complex and shifted back and forth between stability and instability. The severity of the patients' complex state of health was clearly shown through repeated incidents of suspected acute functional decline, referrals to medical services, observations, and medical treatments in the home, hospitalizations, and death within a three-month study period (Papers I and II).

Importantly, slight distinctions of presented symptoms and objective measurements between habitual state and suspected acute functional decline have clearly emerged by exploring older patients' medical records (Paper I), and health care personnel's experiences with assessing older home nursing care patients when acute functional decline was suspected (Paper III).

Acute functional decline was suspected in cases where the older patients presented mostly diffuse and vague symptoms that deviated slightly from their habitual condition (35.5%). Symptoms of infection (19.3%), pain (11.4%), and falls (8.8%) were also perceived by health care personnel to be a possible adverse sign of clinical deterioration (Table 7 in this dissertation). The same symptoms were also found to be frequent reasons for hospital admissions in a cohort study conducted of older home-dwelling patients receiving community care services in Norway (118), and the present study's findings and recent studies (13, 15, 16, 26) show that these symptoms frequently occur.

Research has found that acute functional decline is challenging to identify and diagnose (26, 29). However, the home nursing care personnel in the present study seemed to be aware of the complexities of the symptoms. They initiated actions such as performing MEWS and referring the patient to medical services despite diffuse and only slightly reduced functional abilities (Papers I and III), and in contrast to the cohort study in which the patients

were hospitalized (118), the majority of the patient sample in the present study was primarily observed and treated at home (Paper II).

The patients' care needs seemed to move slightly toward higher levels of community care within the three-month study period. A proportion of patients moved from private homes to community care homes; 6.7% were admitted to long-term skilled nursing homes, and 8.1% died within the three-month study period (Paper II, Figure 6 in this dissertation). Research shows that acute functional decline is associated with severe acute disease, long-term reduced functional ability, and death if undetected and untreated for its causes, (13, 15-17, 30). In the present study, the movement toward increased care needs and higher levels of care and death (Paper II) may be related to possibly untreated causes of suspected acute functional decline. However, this sample represents a patient group that research shows is at great risk of continuing functional decline, frailty, and death due to advanced age and multimorbidity in general (8, 15-17, 30). Deterioration of health may be expected at some point, and acute functional decline may be the start of a further deteriorated state of health, higher levels of care and imminent death.

The present study's findings clearly show the community care services' comprehensive care provision for older patients with chronic and acute diseases. The care provided requires advanced clinical reasoning and decision-making competency among RNs and GPs. The findings also show the health care personnel's capability to identify clinical deterioration and measures taken to manage this patient group within the community care (Paper II, Figure 6 in this dissertation). A potential explanation is that the health care professions represented in the present study were highly experienced (Paper III, Table 9 in this dissertation). Both RNs and GPs represented a broad set of educational specialties and continuing education. Furthermore, they emphasized that high patient continuity ensured that they knew their patients well, regardless of municipal size (Paper III). These characteristics can be assumed to contribute to successful cognitive and interactive clinical reasoning and decision-making processes in the complex patient situations explored in the present study (48-50)

The need for a comprehensive approach from health care services, and in cases of acute disease in particular, is shown through research to be crucial to prevent adverse outcomes and possible premature death for older patients (6, 11-13). Research highlights that this patient group is in particular need of an interdisciplinary and broad comprehensive specialized geriatric approach in hospitals (12, 13, 34, 35) or from ambulatory geriatric units in community care to give them the best possible treatment in order to reverse the functional

decline and to reduce further frailty (38). By contrast, political incentives aim to facilitate assessment and treatment of older patients at the lowest possible level of community care (3).

Managing this patient group at home (Paper II) indicates that the participating municipalities were able to manage the patients' movement between stable and unstable health conditions. This may have been made possible by the organization of community care services in line with political incentives, enabling provision of health care for older patients with chronic, acute, and terminal diseases at the lowest possible level of care in the community (3). This trend is supported by research showing that Norwegian community care services are moving toward becoming more specialized health services (42, 43). Studies have shown that older persons 80 years and older have few transitions between levels of community care (41) further establishing the perception of competent community care services able to care for this group in the community. The majority of the patients in the present study remained, and even died, within community care (Paper II), reinforcing the perception of care trajectories managed within the bounds of community care services.

6.1.1 Factors influencing care trajectories

Age was associated with the level of clinical responses in cases with suspected acute functional decline throughout the three-month study period (Paper II). This finding is in line with other studies showing that age is associated with hospitalizations (118, 119). Considering the sample's advanced median age of 85 years (IQR 79-89.25), the functional decline and objective measurements may have been presented more clearly with the oldest patients due to severely reduced capacity of physiological reserves that is commonly associated with age (12, 13). The health care personnel might have related these symptoms to severe clinical deterioration and the need for higher clinical responses (Papers I and II) based on their cognitive strategies, such as pattern recognition and intuition (48) in each individual patient situation.

In the present study, female patients with suspected acute functional decline were more likely to be transferred to higher levels of care than men (Paper II and Table 8 in this dissertation). Females live longer with multimorbidity and frailty than men (120), which may be the reason for higher levels of clinical responses, such as short-term skilled nursing home admissions, admissions to MAU, or hospital admission. Living longer, older female home nursing care patients are more likely to live alone with multimorbidity and thus without caregivers in the home to compensate for reduced capacity to perform daily activities between home nursing care visits. Research has found a mix of social and health-related factors associated with hospitalizations (121), and persons living alone are more likely to be in need

of higher levels of clinical responses than those living with an informal caregiver. This is linked to informal caregivers' contributions to a wide variety of important practical tasks when patients are unable to take care of themselves (121).

Living in a private home was another factor associated with higher levels of clinical responses and a final level of care in the present study. Those living in private homes received higher levels of clinical responses, such as MAU or admission to the hospital. Those patients were also more likely to move to a higher level of care, such as community care homes or skilled nursing homes, within three months after one or several cases of suspected acute functional decline compared with patients living in community care homes (Paper II). One possible factor could be related to great geographical distances from the patients' home to the home nursing care offices, and limited flexibility for home nursing care personnel to safely monitor and assist patients with unstable health conditions in private homes compared to those in community care homes, which are located closer to the home care offices. There is also reason to discuss whether an episode of acute functional decline could further reduce older multimorbid and fragile home nursing care patients' general health conditions. In combination with limited opportunities for home nursing care services in rural areas to increase the number of visits to patients requiring comprehensive assistance in private homes, a higher level of care may become inevitable. Conversely, patients who already live at a higher level of care in community care homes, may be more likely to stay at that level with an increased number of visits.

Importantly, the patients' MEWS scores were a factor associated with clinical responses throughout the older patient's care trajectories. The present study's three papers have clearly shown that MEWS contributes in RNs' and GPs' clinical reasoning and decision-making processes in home nursing care. Sub-study 1 showed MEWS' predictive value throughout older home nursing patients' care trajectories in cases of suspected acute functional decline (Paper II). Sub-study 2 revealed that MEWS, a highly valued assessment and decision support tool, was supported by exploring RNs' and GPs' perspectives (Paper III), which coincided with the majority of RN's clinical decisions of whether to refer the patients to the medical service in cases with suspected acute functional decline in community care (Paper I),

This is the first study that clearly shows that MEWS can predict death and clinical responses in home nursing care in cases of suspected acute functional decline in older home nursing care patients (Paper II and Table 8 in this dissertation). These findings are similar to studies conducted in hospital settings, where MEWS is found to predict cardiac arrests in older

patients in hospitals (75) and higher levels of hospital care, such as admissions of geriatric patients from medical wards to the ICU (74). The findings support existing international and national recommendations for the use of various EWS decision support tools in the early detection of clinical deterioration in community care (61, 62, 64). As the recommendations have mainly been based on research conducted in hospital contexts (66-76), this study provides important evidence supporting the recommendation to use EWS in community care. The few studies that have explored EWS in community care indicate that these tools are potentially useful in home nursing care (78), care homes (87, 91) and skilled nursing homes (67, 78). However, it is important to note that researchers (87, 91), including the author of the present study, discuss the challenges of using these tools as decision support due to older patients' characteristic changes in vital signs being different from younger patients, and concerns whether EWS triggers safe clinical recommendations in contexts other than the hospital setting (Paper I, II). It has also become clear, by merging the results of the three papers in this dissertation, that MEWS is not used alone as a decision-making tool in clinical reasoning and decisions. MEWS is used to complement the clinical judgment that health care professionals use in clinical practice (Paper III). With the possibility to base clinical decisions on vital signs combined with clinical judgment, a more solid decision-making basis may initiate timely medical treatment and possibly reduce subsequent unnecessary hospitalizations. The findings in this study clearly show that the introduction of MEWS and the new equipment in home nursing care have positively impacted RNs' and GPs' practice in the sense of taking more responsibility for the older patient group with unstable health situations in the patients' home.

In the following section, the discussion moves from older home nursing care patients' state of health and care trajectories based on medical records and objective measurements and statistics toward discussing RNs' adherence to MEWS trigger recommendations (Paper I) when assessing older patients in home nursing with suspected acute functional decline, and health care personnel's perceptions and experiences of using MEWS as a decision support tool (Paper III).

6.2 MEWS' impact on health care personnel's clinical reasoning and decisions

The findings of the present study showed that the implementation of MEWS in home nursing care impacted RNs' and GPs' clinical reasoning and decision-making processes. It has become clear when merging the findings from the present study that MEWS contributed positively in many situations when assessing suspected acute functional decline in older home nursing care patients. However, the findings also revealed several challenges and limitations with using MEWS with older patients in the context of home nursing care (Papers 1 and III). In the following sections, the positive impacts and challenges are discussed in greater detail.

6.2.1 Facilitating systematic assessments and communication

The introduction of MEWS and the procurement of medical technical equipment to the municipalities improved the practical opportunities for RNs to perform systematic clinical assessments and communication across health professions and levels of health care. The acquisition of equipment and the systematization of measurement of vital signs were considered appropriate and wanted by RNs and GPs. Once MEWS and the equipment were introduced and incorporated into practice, they were perceived as an indispensable part of clinical assessment and decision making (Paper III). The improved, structured objective information enhanced both the individual and interactive clinical reasoning processes among the nurses and between the RNs and GPs when collaborating in clinical decisions (48) (Paper III). These results are supported by previous studies conducted in both community care-settings (78, 84, 91) and hospital settings (66, 79, 82, 83, 85), confirming that MEWS facilitates a common language and ensures systematic and precise observations. The common language and precise information, in turn, contribute to improved collaboration between physicians and RNs (Paper III). GPs experienced receiving improved, complete, and relevant clinical information, which was communicated more concisely and systematically by the RNs. The GPs were exclusively positive about the RNs' communication of more precise and objective observations (Paper III), although it must be taken into consideration that GPs did not explicitly relate to scores and recommendations for MEWS measures, as RNs did prior to contacting the medical service. The new practice facilitated clinical reasoning and decisions, which were based on both subjective and objective observations, and led to a more predictable and structured practice, which improved the RNs' and GPs' assessments and basis for clinical decisions (48) (Paper III).

Although MEWS was experienced as a support and a supplement in clinical situations, several challenges were experienced with using a decision support tool that was considered

unadjusted for older patients and in the context of home nursing (Paper III). This will be explored in the next section.

6.2.2 Using an EWS considered unadjusted for population and context

The findings in Paper I showed that RNs adhered to MEWS trigger recommendations to a great extent (68.9%) regarding referring patients to the medical service with MEWS >4 (Paper I). High adherence to MEWS trigger recommendations indicates that MEWS in the majority of the cases corresponded with RNs' clinical judgment and concern for the patient. More specifically, the findings show that with high MEWS (5–8), MEWS clearly supported RNs' clinical reasoning and decision-making processes to refer patients suffering from acute functional decline to medical services. However, MEWS scores between 5 and 8 in this sample were only found in 2.7% of all measurements (Paper I). The low proportion of high MEWS scores is interesting, considering that acute disease was confirmed after referrals to the medical service, resulting in medical treatment in the patients' home, MAU, or at hospital during the study period (Paper I and II).

In the remaining situations (31.1%), RNs disregarded MEWS trigger recommendations and contacted the medical service despite the fact that the MEWS trigger recommendations indicated a "wait-and-see" approach and to performe new measurements after a set amount of time. These MEWS scores were predominantly low (92.6%), that is, between 0 and 4. These findings of the present study may indicate that MEWS <4 do not exclude the possibility of acute disease. With knowledge of the probability that MEWS in most cases would not reflect the older patients' state of health (Paper I), it is reasonable to question the rationale for implementing a standard decision-making tool in the group of older patients with a complex state of health in general, but also to recommend this tool with sparse evidence to support the success of EWS in community care settings in particular (5, 62). However, the present study shows that despite vague symptoms and slight changes in objective measurements, RNs and GPs still managed to identify and initiate clinical responses, which resulted in managing most cases of suspected acute functional decline within the patients' homes.

Challenges with adherence to trigger recommendations, such as contacting medical services for medical attention for patients with concerns for the patient despite low scores, are found in hospital studies (82, 83, 86, 122). In contrast to those in hospital settings, limitations regarding MEWS' recommendations for performing frequent new measurements are found in home nursing care (Paper III), primarily due to long geographic diseases making this

unfeasible. In addition, GPs in community care do not always have the flexibility to respond to and consult their patients physically on short notice. GPs receive electronic messages from RNs when they have concerns for patients (46), and must make decisions based on the RNs' observations. The overall impression in the interviews was that GPs trusted RNs' assessments and that their concerns for the patients were accurate. Frequent referrals to the GPs due to RNs' concern for the patient with low or unchanged MEWS scores might have been perceived as inappropriate by the GPs, as described in hospital settings (82, 83, 85). On the contrary, the overall impression in this study was that the GPs responded to the RNs' concern for the patient, even with diffuse symptoms and low MEWS scores (Paper III).

The intention of implementing MEWS in community care was to enhance patient safety by giving health care personnel a decision support tool to perform structured evidence-based responses based on standard reference values and scores (52, 60, 62). However, the present study's findings showed that in many cases, patient safety could be improved by disregarding MEWS recommendations for responses and relying more on clinical judgment (Paper I). However, reasoning strategies and making safe clinical decisions based on clinical judgment in situations are strongly related to professional experience, and require health care personnel who know the individual patient (48). Conversely, inexperienced health care personnel with a lack of patient knowledge are considered less able to use the clinical judgment and would represent a risk to patient safety if solely relying on MEWS recommendations, particularly in frail older patients. It is important to note, though, that researchers have concluded that EWS are not intended to be used alone, i.e. being superior to the clinical judgement (66), when assessing clinical deterioration (91, 92, 94, 96). Although assessing a patient's vital signs is an essential part of clinical reasoning and decisions, researchers have identified and acknowledged several other important factors that influence identification and responses to clinical deterioration in clinical practice. These include RNs' use of pattern recognition and intuition (48, 54, 55, 95) and knowing the individual patient (33). However, research (92) (92) has found that balancing between adherence to a standard decision-making tool and reliance on clinical judgment is found challenging by RNs. Regardless, research highlights RNs' frustration and challenges due to balance between adherence to a standard decision-making tool and reliance on clinical judgment.

Since this study was conducted, MEWS have been replaced with NEWS2 (65) in the hospitals and community care services in Southern Norway, as recommended by the National Health authorities (62). NEWS2 contain slight changes in reference values for normal vital signs, and measures and generate additional scores regarding the use of oxygen, oxygen

saturation and emerging confusion (65), which is considered as relevant additional measurements when assessing older multimorbid patients. However, although NEWS2 adds more relevant parameters to the assessments, the trigger recommendations are still characterized by being adapted for use in hospitals. However, the Norwegian Health authorities (62) recommend that while observing the standardized intervals for new measurements, the municipalities should adapt the trigger recommendations to the individual local contexts of community care.

The findings in the dissertation demonstrate the complexities in clinical reasoning and decision-making processes when assessing older home nursing care patients' state of health with an EWS not adjusted to older patients and the home nursing care context. Cognitive and interactive clinical reasoning and decision-making processes are comprehensive processes that cannot be reduced to standard procedures, no more than a single tool can ensure patient safety. Complex situations in health care can be safely managed with sufficient competency, experience, continuity of care and multidisciplinary collaboration in community care (48, 49, 58, 59). Assessments such as EWS are important to systematically identify changes in state of health in clinical practice, although the present study have shown that clinical deterioration is first and foremost clearly identified by the pattern recognition of health care personnel (Paper III and Unpublished data, Table 7). Therefore, additional relevant systematic observations may be needed to identify changes in habitual functional abilities in cases of suspected acute functional decline. Interestingly, researchers have recently discussed the need to introduce other objective measures to complement assessments in addition to vital signs and EWS when assessing older patients with complex health conditions. Measuring functional abilities with Barthel's ADL index and Rockwool's Frailty Index (91) and integrating the degree of RNs' concern for the patient into the EWS (95) may provide a more comprehensive approach and broader support for health care personnel. The present study reinforces that EWS cannot be used alone in clinical practice, and that combining health care personnel's clinical judgment with EWS is essential to ensure that the complexity of older home nursing care patients' health conditions are assessed by using a broad set of sources of knowledge to base clinical decisions on.

6.3 Methodological considerations

In the following section, methodological considerations regarding the mixed methods design, sampling procedures, and representativeness are discussed, followed by a discussion regarding the reliability, validity, and trustworthiness of the findings.

6.3.1 Mixed methods design

This study had a mixed methods design with a convergent approach (97). The convergent approach allowed data collection with two independent methodological approaches, where each approach was given equal weight. The rationale for choosing a convergent approach was to enable exploration of the patients' state of health and clinical trajectories as well as the health care personnel's clinical reasoning and decision-making processes regarding care planning and provision from two different perspectives at the same time. Exploring the patient records and all the objective measures recorded there, enabled the delineation of clinical trajectories and exploration of factors predicting different outcomes. Interviewing the RNs and the GPs about their experiences using MEWS and about their clinical reasoning and decision-making processes contributed an additional perspective to understand the care trajectories of the patients.

The analyses and subsequent merging of results enabled comparison, complementation, corroboration, and contrasts of qualitative and quantitative findings (97). In studies using convergent approaches, corroboration is not predetermined. However, in this study the analyses of the qualitative interviews with RNs and GPs showed the same patterns and descriptions of care trajectories as was apparent in the quantitative data from the patient records. In terms of adherence to trigger recommendations in MEWS, the qualitative interview data helped us understand the quantitative findings of adherence. In particular, the qualitative data corroborated the statistical findings from the patient records, and contributed with explanations and decisions behind non-adherence in cases of low MEWS scores. The overall corroboration of findings from each of the two approaches was a strength of the study design.

6.3.2 Reliability, validity, and trustworthiness

Quantitative approach

Sampling procedures and representativeness

The participants were recruited from large, medium, and small municipalities, and we used a systematic consecutive sampling strategy to ensure the recruitment of a representative sample (100, 123). The municipalities recruited different numbers of patients for the study, and there

was no correlation between the size of the municipality and the number of recruited patients (100). We have no reason to believe that the skewed distribution of recruitment impacted the results of this study. Rather, we assume that this represents natural variation in proportion of cases of suspected acute functional decline in the patient group and in combination with variations in recruitment capacity in the various municipalities.

All municipalities were regularly contacted by the PhD candidate with a kind reminder to recruit patients after MEWS was measured in cases of acute functional decline. However, the home nursing care personnel had busy working days, and it may have been demanding to prioritize the recruitment of elderly people with acute illnesses to this study. A weakness of this study is that we did not ask the home nursing care personnel to log eligible patients who were approached to participate, eligible patients who were not approached, or those who did not consent to participate. Adding this logging procedure would make recruitment too time-consuming for the nursing care personnel, which could endanger the recruitment of a sufficient number of patients. Due to the lack of knowledge of non-consenters we were not able to compare characteristics of those consenting relative to those not consenting. The lack of this documentation and lack of response rate calculations challenges the validation of the representativeness of the sample. However, post-hoc comparisons with other comparable studies showed that the sample characteristics of this study is comparable to other studies of the same population (8, 118).

Another weakness that might have influenced the representativeness in this study was the inclusion criteria, which may have reduced the total number of patients recruited to this study. Health care personnel were instructed not to include patients with severe cognitive impairments who were considered not to have the ability to consent to participate. These patients might include older patients with dementia in home nursing care, who represent a very vulnerable patient group at risk of acute illness (124). However, the largest proportion of older patients with advanced dementia live in skilled nursing homes, whereas older patients living at home represent a population considered to have the ability to give informed consent. In general, prior research has shown challenges with the recruitment of older persons to studies, which could be related to medical concerns, frailty, and reduced cognitive function (125, 126). Further, it could be challenging to recruit frail patients suffering from an acute illness, although home nursing care personnel could have possibly waited until the patient had recovered because data collection from patient records was done retrospectively. Furthermore, we do not know if the home care personnel waited to recruit patients who met the inclusion criteria but died in the meantime before being asked to participate in the study. Health care

personnel might also have forgotten to follow-up the consent procedure for the patients they awaited to recruit. These potential sampling biases in this sub-study might have reduced the sample's representativeness, and the results must therefore be interpreted with caution.

Reliability and validity

The prospective and longitudinal design strengthened the reliability of the data material in this study (100, 123). As the study was explorative, the research team developed the data collection form in the present study. The demographic, health-related and clinical data collected in the present study are highly standardized measures. All data were collected from the patient records by the PhD candidate, who is highly experienced in the documentation and interpretation of clinical data in community care practice. However, there is a possibility that the data recorded in the medical records could have been missed or misinterpreted when transferred to the electronic form. There was also a possibility of errors in performing and recording MEWS due to possible user errors or technical malfunctions when using the medical-technical equipment. These potential errors are beyond the control of the researchers. However, the reliability of the data is strengthened due to the provision of training of all health care personnel in the municipalities, and that all municipalities used the same medical-technical equipment. This Sub-study presents data from older home nursing care patient's care trajectories from a limited time window, and we have limited knowledge of possible health-related or social events prior to inclusion in this study.

Bayesian generalized mixed models are strong statistical models with reliable procedures for the imputation of data that have been used in the present study (108). The proportion of missing entries in the first model in T1 was 0.55%, and in the model in T2, 10.86% in the outcome variables and 1.32% in the covariates were missed. However, the missing data were assumed to be missing randomly, and the imputation of the missing data was managed using reliable methods (105, 106).

The outcomes and covariates used in the first and second models in the generalized linear mixed model were standardized measures, which were considered highly relevant to exploring the clinical care trajectories in the present study that substantially increase the validity of this study. We recognize that collecting data from an extended time window would increase the validity of this study. Other relevant variables, such as extended data on demographic and social characteristics (127), may have contributed even more knowledge of factors that are associated with the care trajectories. Whether the patient lived alone was one variable that we recognized as important to explore if it was significantly associated with higher levels of clinical responses and/or final level of community care (121).

The limited number of habitual MEWS recorded in the patient records (37.8%) and the lack of knowledge regarding when the habitual MEWS measurements were performed were unfortunate, and represented a potential bias by complicating the comparison with the MEWS scores with suspected acute illness. However, a strength of this study is that we analyzed a high number of MEWS in cases of suspected acute functional decline. The reliability of the collected data in cases of suspected acute functional decline was strengthened by including only the complete MEWS in the analyses. We used the Wilcoxon signed ranks test, a suitable non-parametric test (123) to compare the MEWS in the habitual state with MEWS scores at suspected acute functional decline. Lastly, all analyses conducted in this sub-study were quality-assured by the study statistician.

Qualitative approach

Sampling procedures and the participants

To determine the quality of qualitative research, a number of quality criteria to ensure the trustworthiness of the findings in Sub-study 2 are addressed (101, 128).

The RNs and GPs included in the present study were recruited from large, medium, and small municipalities. Representativeness was assured by including both professions and variations in municipality size, age, and clinical experience. We included GPs with several medical specializations and RNs both with and without various continuing educations. Although it was challenging to recruit GPs to participate in the interviews, GPs were represented in six out of seven interviews. Research shows that challenges with the recruitment of GPs to participate in research studies are related to great workloads and loss of income when spending time on interviews (129). We therefore offered compensation to cover the loss of income when participating in the interviews, and three GPs used this agreement. However, we have no reason to believe that this compensation influenced the GPs' general contributions; on the contrary, it contributed equal premises for the participants, as all RNs participated during working hours. However, the RNs and GPs may have different motivations for taking part in the study (130). RNs with unique interests regarding MEWS and clinical reasoning and decision-making may have contributed because many RNs were MEWS instructors. The MEWS instructors may have been motivated to bring forth the most positive aspects of MEWS instead of the challenges in practice. However, we have no reason to believe that RNs or GPs had motivation other than to contribute with their experiences, as both advantages and challenges emerged in all interviews. Many RNs and GPs expressed that participation in the interviews was useful, and they gave feedback that they found it

interesting and meaningful to discuss their experiences and perceptions together with colleagues in home nursing care and local GPs regarding how MEWS was used when assessing older home nursing care. One limitation regarding representativeness was that we did not integrate nursing assistants or unskilled workers in the interviews, who represent important health care personnel groups in Norwegian community care. Nursing assistants also use MEWS to assess patients in home nursing care, and their experiences and perceptions could bring forth extensive knowledge regarding the use of MEWS in home nursing care. However, we decided to include health care personnel who explicitly make overall decisions in home nursing care, although we recognize that nursing assistants or unskilled workers may often be the first personnel, in addition to RNs, to identify symptoms of acute functional decline with following MEWS measurements. It would be interesting to explore their perspectives compared with those of personnel with higher or lower levels of experience and education.

Trustworthiness

The sub-study's design, method, data collection, and analysis are explicitly described in detail in this dissertation and in Paper III to promote transparency (101, 128). The analysis process is outlined in detail by giving several examples of coding, categorizations, and main themes from the interviews in Paper III and in Table 5 in this dissertation. However, the possibility that translation of quotes from Norwegian to English may have led to minor changes of the initial meaning in the translation process is present (131).

The pre-understanding and experiences of health care personnel and researchers are recognized as a part of the process of producing the data and interpreting their meanings during the research process (101). As a PhD candidate, an advanced geriatric nurse, and experienced health care personnel in community care, I recognize that my role and the research teams' pre-understandings influenced the perception and interpretation of the data in this study. However, the research team participated in the focus groups, and the team read all transcripts prior to identifying codes, categories, and main themes, and all took part in discussion of the emerging results until we reached agreement (101, 128).

Summarizing comments

The described strengths and limitations affected the reliability and validity of the quantitative sub-study and the trustworthiness of the qualitative sub-study. However, congruency and

consistency were found to a great extent when we compared the main findings from both approaches, which strengthened the validity of the findings and conclusions in the present study (97).

7.0 Conclusions

The overall aims of this dissertation were to describe the state of health and clinical trajectories of older home nursing care patients suffering from acute functional decline and factors influencing the trajectories, and to explore how MEWS impacts health care personnel's clinical reasoning and decision-making processes when assessing suspected acute functional decline in older home nursing care patients.

Based on information from the patient records, older home nursing care patients have complex health conditions and receive comprehensive community health care services, especially related to frequent shifts between stable and unstable chronic and acute health conditions.

The findings show that throughout the care trajectories, the majority of the patients' health issues were managed within the community care services, predominantly while the patients remained in their home.

Demographic, social and clinical factors were found to be associated with higher levels of clinical responses, final level of community care and death in the present study. These findings indicate that health care personnel working with older home nursing care patients should be particularly aware of acute functional decline in older, female home nursing care patients with increased MEWS scores living in private homes.

RNs and GPs confirmed MEWS' important contribution as support in clinical reasoning and decision-making processes when assessing clinical deterioration in older home nursing care patients. Corroborating findings from health care personnel and patients' medical records have shown that MEWS supported health care personnel's clinical judgment and the escalation of clinical responses, and contributed with support for health care personnel to follow up and manage older home nursing care patients with unstable and complex health conditions at home.

However, the present study also shows that MEWS, with its current reference values and trigger recommendations, cannot inherently trigger safe and appropriate responses for this patient group in home nursing care.

7.1 Implications for practice and policy

This study has important implications for practice and highlights the need for health care personnel to be aware of older patients' diffuse and uncharacteristic changes from habitual state. A particular awareness of older patients' low or slightly increased scores when suspecting acute disease must be present. MEWS must be used with care and in combination with clinical judgment, because lower MEWS scores do not exclude the possibility of acute disease in older home nursing care patients. Consequently, health care personnel who have a general concern for the older patient with potential acute functional decline, based on their clinical assessment, should refer the patient to the medical service regardless of unchanged or low MEWS scores. The results also underscore that as long as these tools are in use, each home nursing care patient's habitual functional level should be systematically measured and regularly updated in their medical records. The habitual MEWS can be essential personal reference values that enable comparison with MEWS in cases of suspected acute diseases, which will help determine if there is a significant change in status and subsequent need for clinical response.

This study also has important policy implications. When recommending and introducing new procedures into clinical practice, the procedures should be tested in specific clinical practices to identify both the advantages and challenges of transferring procedures from one context to another. This is particularly the case when transferring a procedure from the hospital to the community care service, because access to colleagues for support and supervision is very different in the community care context. Furthermore, procedures such as the EWS should be sufficiently tested and adjusted to new patient groups before being implemented into everyday practice, in order to assure that they trigger practical and feasible responses that fit the context in the various settings.

Importantly, the use of MEWS in clinical reasoning and decision-making with older home nursing care patients requires comprehensive clinical competency in general, and experience with acute functional decline in particular. Leaders in community care services and policy makers must keep in mind that assessing older patients with MEWS is not a simple task to perform for all health care personnel. Assessing older patients with MEWS requires clinical competency, collaboration across professions, and knowledge of the clinical setting and the individual patient. The latter is achieved through patient continuity. Knowledge of individual patients is important in order to recognize signs of acute functional decline. In combination with clinical judgment, knowledge of the individual is necessary to make safe decisions in practice. Importantly, training and supervision of inexperienced health

professionals, as well as facilitating collaboration between RNs and GPs, are significant measures to ensure patient safety in home nursing care.

7.2 Recommendations for future research

In light of the results of this study, future research is recommended to evaluate how adjustments of the MEWS reference values for older persons' vital signs, and cut-off scores for trigger recommendations adjusted to fit the context of home nursing care, can increase the predictive value and usefulness for health care professions, and patient safety in various community care settings. Further, the development of electronic observational curves to be used with home nursing care's mobile devices and evaluations of how these solutions impact clinical reasoning and decision-making processes are recommended. In addition, research should explore relevant tools to assess functional abilities and health care personnel's clinical judgment as a supplement to the MEWS when assessing older patients with complex health conditions. Lastly, research may explore how EWS are used by other health care personnel, such as nursing assistants and unskilled workers who use EWS in clinical practice.

8.0 References

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Errata

Page	Figure/Table	Original text	Correction type	Corrected text
2	Table 1	Paper II, research question 4. "To what extent did RNs adhere to MEWS' trigger recommendations"?	Writing error	Deleated. This research question belongs to Paper I.
16	Figure 3 – Trigger recommendations- Color-code red.	34	Writing error	3-4
28	Table 3	Number of home nursing care visits pr. week	Writing error	Number of home nursing care visits pr. day
39	Table 6	Number of home nursing care visits pr. week	Writing error	Number of home nursing care visits pr. day

Original papers

I. Jeppestøl, K., Kirkevold, M., Bragstad, L.K. (2021) Early warning scores and trigger recommendations must be used with care in older home nursing care patients: an observational study. *Nursing Open* (in review).

II. Jeppestøl, K., Vitelli, V., Kirkevold, M. & Bragstad, L.K. (2021) Factors associated with care trajectory following acute functional decline in older home nursing care patients: a prospective observational study. *Home Health Care Management & Practice.* 2021; 34 (1):42-51.

III. Jeppestøl, K., Kirkevold, M., Bragstad, L.K. (2021) Assessing acute functional decline in older patients in home nursing care settings using the Modified Early Warning Score: A qualitative study of nurses' and general practitioners' experiences. *International Journal of Older People Nursing*. 2021; 17(1)

I

ORIGINAL PAPER

Title

Early warning scores and trigger recommendations must be used with care in older home nursing care patients: an observational study.

List of authors and institutional affiliations

Kristin Jeppestøl [1, 2,] RN, MSc, Email: kristin.jeppestol@medisin.uio.no

Marit Kirkevold [1, 3,] RN, EdD, Email: marit.kirkevold@medisin.uio.no

Line K. Bragstad [1, 4,] OT, PhD, Email: l.k.bragstad@medisin.uio.no

[1] University of Oslo Faculty of Medicine, Department of Nursing Science P.O. Box 1089 Blindern, Oslo, NO 0318.

[2] Tvedestrand Municipality, P.O. Box 38, 4901 Tvedestrand, Norway.

[3] Oslo Metropolitan University, Faculty of Health Sciences, P.O. Box. 4 St. Olavs Plass, 0130 Oslo

[4] Oslo Metropolitan University, Department of Occupational Therapy, Prosthetics and Orthotics. Pilestredet 48, Oslo, NO 0167

Author contributions

Kristin Jeppestøl is the corresponding author for this manuscript. Jeppestøl was involved in study design, data collection, data analysis, data interpretation and writing. Marit Kirkevold was involved in study design, data analysis, data interpretation and writing. Line K. Bragstad was involved in study design, data analysis, data interpretation, and writing.

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Conflict of Interest

No conflict of interest has been declared by the authors.

Early warning scores and trigger recommendations must be used with care in older home nursing care patients: Results from an observational study

Abstract

Aims

To explore Modified Early Warning Scores (MEWS) and deviating vital signs among older home nursing care patients to determine whether the MEWS trigger recommendations were adhered to in cases of suspected acute functional decline.

Design

Observational study with a descriptive, explorative design.

Methods

Participants were included from April 2018 to February 2019. Demographic, health-related, and clinical data were collected over a three-month period. A Wilcoxon signed rank test was used to compare these MEWS with habitual MEWS.

Results

135 older patients participated. Median habitual MEWS (n=51) was 1 (IQR 0-1). Deviating vital signs were respiratory (72.5%) and heart rates (19.6%). Median MEWS (n=444) was 1 (IQR 1-2). Frequently deviating vital signs were respiratory (88.8%) and heart rate (15.3%). A significant difference between habitual MEWS and MEWS recorded in cases of suspected functional decline was found (p=0.002). MEWS' trigger recommendations were adhered to in 68.9% of all MEWS measurements.

Keywords

observational study, modified early warning scores, vital signs, acute functional decline, clinical decision-making, clinical judgment

Introduction

Despite radically different contexts, early warning score (EWS) tools are recommended in both hospital and community care settings to detect early clinical deterioration and to support clinical decisions in cases of clinical deterioration (NICE, 2007; The Norwegian Directorate of Health, 2020). The implementation of various EWS in home nursing care, care homes, and skilled nursing homes is ongoing, and research exploring how EWS are used and how they impact clinical practice is increasing (Ammitzböll O, 2015; Barker et al., 2020; Brangan, 2018; Hodgson, Greaves, Cook, Fraser, & Bainbridge, 2022; X et al., 2021a). Normal and pathological physiological changes are well known to occur with aging (Chester & Rudolph, 2011; Churpek, Yuen, Winslow, Hall, & Edelson, 2015), and older peoples' vital signs often deviate from standard reference values. The present study explores older home nursing care patients' vital signs and modified early warning scores (MEWS), and how registered nurses (RNs) navigate clinical decisions using MEWS in cases of suspected acute functional decline in home nursing care.

Background

Acute functional decline

Older persons receiving home nursing care are characterized by frailty and multimorbidity (Næss et al., 2017; Vegda, 2009). When older persons become acutely ill, the symptoms are often vague, with an atypical and diffuse presentation of symptoms and a combination of physical, psychological, social, and functional manifestations (Bell et al., 2016; Cigolle, 2007; Hébert, 1997; Hsin-Ju Tang, 2016; Wester, Dunlop, Melby, Dahle, & Wyller, 2013). Acute functional decline is characterized by fatigue, weakness, loss of activities of daily living (ADL) capacity, loss of appetite, falls, incontinence, loss of attention, and/or general cognitive impairment. These symptoms frequently reflect reduced functional and psychological reserves (Chester & Rudolph, 2011) and are often caused by somatic diseases common among the elderly, such as infections and cardiovascular, cerebrovascular, pulmonary, neurological, musculoskeletal, metabolic, and endocrine diseases (Bell et al., 2016; Hébert, 1997). The symptoms of acute functional decline often coincide with symptoms of multiple chronic diseases and present RNs with challenges in detecting the condition and distinguishing between acute and chronic symptoms (X et al., 2021a) . Suspicion of acute functional decline initiates a process in which healthcare professionals must assess the possibility of acute illness. Health professionals decide whether referral for medical service is needed and how

quickly it must occur by comparing the changes in functional abilities and vital signs to the patient's normal and stable habitual state, taking the rapidity of the changes into account.

Older persons' vital signs

Older people are at great risk of hypotension, which is related to a reduction in the cardiovascular system's ability to respond to and compensate for stressors (Chester & Rudolph, 2011). The maximum heart rate decreases with increasing age (Lakatta, 2000), whereas the resting heart rate is often observed to increase (Coupé et al., 2009). Loss of chest wall compliance and reduced diaphragmatic efficiency result in increased respiratory rate (Lalley, 2013; Ridley, 2005), and older persons commonly have lower core body temperatures and altered thermoregulatory responses (Sund-Levander & Grodzinsky, 2009). Changes in vital signs are well known to occur with increasing age, especially among the frail oldest (Chester & Rudolph, 2011; Churpek et al., 2015). However, vital signs do not appear to change as quickly with physiological deterioration in the older population as among younger people (Churpek et al., 2015), and a combination of normal aging, multimorbidity, and polypharmacy can affect the physiological response and thus challenge the interpretation of vital signs.

EWS with clinical deterioration

Various EWS are used in health care, such as modified early warning score (MEWS) (Morgan, 1997) and national early warning score (NEWS) (Royal College of Physicians, 2022). The higher the EWS, the greater the severity of a patient's state of health (Alam et al., 2014; Kyriacos, Jelsma, & Jordan, 2011; Mapp, Davis, & Krowchuk, 2013; McGaughey, O'Halloran, Porter, Trinder, & Blackwood, 2017; Morgan, 1997; Smith, 2014).

In hospitals, increased EWS are associated with acute illness, mortality, and transition to higher levels of hospital care, including transition to intensive care units (Jayasundera, Neilly, Smith, & Myint, 2018). Research conducted in a community care setting shows that slightly increased EWS are associated with higher levels of clinical responses and mortality among older home nursing care patients in the case of acute functional decline (X et al., 2021b).

Previous research has investigated staff experiences using the EWS in prehospital, primary care, and community settings (Brangan, 2018) and among older patients in cases of acute functional decline in home nursing care (X et al., 2021a). These studies found that the use of EWS strengthened health care personnel's communication, but they also indicated the

need for adjustments of the tools' reference values and trigger recommendations to the context and patient groups. EWS increased health care personnel's ability to identify and respond to abnormal vital signs, and the use of EWS may help reduce the number of serious incidents (Jayasundera et al., 2018; Le Lagadec & Dwyer, 2017). However, concerns that the tool could lead to underestimating RNs' clinical judgment and special knowledge of the patient have been raised (Downey, 2017). One major concern is whether the EWS can reduce a complex patient situation to a simple score, running the risk of ignoring clinical signs, small changes, and subtle deterioration (Petersen, Rasmussen, & Rydahl-Hansen, 2017). Nurses have no difficulty referring patients to medical services when presented with high EWS, but difficulties arise when the EWS is low (Dalton, Harrison, Malin, & Leavey, 2018). Early signs of deterioration have been identified through nurses' intuition before measurable deviating signs were apparent (Osborne, Douglas, Reid, Jones, & Gardner, 2015). The EWS has been used to confirm the suspicion of clinical deterioration. RNs' pattern recognition, and analytical assessment suggest that RNs' clinical judgement and sense of worry can accurately predict clinical deterioration in hospital settings with the support of EWS (Romero-Brufau et al., 2019).

Studies recently conducted in hospital and community care settings show that older patients present generally low habitual EWS (Barker et al., 2020) and researchers question whether EWS triggers the appropriate responses for older patients in care homes in cases of clinical deterioration (Barker et al., 2020; Bunkenborg, Poulsen, Samuelson, Ladelund, & Akeson, 2019; X et al., 2021a; Lv et al., 2020; Scott et al., 2019).

Research describing EWS characterizations, specifically among older care home residents, found a statistically significant link between older care home patients' EWS and Barthel ADL scores and health care personnel's reported role empowerment, improved communication, and decision-making with the use of EWS (Hodgson et al., 2022). Hodgson et al. (2020) concluded that although EWS is a useful tool, it could not be used as a diagnostic tool for clinical deterioration due to the complexity of older care home patients' health condition. The authors suggested using additional assessment tools, such as the Barthel ADL or Rockwool Frailty scale, to support assessments of changes in health conditions.

Research regarding the use of EWS in clinical practice shows broad, if implicit, agreement that these tools do not replace health care personnel's clinical judgement; rather, they should be used to support clinical reasoning and decision-making processes (Chester & Rudolph, 2011; Downey, 2017; Dundar et al., 2016; Foley, 2019; Fox, 2015; Fullerton, 2012; Jensen, 2017; X et al., 2021a; Stafseth, 2015; Subbe, 2001).

Despite the growing implementation of EWS in community care, few specific national or international recommendations for the use of EWS with the older patient group or in the home nursing care context have been developed. Only a few studies have examined the characteristics of vital signs and EWS of older home nursing care patients with suspected acute functional decline and how these scoring systems' trigger recommendations support registered nurses' decisions. The present study aims to fill this knowledge gap.

The study

Aim

The study aim was to explore older home nursing care patients' MEWS and deviating vital signs and determine whether RNs adhered to the MEWS' trigger recommendations. The following research questions were formulated:

1. What characterizes older home nursing care patients' MEWS and vital signs in habitual state and in cases of suspected acute functional decline?
2. Is there a significant difference between MEWS in cases of suspected acute functional decline compared to the patients' habitual MEWS?
3. To what extent did RNs adhere to MEWS' trigger recommendations?

Design

This is an observational study with a descriptive, explorative design. The present study is reported in compliance with the STROBE guideline (von Elm et al., 2007).

Sample/Participants

Home nursing care patients were recruited from 8 municipalities in X, and home nursing care personnel invited patients to participate in the study. A consecutive sampling procedure was applied from April 2018 to February 2019. The inclusion criteria were:

- 65 years or older.
- Receiving home nursing care
- Assessed with MEWS in case of suspected acute functional decline.

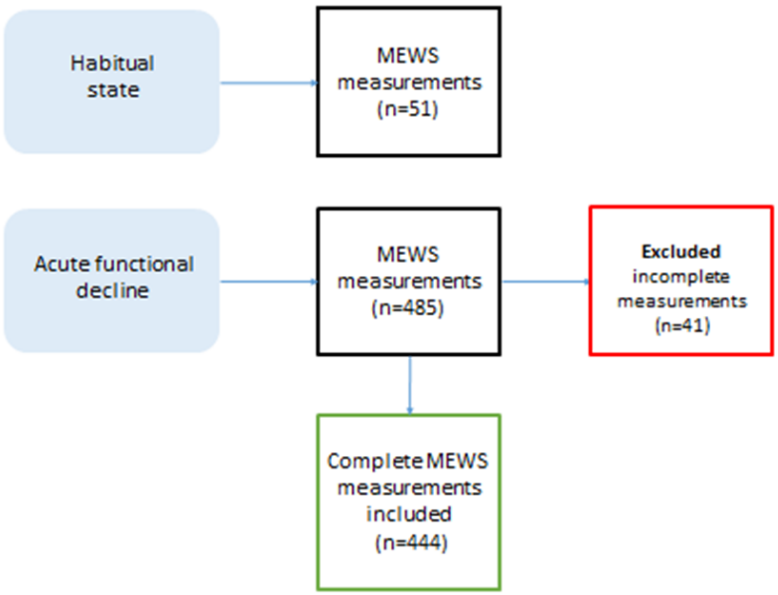
The exclusion criteria were:

- Terminal illness.
- Severe cognitive diseases precluding informed consent.

Data collection

Data were collected from electronic patient records by the first author between April 2018 and May 2019. A structured web-based data collection form developed for this study and used to collect demographic, health-related, and clinical data. MEWS and vital signs recorded in patient's habitual state were collected, as were MEWS and vital signs when acute functional decline was initially suspected. Information about referrals to medical services was collected; a maximum of 10 subsequent MEWS per patient, vital signs, and referrals to medical services were collected over a three-month period from the time of inclusion into the study (Figure 1).

Figure 1: Data collection



Measurements

The EWS system in XXX

A version of the MEWS (Morgan, 1997; Pedersen, 2014) has been implemented in home care in eight xxx municipalities. The MEWS consists of five vital parameters:

- heart rate
- temperature
- respiratory rate
- blood pressure
- level of consciousness

Every MEWS measurement is intended to be performed and assessed in a uniform way by health care personnel, regardless of patient and situation. Vital signs that deviate from reference values represent scores in points and color codes and generate support for health care personnel as to when measurements should be repeated. A MEWS > 4 triggers immediate medical service referral (Figure 2).

Figure 2: Modified Early Warning Score (MEWS)

Score	3	2	1	0	1	2	3
Respiratory rate		<9		9-14	15-20	21-29	>30
Heart rate		<40	41-50	51-100	101-110	111-129	>130
Systolic blood pressure	<70	71-80	81-100	101-199		>200	
Temperature		<35		35-38,4		>38,5	
Level of consciousness				Alert	Voice	Pain	Unresponsive
Contact physician when MEWS score > 4, if oxygen saturation drops to <90 % with oxygen treatment, or if you are concerned about the patient's condition.							

Color-code	MEWS score	Follow up/new measurements
Blue	0	24 hours
Yellow	1	8-12 hours
Orange	2	4-8 hours
Red	34	1-4 hours
	>4	Contact physician

MEWS in habitual state

The habitual MEWS is a measure that reflects the patient's state of health in a stable situation without acute illness. The habitual MEWS is recorded in the medical record as a "baseline" for comparison with single vital signs and MEWS in the event of any change in a patient's health condition, such as with acute functional decline. In this study, we collected the patients' habitual MEWS recorded in the patients' journal prior to the study start. Home nursing care personnel were intended to routinely measure all patients' MEWS in habitual state.

MEWS in a state of suspected acute functional decline

We collected the MEWS recorded at the initial episode with suspected acute functional decline, followed by a maximum of 10 consecutive follow-up MEWS measurements within the three-month study period.

Ethical considerations

Ethical approval was obtained on April 17, 2018 from the XXX ethics committee (approval number: XXX). Nurses and nurses' assistants obtained written informed consent from all patients before data were collected. The health care personnel explained to the patients that their participation was voluntary and the aim of evaluating MEWS among older home nursing care patients in cases of suspected acute functional decline.

Data analysis

Descriptive data analyses were conducted on all variables to obtain frequency distributions of all categorical variables, medians, and interquartile ranges for continuous variables. Wilcoxon signed-ranks test, with a significance level of $\alpha = 0.05$, was used to compare habitual MEWS with the MEWS in cases of suspected acute functional decline (Kirkwood, 2003).The SPSS v. 26.0 software package was used to analyze the data (IBM Corp (2019).

Potential bias

Sample selection bias could be present due to the lack of knowledge of the variations of the patient's health condition and possible events of acute illness that could have affected their vital signs and MEWS prior to inclusion in this study. Further, we have no record of patients who may have declined to participate in the study, or possible patients who were too ill to be asked to participate in the study. These sample selection biases could potentially reduce the sample's representativeness. However, generalizing was not the purpose of this study, but rather to explore and describe the characteristics of the eligible patients and the scores recorded in the given data collection period. The results must be interpreted with caution due to the potential lack of representativeness. It should be noted, however, that our results correspond with existing research, which suggests that this bias is limited. The limited number of habitual MEWS could be a potential bias. However, we used a suitable non-parametric test to compare the MEWS in the habitual state with scores at suspected acute functional decline. Missing data were limited, as structured data collection was carried out by the first author, who is highly experienced in navigating municipal patient records. The reliability of the collected data was strengthened by including only the complete MEWS in the analyses. Since this study was explorative, no forms used in prior research were appropriate; however, the MEWS and vital signs are highly standardized measures that substantially increase the validity of this study.

Results

Characteristics of the sample

A total of 135 patients consented to participate in this study: 64.4% (88) female and 35.6% (47) male. The median patient age was 85 (IQR 79–89.25). The patients were registered with a median of three diagnostic groups (IQR 2–4) and a median of eight daily medications (IQR 5–11). Demographic, health-related, and clinical characteristics are presented in Table 1.

MEWS and deviated vital signs in habitual state and suspected acute functional decline

The habitual MEWS was documented for 51 patients (37.8%). The median habitual state MEWS was 1 (IQR 0–1). The most frequently deviating vital signs in the habitual state were respiratory and heart rates, which were elevated in 37 (72.54%) and 10 (19.60%) habitual MEWS.

During the three-month study period, a total of 444 complete MEWS assessments were carried out; the median MEWS was 1 (IQR 1–2). The most frequently deviating parameters were respiratory rate and heart rate, which were elevated in 326 (88.82%) and 56 (15.25%) MEWS measurements with suspected acute functional decline. Table 1 presents a detailed summary of the patients' habitual MEWS and when acute decline was suspected.

Table 1: Demographic, health-related, and clinical characteristics of the participants

	n=135 (%)	Median (IQR)
Age		85 (79-89.25)
Gender		
Male	47 (34.8)	
Female	88 (65.2)	
Diagnosis groups*		3 (2-4)
Daily medications		8 (5-11)
Living arrangements		
Private	76 (56.3)	
Community care home	59 (43.7)	
Home nursing care	135 (100.0)	
Number of visits per week		2 (1-5)
MEWS in habitual state	51 (37.8)	1 (0-1)
Score 0–4	51 (100)	
Score 5–8	0	
Deviating vital signs		
Respiratory rate	37 (72,5)	
Heart rate	10 (19.6)	
Blood pressure	3 (5.9)	
Temperature	3 (5.9)	
Level of consciousness	1 (2.0)	
None	14 (27.5)	
MEWS in cases of acute functional decline**	444	1 (1-2)
Score 0–4	432 (97.3)	
Score 5–8	12 (2.7)	
Deviating vital signs		
Respiratory rate	326 (88.8)	
Heart rate	56 (15.3)	
Blood pressure	36 (9.8)	
Temperature	18 (4.9)	
Level of consciousness	2 (0.39)	
None	78 (17.5)	

*Classified by the International Statistical Classification of Diseases and Related Health Problems (ICD), ICD-10.
**Maximum 10 MEWS measurements per patient including vital signs were collected after the initial MEWS measurement in cases of suspected acute functional decline.

Comparison of vital signs and MEWS in habitual state and in cases of suspected acute functional decline

There was a statistically significant difference in the median scores comparing habitual MEWS with scores in cases of suspected acute functional decline (z -3.024, p 0.002). The Wilcoxon signed ranks test showed that changes from habitual state to acute functional decline predominately leaned toward higher scores with acute functional decline (47%), but in 35% of the cases, the total score was unchanged, and in 18% of the cases, the score was lower than the habitual score.

Adherence to trigger recommendations

RNs adhered to MEWS' trigger recommendations in 306 (68.9%) cases of all MEWS measurements (n = 444). RNs disregarded MEWS' trigger recommendations in the remaining 138 (31.1%) cases. A total of 137 MEWS measurements with scores between 0 and 4 (92.6%) resulted in the referral of the patient to the medical service. Table 2 presents an overview of MEWS, adherence to trigger recommendations, and referrals (or lack of referrals) to medical services.

Table 2: Distribution of MEWS scores and referrals to medical service in adherence with MEWS' trigger recommendations

	MEWS n (%)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Referrals in adherence with MEWS' trigger recommendations**	**Referrals not in adherence with MEWS' trigger recommendations**
Referred to medical service												
Yes	148 (33.3)	16	44	41	25	11	**4**	**2**	**4**	**1**	11 (7.4)	137 (92.6)
No	296 (66.7)	**60**	**130**	**75**	**26**	**4**	1				295 (99.7)	1 (0.3)
Total	444 (100)	76	174	116	51	15	5	2	4	1	306 (68.9)	138 (31.1)

Note. MEWS scores >4 triggers medical service referral.
MEWS scores referred to medical services in adherence with MEWS' trigger recommendations are highlighted with **bold.**

Discussion

In the following sections, we discuss the most frequently deviating vital signs in the habitual state and in cases of suspected acute functional decline. Furthermore, differences between habitual MEWS and suspected acute functional decline are discussed, along with RNs' adherence to MEWS' trigger recommendations.

Frequently deviating vital signs in habitual state

The sample in this study was characterized by multimorbidity, polypharmacy, and advanced age, which represent complex health conditions. Respiratory rate and heart rate were slightly elevated, and the most frequently deviating vital signs in habitual state. These findings are in line with previous research exploring older persons' typical habitual vital signs (Lalley, 2013; Ridley, 2005).

Heart rate was the second most frequent deviating vital sign in the habitual state (19.6%), a result supported by research showing that an increased resting heart rate is common in the habitual state of older persons (Coupé et al., 2009). The median MEWS was 1 (IQR 0–1), and MEWS were elevated in the majority (72.5%) of the 51 patients measured in habitual state. These results are in keeping with a study showing slightly elevated EWS in older care home residents' habitual state (Barker et al., 2020). This knowledge provides important implications for health care personnel, who should consider that elevated respiratory rate or/and heart rate do not necessarily reflect acute illness for older multimorbid patients. Furthermore, habitual MEWS can give health care personnel important support when suspecting acute functional decline, due to the ability to compare habitual measurements with the current MEWS to prevent unnecessary new measures or referrals to the medical service. However, health care personnel must use MEWS as a decision support with care, with the knowledge that slightly increased respiratory rate or/and heart rate are associated with possibly higher levels of clinical responses and death (Bunkenborg et al., 2019; X et al., 2021b).

MEWS and frequently deviating vital signs with suspected acute functional decline

The MEWS with suspected acute functional decline were generally low, with a median score of 1 (IQR 1–2). These results are consistent with another study concluding that older patients present lower scores than younger patients prior to adverse events (Churpek et al., 2015). In cases where health care personnel suspected acute functional decline, the patients' respiratory rate (88.8%) and heart rate (15.1%) frequently deviated. These findings are in keeping with

other studies that have found elevated respiratory and heart rates in clinically deteriorated hospital patients (Bunkenborg et al., 2019; Chester & Rudolph, 2011) and are significantly associated with further clinical deterioration (Bunkenborg et al., 2019). Reasoning whether an elevated respiratory rate in older multimorbid patients is caused by age-related changes, chronic illness, acute illness, or a combination of these has been shown to be challenging (X et al., 2021a). A rise from 15 to 28 breaths per minute, indicating tachypnea, should generate 2 MEWS points. Although tachypnea is considered an adverse sign of clinical deterioration (Bunkenborg et al., 2019), this change alone does not indicate medical service referrals according to the trigger recommendations (Morgan, 1997) (Figure 2). Similarly, a rise from 70 heartbeats per minute to 100 in a case of suspected acute functional decline would not generate a higher MEWS, although it could be considered a major physiological change with the risk of clinical deterioration in older multimorbid patients with complex health conditions (Bunkenborg et al., 2019; Coupé et al., 2009).

Difference between MEWS in states of suspected acute functional decline compared to the patients' habitual MEWS

This study showed that changes in the MEWS from habitual state relative to scores recorded at the time of suspected acute, functional decline predominately leaned toward higher scores (47%). Slightly increased MEWS in older patients in hospital settings has been associated with clinical deterioration and death (Bunkenborg et al., 2019; Churpek et al., 2015). In home nursing care settings, slightly increased MEWS has been associated with higher levels of clinical responses and death (X et al., 2021b). Although the use of the EWS in clinical practice has been shown to be important and useful, it is also challenging. Barker et al. (2020) concluded NEWS to be feasible but also challenging to use as a supportive reasoning decision-making tool with older care home residents, due to unclear interpretation of slightly elevated habitual scores and few high scores with clear interpretations.

Furthermore, in 35% of the cases in the present study, the total MEWS was unchanged, and in 18% of the cases, the score was lower than the habitual score. These results highlight the challenges of interpreting slight changes in vital signs and the difficulties in adhering to MEWS' trigger recommendations when suspecting clinical deterioration with only slightly increased heart rate and respiratory rate (X et al, 2021b). In this study, only 51 patients (37.8%) had recorded habitual measures for comparison. Minor changes in vital signs and low MEWS can easily be overlooked and misinterpreted in clinical practice, especially with a lack of habitual measurements that could be compared and combined with vague, non-

characteristic, and slight changes in functional abilities in cases of suspected acute functional decline in older patients (Bell et al., 2016; Cigolle, 2007; Hébert, 1997). Unchanged or low MEWS cannot exclude the possibility of acute illness among older people because one parameter can compensate for another, and lower scores than habitual scores in cases of suspected acute functional decline could actually represent severe clinical deterioration. One example of an unchanged MEWS that could be misinterpreted to mean stability in clinical status can occur in an older patient with a habitual state MEWS of 1 due to an elevated respiratory rate. In the case of suspected acute functional decline, the patient may still have a MEWS of 1 but may demonstrate changes in respiratory and heart rates (Figure 2).

Adherence to MEWS' trigger recommendations

The MEWS trigger recommendations were adhered to in 68.9% of all 444 registered measurements in this study. The MEWS clearly supported RN's concerns and clinical judgment regarding patients' health conditions in 11 of the 12 (91.7%) high MEWS (5–8). Referring patients to medical services in response to high scores is in line with the core principle of EWS in general, based on the fact that a high MEWS indicates increased severity of a patient's state of health (Alam et al., 2014; Kyriacos et al., 2011; Mapp et al., 2013; McGaughey et al., 2017; Morgan et al., 1997; Smith et al., 2014).

In this study, referral of patients with slightly increased low MEWS to medical services did not adhere to MEWS' trigger recommendations; however, in line with other studies, it showed that rather than replace or overrule, MEWS was used along with the clinical judgement (Downey, 2017; Dundar et al., 2016; Foley, 2019; Subbe, 2001).

MEWS in combination with clinical judgment

This study and previous and recent research show the complexity of identifying and reasoning physiological changes with the use of the EWS in older multimorbid patients (Barker et al., 2020; Bunkenborg et al., 2019; Downey, 2017; Hodgson et al., 2022; X et al., 2021a). Although slightly increased vital signs and MEWS are associated with adverse events, low MEWS are found in both habitual state and clinical deterioration, which may challenge health care personnel's clinical reasoning and decision-making processes and require alertness and clinical competency beyond MEWS in clinical situations.

Hodgson et al. (2021) explored and discussed additional tools, such as the Barthel ADL score and Rockwool Frailty scale, that could be used with EWS to identify changes related to functional decline in older community care-dwelling patients with complex health

conditions in cases with clinical deterioration. Romero-Brufau et al. (2019) found that RNs' cognitive reasoning strategies, such as pattern recognition and intuition, can predict clinical deterioration, and the researchers suggest combining a simple nurse worry factor score with EWS or incorporating it into the existing EWS. The results of the present study, consistent with health care personnel's experiences with the use of EWS (Hodgson et al., 2022; X et al., 2021a), underline that identification of clinical deterioration in the older patient population is complex, given the nature of the older patient's health conditions (Hodgson et al., 2022; X et al., 2021b). The complexity of older home nursing care patients' health conditions challenges the use of MEWS as the only support in clinical reasoning and decision-making processes and highlights the need to consider additional systematic assessment tools in addition to EWS, which can complement assessments by identifying changes in functional ability and support RN's clinical judgment.

Strengths and limitations

A strength of this study is that we analyzed a high number of MEWS from older home nursing care patients in cases of suspected acute functional decline, but we have limited data on what caused the functional decline and what happened to them further in the care trajectories. Another strength is that all participating municipalities used the same type of medical equipment (blood pressure monitors, ear thermometers, pulse oximeters, etc.), and all health care personnel received the same training in the use of the equipment and MEWS. We collected data regarding patients' medication use and comorbidities that may have impacted their physiology, vital signs, and MEWS, which is also a strength in discussing these results in comparison with prior research. One limitation of the study is that we did not have data to determine how old the registered habitual scores were, which may also complicate the comparison with the acute-phase scores. Further, the low proportion of habitual MEWS measurements registered (37.8%) meant that the interpretation of the results comparing habitual scores with scores in suspected acute deterioration should be interpreted with caution. Lastly, quantitative data alone can only to some degree describe RNs' decision-making processes or older home nursing care patient's state of health. Qualitative studies and/or mixed methods studies are suitable for expanding knowledge of how MEWS impact health care personnel's clinical reasoning and decision-making processes.

Conclusion

Generally, low MEWS and slightly deviated respiratory and heart rates characterize patients in a habitual state and in cases of suspected acute functional decline. Although changes from the habitual state to suspected acute functional decline were generally accompanied by increased MEWS, the majority of the scores in this sample did not trigger referrals to the medical services. The RNs adhered to the MEWS trigger recommendations to a large extent, but they also frequently referred patients to medical services, despite lower MEWS.

This study shows that the MEWS is used as support by RNs in home nursing care but cannot be used alone as a decision support tool in cases of suspected acute illness due to older patients' complex state of health. A combination of assessments of changes in older home nursing care patients' functional abilities and RNs' clinical judgement may provide additional support together with MEWS in clinical practice.

Conflict of interest

No conflict of interest has been declared by the authors.

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II

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Factors Associated With Care Trajectory Following Acute Functional Decline in Older Home Nursing Care Patients: A Prospective Observational Study

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Kristin Jeppestøl, MSc[1,2], Valeria Vitelli, PhD[2], Marit Kirkevold, EdD[2,3], and Line K. Bragstad, PhD[2,3]

Abstract

Health policies and previous research highlight the importance of early identification and treatment of clinical deterioration in older patients to prevent frailty, higher levels of care, and mortality. This study explores older home nursing care patients' care trajectories and factors associated with clinical response (type and level of intervention) from the health care services, final level of community care and death within 3 months after an incidence of acute functional decline. This observational study with a prospective, descriptive design includes a sample of 135 older home nursing care patients with acute functional decline. Demographic, health-related, and clinical characteristics were analyzed and prediction models for care trajectories were fitted using Bayesian generalized mixed models. Age ranged from 65 to 100, with a median age of 85. Hospital admission were registered for 13.33% (T_1) and 8.77% (T_2) of the participants. Nine patients (6.7%) were transferred to a higher level of community care, and 11 patients (8.1%) died. Frequent transitions between levels of care characterized care trajectories for patients experiencing more severe functional decline. Age, living in a private home, and increased Modified Early Warning Scores (MEWS) were associated with level of clinical responses throughout the care trajectory. Living in a private home was associated with the patients' final level of community care. Female gender, hospital admission, and increased MEWS scores were associated with death. Health care personnel must be vigilant when MEWS scores rise even slightly, as this might be an indication of acute functional decline with possible increased risk of mortality.

Keywords

older, home nursing care, acute functional decline, care trajectory, Early Warning Score, clinical response, level of community care, death

Background

Health reforms have been implemented worldwide to strengthen primary health care by facilitating early identification of clinical deterioration and adequate treatment and care at the lowest possible level of care.[1,2] In Norway, the context of this study, the majority of care is provided by municipalities. The levels of community care include care delivery in private homes and community care homes until long-term institutional care is required.[1] Furthermore, several alternative clinical responses and care trajectories across levels of care exist. A typical patient trajectory for acutely ill home nursing care patients starts in the private home and ends with hospitalization as the highest level of care. Medical treatment can typically be administered in private homes, skilled short-term nursing homes, or municipal acute care units (MAU) prior to transitions to higher levels of care.[2]

Older patients receiving home nursing care are typically comorbid and frail, with complex diseases, and in need of comprehensive health care.[3-6] Several factors are known to be associated with advancements through care trajectories in community and specialist care settings. A mix of social and health problems in elderly persons are associated with hospital admissions.[7] Gender differences as a risk factor of hospitalization have been inconclusive in previous research,[8,9] but one study found that female gender is associated with

[1]Tvedestrand Municipality, Tvedestrand, Norway
[2]University of Oslo, Faculty of Medicine, Oslo, Norway
[3]Oslo Metropolitan University, Faculty of Health Sciences, Oslo, Norway

Corresponding Author:
Kristin Jeppestøl, Tvedestrand Municipality, P.O. Box 38, 4901 Tvedestrand, Norway.
Email: kristin.jeppestol@medisin.uio.no

comorbidity, and consequently, females had an increased risk of hospitalization.[10] Frailty[6] and higher age[9] are identified as risk factors for hospitalizations. Likewise, age, frailty, comorbidity, and cancer are factors associated with increased risk of death.[6]

Hospitalization and acute diseases in older patients are often associated with functional decline, increased disability, loss of ability to live at home, and mortality.[11] A study exploring consequences of transferring aged-care facility residents to hospitals, showed that it was not clear whether the benefits of in-hospital emergency care outweigh potential adverse complications such as pressure ulcers and delirium, invasive interventions, and mortality after transfer.[12] Conversely, several studies have found that hospital acute geriatric units reduce functional decline at discharge and increase the probability of continued community dwelling.[13-15]

When frail older individuals become acutely ill, the symptoms are often vague, with an atypical presentation of physical, psychological, social, and functional manifestations.[16-21] The symptoms may reflect reduced functional and psychological reserves and are often caused by somatic diseases common among older people, such as infections, pain, and unspecified dyspnea.[9,22] After an incident of acute functional decline, patients may regain function, remain stable, or suffer further functional decline necessitating a higher level of care. It is crucial to identify acute functional decline early to initiate proper medical treatment and prevent, frailty, the need for higher levels of care, and mortality.[13]

To assist in identifying clinical deterioration, Early warning scores (EWS) are implemented worldwide across specialist and primary health care services and have been thoroughly evaluated as tools predicting and improving patient outcomes. Research indicates that EWS may have a positive effect on predicting patient outcomes such as intensive care unit (ICU) admissions, cardiac arrests, and in-hospital mortality across various hospital settings and populations.[23-29] Elevated EWS detected in the community during the emergency admission process are associated with adverse outcomes such as ICU admissions and higher mortality.[30] However, it can be challenging for RNs and GPs providing home health care services to interpret the EWS scores, and the EWS do not always provide clear decision support for home nursing care personnel.[31]

Despite the fact that health policies and research highlight the importance of treatment at the lowest level of care, and that many factors linked to advancements through care trajectories in the specialist health care services are identified, no studies have specifically investigated factors associated with clinical responses, care trajectories and mortality in the community. This study addresses this knowledge gap.

More specifically, the study explores demographic, health-related and clinical factors associated with clinical response, final level of community care and death 3 months after an initial incidence of acute functional decline among older home nursing care patients. Three research questions are addressed:

1. What characterizes the care trajectories of older home nursing patients suffering acute functional decline?
2. Which factors are associated with initial and follow-up clinical response after an incidence of acute functional decline?
3. Which factors were associated with the final level of community care and death within a 3-month period after the initial incidence of acute functional decline?

Methods

Design

This is a quantitative observational study with a prospective, descriptive design.

Participants/Sampling

A consecutive sampling procedure was applied in 8 municipalities in southern Norway to recruit participants with identified functional decline from April 2018 to February 2019.

The inclusion criteria were:

- 65+ years.
- Home-dwelling.
- Receiving home nursing care.
- Acute functional decline assessed with the Modified Early Warning Score (MEWS).

The exclusion criteria were:

- Terminal illness.
- Severe cognitive diseases precluding informed consent.

Data Collection

Data were collected from participants' electronic patient records between April 2018 and May 2019.

Data were collected by the first author using a structured, web-based data collection form developed for this study. Table 1 provides an overview of the main demographic, health related, and clinical data collected at the time of study inclusion (T_1, baseline) and 3 months after study inclusion (T_2).

Outcomes

Based on the patients' first incidence of acute functional decline (T_1) and follow-up or new incidents (T_2), 4 outcomes were investigated:

Table 1. Demographic, Health-Related, Clinical, and Care Trajectory Data Collected From Electronic Patient Records in T_1 and T_2.

Type of data	Variables	T_1	T_2
Demographic, health-related, and clinical data	Age	x	x
	Gender	x	
	Municipality	x	x
	Level of community care	x	x
	Number of daily medications	x	x
	Diagnose groups[a]	x	x
	IPLOS score[b]	x	x
	Number of home nursing care visits per week	x	x
	Type of home care assistance[c]	x	x
	Duration of symptoms	x	x
	MEWS score[d]	x	x
	New incidence of acute functional decline		x
Care trajectory data	Assessment by medical service	x	x
	Hospital admission	x	x
	Municipal acute care unit (MAU) admission	x	x
	Nursing home admission	x	x
	Death		x

[a]Classified by the International Statistical Classification of Diseases and Related Health Problems (ICD), ICD-10.
[b]IPLOS score (acronym for "statistics linked to individual needs for care"): The patient's functional ability in daily life activities: Score 1 to 2 = Dependent in all activities of daily living, 3 = medium need for personal assistance, 4 = extensive need for personal assistance, 5 = full need for all personal assistance.
[c]Assistance with instrumental activities of daily living (IADL) and personal activities of daily living (PADL).
[d]Maximum 10 MEWS measurements were collected at T_2. MEWS consists of the following vital parameters: heart rate, temperature, respiratory rate, blood pressure, and level of consciousness. Oxygen saturation is part of the assessment but does not contribute to the score.

1. The initial clinical response: whether the patient was observed and treated at home, in MAU or at hospital (Figure 1a).
2. Follow-up clinical response: whether the patient was observed and treated at home, in skilled short-term nursing home, in MAU or at hospital (Figure 1a).
3. Final level of community care: whether the patient lived in a private home, in a community care home, or in a skilled long-term nursing home (Figure 1b) within 3 months after the initial functional decline.
4. Death: whether the patient died within the 3-month period after 1 or several episodes of acute functional decline.

Data Analysis

Descriptive data analysis. Descriptive data analyses including frequency distributions of categorical variables and mean, median, and standard deviations for continuous variables were conducted. The SPSS software package (version 26.0) was used for the descriptive analyses.[32] Demographic, health-related, and clinical data are presented in Table 2.

Statistical models. Prediction models for the 4 outcomes of interest; initial and follow-up clinical response, final level of community care, and death were fitted using Bayesian generalized mixed models, implemented using the R package MCMCglmm.[33] All statistical analyses used version 3.4.4 of the R software for statistical computing.[34] All models were estimated via Bayesian inference to propagate the uncertainty in the data. We used uninformative priors unless a default conjugate prior was available.[35] We report the odds ratio (OR) associated with significant covariates, with the associated 90% highest posterior density intervals (HPDI).[36] All statistical tests were performed as 2-sided tests with a significance level of $\alpha = .05$.

Initial clinical response at T1. The baseline model of initial clinical response is a Bayesian generalized mixed effects model with a 4-level multinomial outcome (Table 3). The covariates age, gender, level of community care (private home or community care homes linked close to the home nursing care office), functional status measured with IPLOS, number of home care visits per week, number of daily medications, MEWS score, duration of symptoms of functional decline, and type of home care assistance were included in the model. Municipality was included as a random effect while all covariates were included as fixed effects.

Follow-up clinical response, final level of community care, and death at T2. To describe patients' care trajectories over the 3-month study period, 3 Bayesian generalized mixed models were fitted (Table 3). The T_2 models of follow-up clinical response and final level of community care are 5-level and 3-level multinomial outcomes, respectively. Four additional covariates were added to the models at T_2 to account

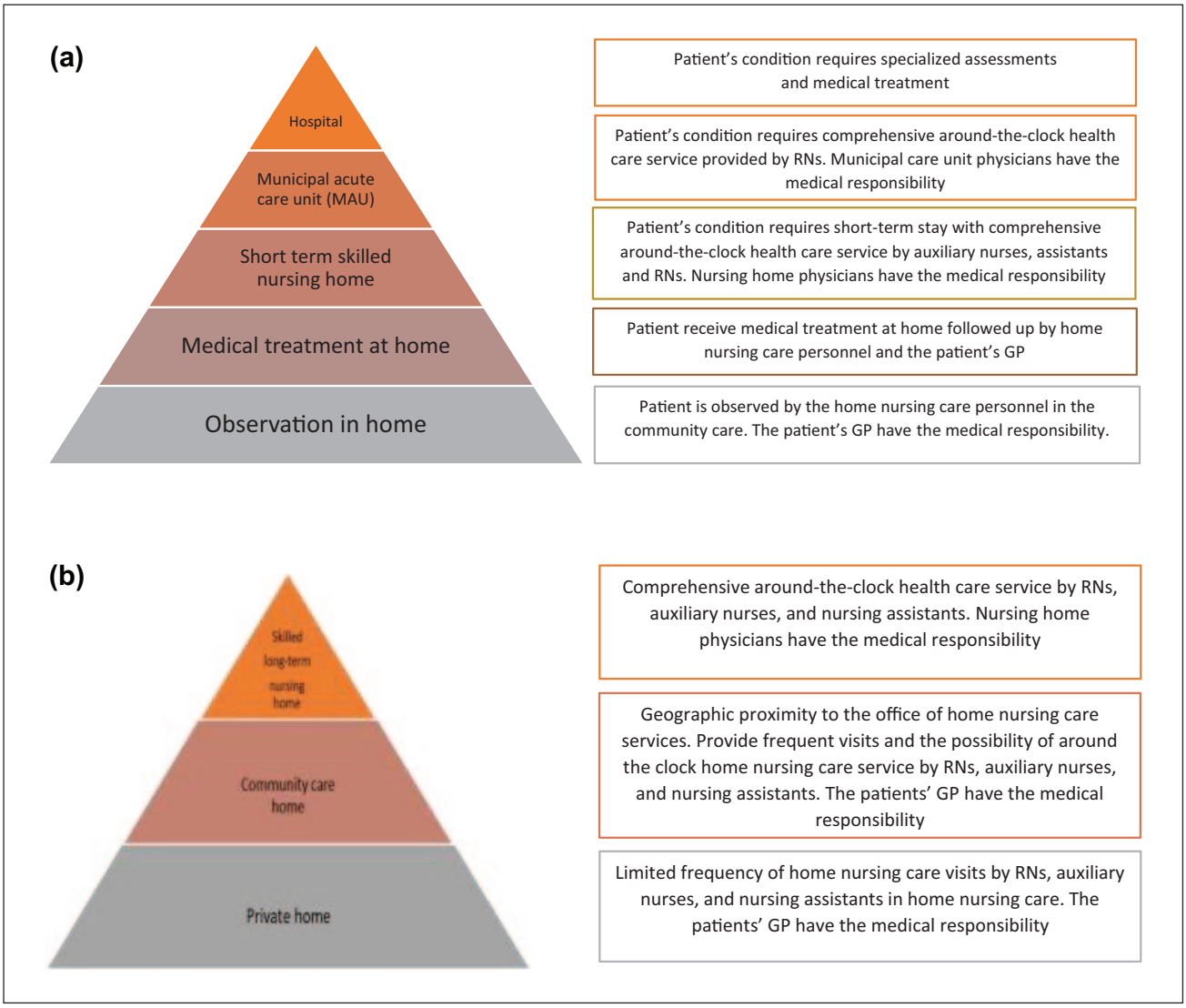

Figure 1. Levels of clinical response with acute functional decline in older home nursing care patients and levels of community care in Norway: (a) Care trajectories with acute functional decline in the Norewgian home nursing care. The model illustrates the levels of clinical response to acute illness from the lowest (private home) to the highest (hospital) level. Characteristics of care needs and care provision within each level of the trajectory is provided in the box on the right-hand side. (b) Community care levels in Norway. The model illustrates the levels of care from the lowest (private home) to the highest (skilled long term nursing home) level of care in Norwegian community care. Characteristics of care provision within each level of care is provided in the box on the right-hand side.

for developments in the care trajectory. The T_2 models thus include the variables MEWS score at T_2, new incidences of acute functional decline, admission to hospital, and assessment by medical service.

The outcome of death was modeled using a binary outcome in a logistic mixed model. Since all outcomes were time-dependent variables in the data, we used as outcome at T_2 the patient-specific measurement closest in time to T_2. Municipality was included as a random effect while all covariates were included as fixed effects in all 3 T_2 models.

Missing data. We fitted models at baseline and T_2 with different covariates for the models at different timings and for several outcomes. The T_1 model had 0.55% missing entries in the covariates, while models at T_2 showed 10.86% missing in the outcome variables, and 1.32% missing among covariates. The missing data were assumed to be missing randomly as no specific structure could be detected. Single imputation of missing data was performed using the *k*-nearest neighbors (*k*-NN) method, implemented using the R package VIM.[37] The distance computation for defining the nearest neighbors was based on an extension of the Gower

Table 2. Demographic, Health Related, and Clinical Characteristics of the Participants.

	T_1			T_2		
Demographic, health related, and clinical data	N = 135 (%)	Median	Range	N = 135 (%)	Median	Range
Age		85	65-100		86	65-101
Gender						
Male	47 (34.8)					
Female	88 (65.2)					
Diagnose groups		3	1-7		3	1-7
Daily medications		8	0-18		8	0-16
IPLOS score		2.11	1.11-3.94		2.31	1.11-4.0
Level of community care						
Private	76 (56.3)			66 (48.88)		
Community care home	59 (43.7)			60 (44.44)		
Skilled long-term nursing home				9 (6.66)		
Dead[a]				11 (8.1)		
Home nursing care	135 (100)			126 (93.3)		
Number of visits per week		2	0-11		2	0-14
Type of home care assistance[b]						
PADL	135 (100)			126 (100)		
IADL	24 (17.8)			24 (17.8)		
Participants with symptoms of acute functional decline	135 (100)			88 (65.2)		
Duration of symptoms before initial MEWS was performed						
Hours	69 (51.1)					
1 day	32 (23.7)					
2-6 days	24 (17.8)					
1 week	3 (2.2)					
2-3 weeks	5 (3.7)					
Complete MEWS measurements	125	1	0-8	319	1	0-7
Score 0-4	122 (97.6)			310 (97.2)		
Score 5-8	3 (2.4)			9 (2.8)		
Acute and endpoint outcomes after MEWS measurements	n = 135 (%)			n = 319 (%)		
Observation in the patient's home	89 (65.92)			250 (78.37)		
Medical treatment in the patient's home	24 (17.77)			33 (10.34)		
Admitted to the Municipal acute care unit	4 (2.96)			7 (2.19)		
Admitted to hospital	18 (13.33)			28 (8.77)		
Admitted to nursing home				1 (0.31)		

[a]1 patient died in private home, 1 patient died in community home, 9 patients died in nursing homes.
[b]Multiple responses were available for the category PADL (Personal activities of daily living) and IADL (Instrumental activities of daily living).

distance.[38] We choose $k = 5$ neighbors to impute after trial-and-error tests.

A sensitivity analysis of the chosen imputation method was performed by comparing the *k*-NN results with the other simple imputation methods available in VIM. No significant change resulted in the output when varying the imputation method and therefore *k*-NN was chosen as the most established and reliable approach.

Ethical Considerations

The Regional Committee for Medical and Health Research Ethics approved the study (approval number: 2018/469). The participants were informed about the aim of the study. They were informed that participation was voluntary and entailed giving consent to gathering information from their electronic patient record and that (non-) participation would not impact medical or nursing care. Nurses and nurses' assistants obtained written informed consent from all participants. Consent forms were stored in locked cabinets; digital data are securely stored in the University of Oslo's Services for Sensitive Data. No participants withdrew during or after the 3-month study period.

Results

Study Sample and Care Trajectory Characteristics

A total of 135 patients recruited from 8 municipalities participated. The sample consisted of 34.8% (47) males and

Table 3. Factors Associated With Outcomes in Older Home Nursing Care Patient's Care Trajectory.

T_1	Outcome	Covariate	OR (90% HPDI)	*p*-Value
	Initial clinical response[a]			
	Observation in home (*r*)	Age	3.84 (2.94, 4.44)	**.011**
	Medical treatment home	Gender	7.01 (5.68, 7.78)	**.015**
	Admitted MAU	Level of community care T_1	8,04 (7.40, 8.60)	**<.0001**
	Admitted hospital	Number of daily medications	3.57 (1.92, 4.51)	.08
		IPLOS (average)	5.12 (3.20, 6.22)	.174
		Number of home nursing care visits per week	3.84 (1.80, 5.05)	.248
		Type of home care assistance	8.54 (7.39, 9.23)	**.005**
		Duration of symptoms	5.44 (4.59, 6.11)	**.004**
		MEWS score T_1	5.23 (4.49, 5.79)	**.002**
T_2	Follow-up clinical response[b]			
	Observation in home (*r*)	Age	9.22 (8.42, 9.81)	**.001**
	Medical treatment home	Gender	10.66 (8.48, 12.00)	.928
	Admitted MAU	Level of community care T_1	10.95 (8.87, 12.20)	.447
	Admitted hospital	Number of daily medications	11.88 (11.12, 12,45)	.232
	Admitted long- term nursing home	IPLOS (average)	10.69 (8.58, 12.01)	.640
		Number of home nursing care visits per week	9.86 (7.64, 11.26)	.433
		Type of home care assistance	11.01 (8.93, 12.24)	.416
		Duration of symptoms	10.23 (8.10, 11.53)	.342
		MEWS score T_1	11.13 (9.61, 12.04)	.054
		MEWS score T_2	11.88 (11.12, 12.45)	**.001**
		New incidence of acute functional decline	10.66 (8.51, 11.99)	.984
		Assessed by medical service	11.64 (9.90, 12.56)	.127
		Admitted to hospital	11.08 (9.04, 12.26)	.329
	Final level of community care			
	Private home	Age	7.39 (5.30, 8.65)	.298
	Community care home (*r*)	Gender	10.41 (8.23, 11.71)	.619
	Skilled short term nursing home	Level of community care T_1	12.57 (12.19, 12.91)	**<.0001**
		Number of daily medications	8.59 (6.44, 9.96)	.407
		IPLOS (average)	11.21 (9.70, 12.10)	.059
		Number of home nursing care visits per week	9.59 (7.55, 10.86)	.203
		Type of home care assistance	11.34 (9.73, 12.23)	.092
		Duration of symptoms	9.14 (6.96, 10.56)	.617
		MEWS score T_1	9.63 (7.49, 11.04)	.467
		MEWS score T_2	10.25 (8.27, 11.47)	.201
		New incidents of acute functional decline	10.28 (8.19, 11.65)	.875
		Assessed by medical service	10.54 (8.41, 11.86)	.668
		Admitted to hospital	10.65 (8.56, 11.86)	.350
	Death			
	Alive (*r*) Dead	Age	5.98 (3.10, 7.33)	.269
		Gender	9.66 (8.47, 10.65)	**.014**
		Level of community care T_1	8.62 (6.40, 10.15)	.562
		Number of daily medications	6.45 (4.28, 7.90)	.739
		IPLOS (average)	8.39 (6.20, 9.89)	.657
		Number of home nursing care visits per week	7.09 (4.89, 8.60)	.713
		Type of home care assistance	9.05 (6.95, 10.43)	.351
		Duration of symptoms	7.38 (5.35, 8.68)	.234
		MEWS score T_1	8.78 (7.26, 9.94)	**.036**
		MEWS score T_2	7.87 (5.84, 9.21)	.231
		New incidence of acute functional decline	9.16 (6.96, 10.73)	.348
		Assessed by medical service	9.38 (7.29, 10.76)	.358
		Admitted to hospital	9.94 (8.54, 10.92)	**.035**

Note. **Significant covariates are highlighted with bold.**
(*r*) = reference category.
[a]Initial clinical response = response to first incidence with acute functional decline.
[b]Follow-up clinical response = response as follow-up or to new incidences with acute functional decline.

65.2% (88) females and ranged in age from 65 to 100 years with a mean age of 83.5 years. Patients lived in private homes (56.3 %) or in community care homes which were located close to the home care office (43.7 %). They received a range of 0 to 11 visits from home care professionals per day. During the 3 month-period, new incidents of acute functional decline were identified for 65.2% of the sample. The patients were further observed or medically treated at home in 83.69% (T_1)

and 88.71% (T_2) of the incidences. About 2.96% (T_1) and 2.19 % (T_2) were admitted to MAU. Hospital admissions were reported for 13.33% (T_1) and 8.77% (T_2) and 0.31% were admitted to short term skilled nursing home in T_2. A total of 9 patients (6.7%) were permanently transferred to a higher level of community care, and 11 patients (8.1%) died within the 3-month period (Table 2).

Factors associated with initial clinical response at T1. The baseline model assessing factors influencing the initial clinical response in T_1 showed 6 statistically significant factors (Table 3). Controlled for the other factors in the model, the initial clinical response in this study was predicted by age, gender, current level of community care, type of home care assistance, duration of symptoms, and MEWS score. The odds of needing medical treatment at home or at a higher level of care was 3.84 times higher with each year of increasing age and 7.01 times higher for females than for males. Furthermore, the model showed that the odds were 8.04 times higher for the participants who lived in private homes than for the participants who lived in community care homes. Similarly, the odds were 8.54 times higher for participants receiving assistance with personal ADL activities compared to those who received help with instrumental ADL activities. Lastly, the odds were 5.44 times higher for each day of symptom duration before medical treatment was initiated, and participants with a 1 point increase in MEWS score at T_1 had an odds 5.23 times higher for needing medical treatment at home or at a higher level of care than those with 1 point lower MEWS scores at T_1.

This indicates that patients with 1 or more of these traits or characteristics are at risk of needing a higher level of clinical response such as MAU or hospital admission after the initial episode of acute functional decline.

Factors associated with follow-up clinical response at T2. The Bayesian generalized linear mixed model with multinomial outcomes assessing the follow-up clinical response at T_2, showed 2 statistically significant factors and 1 borderline factor (Table 3). Age and MEWS score at T_2 were significantly associated with the follow-up clinical response, while MEWS score at T_1 was close to significant.

The odds of needing medical treatment at home or at a higher level of care within this 3-month period following the initial functional decline was 9.22 times higher with each increasing year of age. Furthermore, participants with a 1 point higher MEWS score at T_2 had an odds 11.88 times higher than those with 1 point lower MEWS scores at T_2 of needing medical treatment at home or at a higher level of care within this 3-month period, controlling for all the other factors in the model. Lastly, the results show that participants with a 1 point higher MEWS score at T_1 had an odds 11.13 times higher than those with 1 point lower MEWS scores at T_1 of needing medical treatment at home or at a higher level of care within this 3-month period. MEWS at T_1 was close to significant, and must be interpreted with caution. This indicates that higher age and increased MEWS scores signal the need for treatment in higher levels of care after 1 or more episodes of acute functional decline.

Factors associated with patients' final level of community care. The Bayesian generalized linear mixed model assessing factors influencing the final level of community care at T_2 showed 1 statistically significant factor and 1 factor bordering significant in influencing participants' type of residence, which is a proxy for community level of care at T_2 (Table 3). Level of community care at T_1 was significantly associated with the final level of care while the patients functional status measured with IPLOS was borderline significant.

The odds of a higher level of community care was 12.57 times higher for those participants who lived in private homes than those who lived in community care homes at the time of the initial episode of functional decline. Furthermore, functional status measured with IPLOS was borderline significant. This indicates that home nursing care patients living in private homes and those with limited functional abilities are at greater risk of needing a higher level of care after an episode of acute functional decline.

Factors associated with death within 3-months. The Bayesian generalized linear mixed model assessing factors predicting death within 3 months, showed 3 statistically significant factors. (Table 3). Gender, MEWS score at T_1, and hospital admission were statistically significant predictors of death within 3 months.

The odds of dying was 9.66 times higher for females than for males. Controlling for the other factors in the model, the results show that participants with a 1 point higher MEWS score at T_1 has an odds 8.78 times higher than those with 1 point lower MEWS scores at T_1 for dying within this 3-month period. Lastly, participants who were admitted to hospital within this 3-month follow up period had 9.94 times higher odds of dying than those participants who were not admitted to hospital, controlling for all the other factors in the model. This indicates an increased risk of death within 3 months for females, home nursing care patients who were admitted to hospital, and those with increased MEWS scores.

Discussion

Care Trajectories

This study explored care trajectories of home nursing care patients who experienced 1 or several episodes of acute functional decline within a 3-month period. The majority of the clinical trajectories were characterized by medical treatment and observations within the community health care service. The patients were mainly observed and treated in the patients' home. A total of 9 patients (6.7%) required a higher level of

community care and 11 (8.1%) died within the study period, but the majority of the patients remained in their private homes or community care homes at the end of the study.

The characteristics of the clinical trajectories indicate that the municipalities strive to adhere to political regulations by providing care for this patient group.[1,2] New incidents of functional decline occurred for 65.2% of the patients within 3 months, which reinforce the impression of home nursing care patients' health conditions as unstable. These findings strengthen the perception of this patient group as particularly vulnerable and at high risk of acute illness and consequently functional decline, which are in line with similar studies.[3-6,39,40] Despite contemporary health reforms and health policies, the discussion of whether to diagnose and medically treat older patients in hospitals or primary care is contested, and research shows both advantages and disadvantages of hospitalizing older patients.[12-15] However, there's is reason to question if this particularly vulnerable older patient group, with several acute incidences in need of subsequent medical treatment and transitions to different levels of care in a short period of time, could have postponed transfer to higher level of community care or death with a specialized comprehensive geriatric approach in hospital.[13-15]

Factors associated with care trajectories. Several factors were shown to be associated with the patients' care trajectories within the 3-month period after the first incidence of acute functional decline. The factors age, gender, level of community care, and MEWS are discussed in this section.

Age was associated with the level of clinical response in this study. Age has previously been shown to be associated with comorbidity, frailty, and hospital admissions,[6] which may reflect the patients' reduced functional and psychological reserves.[22] Advanced age may thus reflect a need for higher level of clinical response such as hospital admissions when acute clinical deterioration is detected.[9]

Although gender as a predictive factor for hospitalization and death was inconclusive in other studies,[8,9] female gender was associated with the need of higher levels of care at T_1 and with death at T_2 in this study. The increased need for higher level of care at the initial acute illness and death within 3 months, could be related to comorbidity which has a known association with female gender[10] and frailty which is related to comorbidity and death.[6]

Level of community care was strongly associated with the initial clinical response and final level of care; patients living in private homes at T_1, were more likely to be admitted to MAU, hospital, or short-time skilled nursing homes than patients living in community care homes. This may be explained by several social and contextual factors in the services,[7] such as unwillingness to risk further deterioration at home without proper monitoring, geographical distance to the home nursing care office and limited staffing resources and inability to increase visit frequency.[31] Conversely, living in community care homes where the frequency and duration of home nursing care visits and around-the-clock monitoring could be rapidly implemented, constitutes a lower risk of undetected deterioration. The factor predicting the final level of community care, highlights that the patient group receiving care at the lowest level of community care are extremely vulnerable and disposed to the need for more specialized clinical care and long term higher level of community care after an episode of acute functional decline.

Studies show that EWS can predict patient outcomes such as hospitalizations, ICU admissions, cardiac arrests, and in-hospital mortality across a range of hospital settings, conditions and populations.[11,23-30] Although EWS scores have only recently been implemented in community care settings, this study showed that increased MEWS can predict the need for a higher level of care and death for older home nursing care patients experiencing acute functional decline. These results demonstrate the capability of MEWS as a tool also in the home nursing care setting. However, the median MEWS score in this study was 1, which according to MEWS' trigger recommendations does not indicate an acute response such as contacting the medical service. From a clinical perspective, a slightly elevated MEWS, combined with diffuse and uncharacteristic symptoms are common in older persons. It can thus be challenging to interpret the scores, and the tool will not always provide clear decision support for health care personnel.[31] However, this study emphasizes the need for the health care personnel to be vigilant when the MEWS scores rise even slightly, as this might be an indication of acute functional decline with possible increased risk of mortality. Additionally, the study showed that hospital admission was also a predictor for death. Severe acute conditions identified by MEWS combined with hospital admission predicts mortal outcomes, however, this may not be due to the hospitalization itself, but may also be a general initial indication of approaching the "end of life."[11]

Collectively, these study results illustrate the seriousness of acute functional decline in older home nursing care patients and the complexity of factors associated with the need for medical treatment at a higher level of care. The study clearly identifies characteristics of the patients to be particularly aware of, in assessing needs for increased levels of care, and to prevent untimely death. Identifying these factors may help the services target the particularly vulnerable patient groups with precautionary measures to prevent functional decline and care transitions.

This study has strengths and limitations. This prospective, longitudinal study included participants from several municipalities and used a systematic consecutive sampling strategy ensuring recruitment of a representative sample. Strong statistical models with reliable procedures for imputation of data have been used. However, the study presents data from a limited time window of the participants' care trajectories, and there is limited knowledge of possible adverse events prior to the initial incidence. There may have been previous acute incidences, hospitalizations, or transitions within

different levels of care prior to collecting the baseline data which could have affected the outcomes investigated in the study. The exact timing of the MEWS measurements were not registered in the patient records, this complicated the interpretation of the outcomes in terms of sequence of events. IPLOS registrations were not always updated in the patient records, thus, the scores may not represent the patients' most current level of function at T_1 or T_2.

Conclusions

This study has demonstrated that the care trajectories of older home nursing care patients are characterized by observation and medical treatment in the patients' home, and frequent transitions between levels of care for those experiencing more severe functional decline. Although this population is an older population segment, age is still an important predictor of the level of clinical response at the onset of acute functional decline. Female gender and living in private homes are characteristics of patients that appear to be at a particular risk of higher levels of care and death. Importantly, this study shows clear indications that MEWS scores predict clinical responses and even death throughout the care trajectory for this patient group. That health care personnel working with this population must be vigilant when the MEWS scores rise even slightly as this might be an indication of acute functional decline with possible increased risk of mortality.

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ORCID iDs

Kristin Jeppestøl https://orcid.org/0000-0002-1932-8685
Line K. Bragstad https://orcid.org/0000-0002-9645-3770

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III

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ORIGINAL ARTICLE

Assessing acute functional decline in older patients in home nursing care settings using the Modified Early Warning Score: A qualitative study of nurses' and general practitioners' experiences

Kristin Jeppestøl RN, MSc, Public PhD Fellow/Advanced Geriatric Nurse[1,2] | Marit Kirkevold RN, EdD, Professor[1,3] | Line K. Bragstad OT, PhD, Associate Professor[1,4]

[1]Department of Nursing Science, Faculty of Medicine, University of Oslo, Oslo, Norway

[2]Tvedestrand Municipality, Tvedestrand, Norway

[3]Department of Nursing and Health Promotion, Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway

[4]Department of Occupational Therapy, Prosthetics and Orthotics, Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway

Correspondence
Kristin Jeppestøl, Department of Nursing Science, Faculty of Medicine, University of Oslo, P.O. Box 1089 Blindern, 0317 Oslo, Norway.
Email: kristin.jeppestol@medisin.uio.no

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Abstract

Aims and objectives: The study describes experiences of registered nurses and general practitioners when using the Modified Early Warning Score (MEWS) to assess acute functional decline in older home nursing care patients.

Background: Acute functional decline is common among older home nursing care patients; typically characterised by nonspecific symptoms and a mix of manifestations. Early warning score systems for detecting clinical deterioration have been thoroughly evaluated in hospital settings, but few studies have evaluated these systems used with older people in a community care setting.

Methods: A descriptive exploratory research design and a qualitative approach. 36 nurses and eight general practitioners were purposively sampled. Data were collected in seven mixed focus groups and analysed using an inductive thematic content analysis in an iterative process that moved between text, codes, categories and themes. The COREQ checklist was used.

Results: Two main themes were developed in the analysis. The first theme derived, was that the MEWS along with medical-technical equipment and clinical judgement, was used to support nurses' and general practitioners' clinical decisions in assessing older deteriorating patients. The second theme referred to nurses' and general practitioners' experiences with several adjustments when using the MEWS with the older patient group and in complying with its trigger recommendations.

Conclusion: The use of the MEWS when assessing older patients in home nursing care is potentially useful in supporting clinical reasoning. However, the tool's usefulness is limited because it is not experienced as sufficiently adapted to neither the home nursing care services nor to older patients.

Implications for practice: This study increases our knowledge of how the MEWS tool is used in a community care setting and highlights the importance of adjustment of assessment procedures for older persons with acute functional decline.

KEYWORDS
assessment, clinical, content analysis, decision-making, evidence-based practice, home care, older people

1 | INTRODUCTION

Standardised hospital procedures, such as early warning score (EWS) systems have been widely implemented in community-based settings in order to structure the communication across levels of care and between health professionals and to promote early detection of clinical deterioration.

The key to successfully implementing standardised procedure like an EWS is to strike a balance between flexibility and rigidity and to deploy the procedure in a physical and cultural infrastructure that allows it to function (Timmermans & Almeling, 2009). Additionally, standardised procedures leave some residual work that requires active involvement by the practitioners to use their clinical judgement and ensure compliance with the instructions (Timmermans & Epstein, 2010).

The present study focuses on how an EWS tool designed to function in acute hospital settings is perceived and experienced to influence clinical reasoning and decisions by registered nurses (RNs) and general practitioners (GPs) working with older home nursing care patients with acute functional decline.

Summary statement of implications for practice

What does this research add to existing knowledge in gerontology?

- This research contributes to the literature by providing new insight and knowledge of how Modified Early Warning Score (MEWS) is used by registered nurses (RNs) and general practitioners (GPs) to assess acute functional decline in older patients in a home nursing care setting.
- The MEWS has become an important tool in facilitating RNs' and GP' clinical reasoning and decision-making when acute functional decline is detected.
- The usefulness of the tool is experienced as limited by RNs and GPs, because it is neither experienced as sufficiently adapted to the home nursing care setting nor to the older patient population suffering from acute functional decline.

What are the implications of this new knowledge for nursing care with older people?

- Modified Early Warning Score along with the medical-technical equipment and clinical judgement, is potentially useful to support RNs' and GPs' clinical decisions in assessing older home nursing care patients with acute functional decline.

How could the findings be used to influence policy or practice or research or education?

- This study shows that further research is needed to explore the characteristics of the vital signs of older home nursing care patients experiencing acute functional decline.
- This study highlights the need to adapt MEWS' normal ranges of vital signs to the older patient population with acute functional decline and the need to adapt trigger recommendations to the home nursing care.

2 | BACKGROUND

The older population receiving home nursing care is a frail group of individuals with complex diseases who need comprehensive health care (Bing-Jonsson et al., 2015; Næss et al., 2017; Vegda et al., 2009). When frail older persons become acutely ill, the symptoms are often nonspecific and atypical and present with a combination of physical, psychological, social and functional manifestations (Anpalahan & Gibson, 2008; Bell et al., 2016; Cigolle et al., 2007; Hébert, 1997; Hsin-Ju Tang et al., 2016. When this condition develops within a few days or weeks, it is referred to as 'acute functional decline'. The condition refers to both physical symptoms such as fatigue, weakness, loss of activities of daily living (ADL) capacity, loss of appetite, falls and incontinence and psychological symptoms such as loss of attention, initiative and motivation and general cognitive impairment. Acute functional decline is often caused by somatic diseases common among the older population (Bell et al., 2016; Hébert, 1997), such as infections and cardiovascular, cerebrovascular, pulmonary, neurological, musculoskeletal, metabolic and endocrine diseases. Based on the knowledge that physiological parameters change rapidly when a patient's health condition deteriorates, EWS tools, such as MEWS, can provide health care personnel additional clinical support in detecting acute functional decline (Subbe et al., 2001).

Early warning score systems, or physiological 'track-and-trigger' systems, were designed to support health care professionals in identifying and responding to acutely unwell patients at risk of clinical deterioration (Brangan et al., 2018). The effects of EWS systems have been thoroughly evaluated in hospital settings. Various scoring systems used in hospital settings perform well for predicting cardiac arrest and death within 48 h (Downey et al., 2017; Smith et al.,

2014; Subbe et al., 2001). However, studies show that EWS systems cannot replace clinical judgement, and combining EWS systems with clinical judgement is important for making appropriate clinical decisions in pre-hospital and hospital settings (Brangan et al., 2018; Foley & Dowling, 2019; Fox & Elliot, 2015; Fullerton et al., 2012; Jensen et al., 2017; Williams et al., 2016). Several studies have noted the challenges of using EWS in a variety of clinical settings and patient groups and pointed out the need to adjust EWS approaches to ensure their proper use (Brangan et al., 2018; Downey et al., 2017; Foley & Dowling, 2019; Fox & Elliot, 2015). One study showed that EWS and rapid response systems (RRS) improved RNs' decisions about whether to summon help and their collaboration and communication during the referral process. Conversely, RNs found it challenging to contact the physician when their clinical intuition caused them to be concerned about a patient even though the patient's EWS score was low (Jensen et al., 2017).

Few studies have investigated the use of EWS in community care settings. One study found that an EWS in pre-hospital settings could identify patients at risk of deterioration and the need for hospitalisation, while patients at low risk of deterioration could be safely managed at home (Patel et al., 2018). Another study explored RNs' and GPs' experiences with the UK's track-and-trigger National Early Warning Score (NEWS) system in pre-hospital, primary and community health care setting. Participants reported that NEWS could support clinical decision-making around the escalation of care and could provide a clear means of communication between clinicians and across different health care organisations. However, the study suggested that modifications were needed to make the tool relevant for specific patient groups in community services, such as older patients (Brangan et al., 2018).

In the Hospital of Southern Norway, an EWS system for early identification of life-threatening conditions with the Norwegian acronym TILT was developed in 2014 (Pedersen, 2014). TILT consists of a five-item Modified Early Warning Score (MEWS), an observational curve for vital parameter registration and an e-learning system for training health care personnel.

In 2016, eight municipalities in southern Norway decided to implement MEWS, the same tool used at the regional hospitals, to ensure consensus and common terminology across settings. Necessary medical equipment such as blood pressure monitors, ear thermometers and pulse oximeters to conduct measurements related to MEWS was purchased by all municipalities. MEWS in combination with the medical equipment, represented a new opportunity for RNs to assess vital signs in home nursing care.

Modified Early Warning Score consists of five items of vital parameters: heart rate, temperature, respiratory rate, blood pressure and level of consciousness (Morgan et al., 1997; Pedersen, 2014) (Figure 1). The score is calculated based on vital sign measurements. These parameters provide information about a person's overall physical condition; parameters that deviate from the normal range represent scores in points and colour codes and generate support concerning when the measurements are to be repeated and when to contact a physician: a MEWS score of 0 (blue) triggers new measurements every 24 h, a score of 1 (yellow) within 8–12 h, a score of 2 (orange) every 4–8 h and a score of 3–4 (red) every 1–4 h. A score of four or higher requires health care personnel to contact a physician. In TILT, the MEWS version used at the Hospital of Southern Norway and by the municipalities in this study, oxygen saturation is also part of the assessment but does not contribute to the score. A sudden drop in saturation (<90%) requires the health staff to contact a physician and indicates general concern for the person's condition (Pedersen, 2014).

Despite the lack of research into the effect of these systems on older persons in general and in community health care in particular, international and Norwegian health authorities, have strongly recommended that EWS be implemented at all levels of health care services (Brangan et al., 2018; The Norwegian Directorate of Health, 2020). Knowledge is therefore needed on whether these scoring systems are used as intended and how they are perceived to influence the clinical reasoning and decision-making of RNs and GPs in community care.

Score	3	2	1	0	1	2	3
Respiratory rate		<9		9-14	15-20	21-29	>30
Heart rate		<40	41-50	51-100	101-110	111-129	>130
Systolic blood pressure	<70	71-80	81-100	101-199		>200	
Temperature		<35		35-38,4		>38,5	
Level of consciousness				Alert	Voice	Pain	Unresponsive
Contact physician when MEWS score >4, if oxygen saturation drops to <90 % with oxygen treatment and if you are concerned of the patients' condition.							

Color-code	MEWS score	Follow up/new measurements
Blue	0	24 hours
Yellow	1	8-12 hours
Orange	2	4-8 hours
Red	3-4	1-4 hours
	>4	Contact physician

FIGURE 1 Modified Early Warning Score (MEWS)

2.1 | Aim

The aim of this study was to describe RNs' and GPs' experiences with the MEWS tool to support clinical reasoning and decision-making when working with older home nursing care patients who suffer from acute functional decline.

3 | METHODS

3.1 | Design

This is a qualitative interview study with a descriptive exploratory research design.

3.2 | Setting

In Norway, municipalities are responsible for the primary health care of older persons living at home. Older persons in need of assistance with personal and instrumental ADL receive individualised help based on their needs that is provided by home nursing care services. The service hours are set for a certain number of visits and times for daily or around-the-clock care; service is based on individual assessment and is adjusted as needed (Dale et al., 2008). The overall responsibility for medical treatment is assigned to the patient's GP, who cooperates with RNs mainly through telephone calls or electronic messages (Lyngstad et al., 2014). An intermunicipal after-hours emergency service can be contacted when the GP's office is closed if there is a need for acute medical supervision.

This study explicitly evaluates the MEWS tool, which is used by RNs in home nursing care, while GPs indirectly relate to MEWS by receiving vital parameters and information systematised and communicated when RNs consider that a patient needs medical assessment. GPs and RNs with experience using MEWS in clinical settings with older home nursing care patients were invited to participate. The participants were recruited from one large (more than 20,000 inhabitants), three medium (5000–20,000 inhabitants) and three small (fewer than 5000 inhabitants) municipalities in southern Norway. The COREQ checklist was used.

3.3 | Sampling and recruitment

A purposive sampling procedure was applied in this study to recruit individuals with experience using MEWS in clinical settings with older home nursing care patients (Green & Thorogood, 2014). The administrative leaders and district medical officers of the municipalities approved the study and gave access to invite RNs and GPs to participate in focus groups. A letter outlining study information and an extended invitation to participate was posted at the workplaces of RNs and GPs. RNs and GPs who met the inclusion criteria were invited to contact the researchers to be enrolled in the study. All RNs and GPs who consented to participate signed an informed, voluntary consent at the time of the focus group. No participants withdrew their consent during or after the focus groups.

3.4 | Data collection

Seven semi-structured mixed focus groups were conducted in the participants' workplaces to explore issues and challenges regarding using MEWS in clinical practice from the participants' perspectives (Green & Thorogood, 2014). Data collection started in September 2018 and was completed in November 2018. A dynamic interview guide was developed by the researchers in this study. Overall questions related to the advantages and challenges of using MEWS in clinical practice was employed during all focus groups (Figure 2). The researchers presented their academic background to the participants before the focus groups started. The focus groups lasted an average of 68 min (range 53–78 min).

All focus groups were audiotaped to ensure accuracy for transcription and analysis. Field notes were made during all focus groups. All authors participated in the data collection. MK (EdD) and LKB (PhD) are experienced researchers with experience in focus group interviewing, while KJ is a PhD candidate who was less experienced in focus group interviews at the outset of the study. MK moderated the two first interviews, with KJ attending as co-moderator. KJ moderated the remaining five interviews, with LKB attending as co-moderator.

3.5 | Data analysis

All interviews were transcribed verbatim using transcription software (f4transkript) (Autotranskription, 2018). The purpose of the present study is to describe the experiences of RNs and GPs in using MEWS with older home nursing care patients. The data were analysed using a basic thematic content analysis in an iterative process that moved between text, codes, categories and themes. The analysis was inspired by Green and Thorogood (2014). All transcripts were read by KJ, MK and LKB to obtain an overview of the interviews. KJ and LKB coded the first interview together to identify codes and ensure consensus. Subsequently, all transcripts were imported into the qualitative analysis software NVivo12 (QRS International, 2018). Furthermore, the second interview was coded by KJ and LKB separately. New and similar codes were discussed; the degree of agreement was assessed using NVivo12, resulting in 95%–98% agreement. KJ coded the remaining five interviews. The first coding process resulted in a total of 114 codes that were identified as suitable for sorting the material to obtain an overview of the interview content. All interviews were read again, and codes were grouped into 24 categories based on similarity of content. Several codes were included in these main categories, and examples of how we arrived at the main themes are presented in Table 1.

FIGURE 2 Interview guide

The purpose of this interview is to explore RNs and GPs experiences and perceptions regarding the use of MEWS with acute functional decline in older home nursing care patients, and whether the use of MEWS has had an impact in clinical practice:

- Would anyone please start with sharing immediate experiences with the use of MEWS in your clinical practice?
- Could anyone please share if the use of MEWS have changed clinical practice in any way? In case how? Feel free to give examples
- What would you say are the main advantages of using MEWS?
- What would you say are the main challenges of using MEWS?

The categories were discussed by KJ and LKB before subsequent analysis was commenced. In the ensuing analysis, two main themes emerged from nine categories and were found to be relevant for the purpose of this study.

3.6 | Ethical considerations

This study was approved by The Norwegian Regional Committees for Medical and Health Research Ethics (2018/469). All participants signed a consent form, assuring voluntary participation and confidentiality. All data are securely stored in the University of Oslo's Services for Sensitive Data.

4 | RESULTS

Altogether, 44 health care personnel were included in this study: 36 RNs and eight physicians. The mean ages of the RNs and GPs were 43.92 and 43.25, respectively. The mean work experience for RNs was 15.81 years and ranged from 0 to 40 years, while the mean work experience for GPs was 15.13 years and ranged from 6 to 20 years. All RNs worked in direct patient care, and all participating physicians worked as GPs, and four had additional functions in the municipal health service, such as supervisory doctors in nursing homes and municipal superiors. Participant characteristics are presented in Table 2.

The RNs and GPs had different perspectives on their experiences with MEWS. Whereas the GPs discussed the use and usefulness of MEWS through their experiences from collaborating with the RNs, the RNs alternated between sharing perceptions of how MEWS was intended to be used and experiences of how MEWS actually worked in the home nursing care setting. In the following sections, two main themes are presented: *MEWS as a support in clinical decision-making* and *adjusting the use of MEWS to older patients in community-based settings*.

4.1 | MEWS as a support in clinical decision-making

The interviews showed that MEWS had become an important tool in facilitating the RNs' clinical reasoning and decision-making when acute functional decline was detected in home nursing care patients.

4.1.1 | MEWS as a part of the clinical judgement

It was not merely the MEWS tool that made the difference. The majority of the RNs emphasised that the new medical-technical equipment—including digital blood pressure monitor, pulse oximeter and ear thermometer—accompanying the introduction of MEWS as an important quality improvement in their clinical practice. One RN stated that the equipment for measuring vital signs had become an indispensable part of her practice:

> It's like… when you are on your way to the patients and you discover that the MEWS equipment bag is not there [in the car]… then you feel so naked! (RN-37)

According to the RNs in all municipalities, MEWS was considered a common tool across the health service to comprehensively present vital signs, and it was perceived as a concise tool for communicating the deterioration of a patient's state of health. The GPs also emphasised the importance of concise communication from the home nursing care RNs in order to promote efficiency and quality in assessing patients and noted that MEWS facilitated that communication. One GP reported that he received more complete and objective information from the RNs after MEWS was implemented:

> Really, before MEWS… I could ask the nurse, 'What is the respiratory rate'? It really didn´t happen. It didn´t happen before… or… I didn´t get the answer to these questions. It´s something that has happened after

TABLE 1 Examples of codes, categories, and main themes of the qualitative analysis

Transcribed text	Code	Category	Main theme
It gives a certain reassurance that there may not be anything seriously wrong with the patient if the MEWS score has not changed much from what is normal. They do not suffer from sepsis when the pulse and everything is fine. (RN-27) "Really, before MEWS… I could ask the nurse, 'What is the respiratory rate'? It really didn´t happen. It didn´t happen before… or… I didn´t get the answer to these questions. It´s something that has happened after implementing MEWS. I don´t think the nurses measured the respiratory rate. They would say 'shortness of breath' or 'no shortness of breath' or 'the patient is breathing fast". (GP-3)	MEWS provides specific information	Change of practice after the introduction of MEWS	MEWS as a support in clinical decision-making
'A lot of our patients have dementia, and they are often unable to express symptoms; you just really have to know your patients in order to assess if it's normal or not'. (RN-3) 'I think it's something about that continuity and that home nursing care nurses know the care recipients very well, and that is important. It is as important as well as an instrument like MEWS'. (GP-6)	Nurses must be in contact with the patients to identify changes	Nurses and GPs have to know their patients to make proper clinical decisions	
'We work a lot with geriatric patients, and I think that MEWS is not adapted to geriatric patients. It's kind of more like it would be suitable for me if I were hospitalised'. (RN-4) I think that the respiratory rate score is very low; it's for a healthy person, and we really have none of those. (RN-2)	Patients have parameters outside MEWS' normal range in habitual state.	MEWS is not an appropriate tool for all patient groups	Adjusting the use of MEWS to older patients in community-based settings
'It should be said that we are not that structured when it comes to the MEWS follow-up intervals. But sure, we do our own reasoning, even if it's a score of three [red] or two' [yellow]. (RN-44) 'Really, to leave the patient at home and to come back again for new measurements in one to two hours… that is really not how we work in home nursing care'. (RN−20)	MEWS trigger recommendations are not always relevant nor feasible		

> implementing MEWS. I don´t think the nurses measured the respiratory rate. They would say 'shortness of breath' or 'no shortness of breath' or 'the patient is breathing fast'.
>
> (GP-15)

The nurses explained that whereas the intention of using MEWS was to identify physiological changes early by comparing the most recent MEWS with the patient's habitual score, MEWS could not stand alone. Rather, MEWS was described as a tool to support the overall clinical assessment, as one RN made clear:

> MEWS is just a tool to complete a comprehensive assessment. You do not solely make decisions on the basis of MEWS, there are many other observations as well.
>
> (RN-44)

One RN described the constant possibility of making the wrong decision by relying solely on objective parameters:

> There is a risk of blindly trusting the measurements and not interpreting the clinical situation. [MEWS] is a starting point, but there can be serious misjudgements.
>
> (RN-44)

Throughout the interviews, both RNs and the GPs highlighted the importance of combining MEWS with knowledge of the individual older patient as an important part of reasoning about the clinical situation. The full sense of 'knowing the patient' included detailed knowledge of how patients managed daily functional activities and their diagnoses, including MEWS and vital signs in their habitual condition. An RN and a GP highlighted the importance of knowing the older home nursing care patients:

> A lot of our patients have dementia, and they are often unable to express symptoms; you just really have to know your patients in order to assess if it's normal or not.
>
> *(RN-3)*

> I think it's something about that continuity and that home nursing care nurses know the care recipients very well, and that is important. It is as important as well as an instrument like MEWS.
>
> (GP-36)

The RNs explained that MEWS, combined with clinical knowledge, could give them an indication of the severity of a patient's clinical deterioration and whether there was a need for a medical assessment or a higher level of care:

> It gives a certain reassurance that there may not be anything seriously wrong with the patient if the MEWS score has not changed much from what is normal. They do not suffer from sepsis when the pulse and everything is fine.
>
> (RN-27)

The RNs considered the clinical situation to be stable if the MEWS did not change significantly, but they were aware of the possibility of making incorrect decisions.

A MEWS score of 1–2 points higher than the habitual score, combined with diffuse clinical changes, resulted in a dilemma, because the symptoms and changes in vital signs could reflect both the complexity of the patient's chronic state of health or severe acute illness. A MEWS score higher than three or other obvious clinical indications of acute illness were situations that RNs found easier to assess, because they reasoned the clinical situation to be severe.

4.2 | Adjusting the use of MEWS to older patients in community-based settings

Implementing MEWS in the home nursing care setting entailed clinical and contextual challenges that needed to be addressed. In the following, descriptions of how RNs and GPs adjusted their use of MEWS to the older patient group in the context of home nursing care are presented.

4.2.1 | Adjusting MEWS' normal range to fit the patient group

The RNs and GPs emphasised that a significant limitation of the current MEWS version was the lack of an adjusted normal range to reflect the older patients' typical health conditions. These patients often have several chronic diseases that may cause deviations from the standardised normal range for vital signs in MEWS, which were developed for the general adult population. A GP stated that MEWS was not adapted to the older population:

> I don't know which age population MEWS is adapted to, but the normal variations in vital signs with older patients are wide.
>
> (GP-15)

The shortcoming of the tool led to difficulties in applying the MEWS normal range and trigger recommendations directly, and the RNs had to rely on their knowledge of a given patient's state of health when deciding what action was necessary. This was also clearly identified as a limitation by one RN:

> We work a lot with geriatric patients, and I think that MEWS is not adapted to geriatric patients. It's kind of more like it would be suitable for me if I was hospitalised.
>
> (RN-4)

This RN found that she rarely could relate MEWS' normal range with the realities of older patients. The RNs constantly assessed and differentiated between normal or abnormal vital signs by interpreting the patients' scores in the light of other relevant information. In particular, RNs in all municipalities identified a challenge with the normal range for respiratory rate. One RN emphasised that most patients had higher respiratory rates than MEWS' normal' range:

> I think that the [normal] respiratory rate score is very low; it's for a healthy person, and we really have none of those.
>
> (RN-2)

The RN indicated that the respiratory values were not adjusted to the elevated rates typical among older patients. The normal range

TABLE 2 Characteristics of the sample

Variable	GP ($n = 8$)	RN ($n = 36$)	Total ($n = 44$)
Age [mean (SD)][a]	43.25 (5.94)	43.92 (13.26)	43.8 (12.2)
20–29			9 (20.5)
30–39			6 (13.6)
40–49			13 (29.5)
50–59			12 (27.3)
60–69			4 (9.1)
Clinical experience [mean (SD)]	15.13 (6.33)	15.81 (10.89)	15.69 (10.16)
0–5	0	6 (17.14)	7 (15.9)
6–10	3 (37.5)	6 (17.14)	9 (20.5)
11–20	5 (62.5)	11 (31.42)	15 (34.1)
21–30	0	8 (22.85)	9 (20.5)
31–40	0	4 (11.42)	4 (9.1)
Medical specialisation, physicians			
General medicine	7 (87.5)		7 (87.5)
Internal medicine	2 (25.0)		2 (25.0)
Anaesthesia	2 (25.0)		2 (25.0)
Continuing education, nurses ($n = 9$)			
Palliative care		4 (66.6)	4 (66.6)
Dementia care		1 (11.1)	1 (11.1)
Rehabilitation		1 (11.1)	1 (11.1)
Geriatric		1 (11.1)	1 (11.1)
Critical care		2 (22.2)	2 (22.2)

All values are *n* (%) unless otherwise specified.

aThe individual age of the participants is not presented due to data protection restrictions to protect the identity of the participants.

for blood pressure used by MEWS was also cited by many RNs as too broad, and the normal range for temperature were also noted as not adjusted to the typical home nursing care patient. One RN explained that a patient's temperature could appear falsely low due to medication use:

> There are many who believe that older patients 'should' develop fever with serious infections. It could be fatal if RNs don't consider that the patient regularly uses paracetamol, because they will never develop a fever if they do.
>
> (RN-26)

The RNs could not initially relate to MEWS' normal ranges, which resulted in uncertainty and ambiguity rather than support. They were obliged to carry out comprehensive clinical reasoning and make decisions while interpreting measurements with a tool that was perceived as not fully adopted to the patient group.

4.2.2 | Adjusting the MEWS trigger recommendations to the home nursing care setting

Throughout the interviews, situations of not following the MEWS trigger recommendations were discussed. RNs made it clear that it was not always feasible to follow the MEWS trigger recommendations in home nursing care because of geographic distance and work lists with limited flexibility. One RN described the great distances involved in her home nursing care district and how it was impractical and sometimes even impossible to comply with MEWS trigger recommendations:

> To achieve continuity all the time… it is fine if they live close to the base, but if the patient lives far away, for example, a 40-minute drive, and you are supposed to do a MEWS again two hours later [it becomes impossible].
>
> (RN-2)

Another RN explained that if a patient had deteriorated significantly and MEWS triggered frequent measurements, the RNs often reasoned that it was not prudent to keep the patient at home, with the patient often admitted to a higher level of care:

> Really, to leave the patient at home and to come back again for new measurements in one to two hours… that is really not how we work in home nursing care.
>
> (RN-20)

This RN emphasised that the home nursing care service did not have the capacity to follow-up with patients as closely as the MEWS

trigger tool system required. In these cases, MEWS supported RNs who decided to contact the medical service and recommend a higher level of care when both MEWS and clinical deterioration appeared clear to them.

The RNs pointed out the challenge of complying with MEWS trigger recommendations, which highlights that MEWS was not adjusted to the home nursing care context before it was introduced into that practice setting. Another RN explained that, although the MEWS trigger recommendations were not routinely followed, comprehensive reasoning was safely adjusted to each patient's situation:

> It should be said that we are not that structured when it comes to the MEWS follow-up intervals. But sure, we do our own reasoning, even if it's a score of three [red] or two [yellow].
>
> (RN-44)

A GP supported experienced RN's ability of clinical judgement, and did not expect experienced RNs in home nursing care to comply with MEWS trigger recommendations, although the tool in some cases could support inexperienced RNs:

> The inexperienced RNs don't know when to perform a new MEWS assessment, but experienced RNs have a 'gut feeling' and just know how to follow-up.
>
> (GP-6)

The RNs made decisions regarding how and when to follow-up after conducting a MEWS measurement based on their clinical reasoning, often by consulting other colleagues rather than simply following the MEWS recommendations. In the following, we discuss advantages and challenges of applying standardised procedures designed for hospital settings in a community-based setting such as home nursing care.

5 | DISCUSSION

In this study, we have explored how RNs and GPs experienced the use of a EWS tool designed for acute hospital settings as a clinical decision-making tool in older home nursing care patients.

Although a number of challenges related to the use of MEWS with acute functional decline in older home nursing care patients emerged in all interviews, both RNs and GPs expressed a generally positive attitude towards MEWS as a support in clinical decision-making. This positive attitude may be attributed not only to the MEWS tool itself but also to the home nursing care services being provided with sufficient equipment to assess vital signs when clinical deterioration was suspected. Standardised procedures and evidence-based practice measures such as MEWS are considered the gold standard in health care practice (Timmermans & Epstein, 2010). For the home nursing care service to have MEWS and the equipment to perform these assessments may be perceived as confirming the importance of comprehensive clinical reasoning and decision-making with older home nursing care patients by using similar standardised procedure as those found in acute hospital care. Indeed, MEWS in the home nursing care service provides RNs and GPs a common way of conveying a patient's clinical condition by using an aggregated score based on an agreement of specific relevant vital signs rather than relying on random descriptions combined with a variable selection of physiological observations. The GPs could respond to RNs' patient information on the basis of both subjective and objective information. The structuring effect of MEWS and the consequent concretisation of the older patients' state of health was interpreted as an improvement of the interdisciplinary collaboration, and these results are in line with other studies in other settings (Brangan et al., 2018; Downey et al., 2017; Jensen et al., 2017).

A high MEWS score indicates the need to contact the medical service and assess the proper level of care, but a low score combined with vague and uncharacteristic symptoms were difficult for the RNs to assess. Unlike Jensen et al.'s study (2017), where RNs in a hospital setting found it challenging to contact a physician when the patient was assessed to have a low score, the RNs in the present study did not report any hesitation in contacting the medical service when their clinical intuition aroused their concern about a patient, even when the MEWS score was low. However, the RNs found it challenging to comply with the MEWS trigger recommendations in home nursing care. The fact that MEWS was applied in a community care setting without any formal adjustment to the older patient groups' normal range in vital parameters and without adjusting the trigger recommendations to that context, resulted in situations characterised by uncertainty, ambiguity and individual interpretation rather than objective clinical support for the RNs. This is in line with the arguments of Timmermans and Almeling (2009), who point out the importance of applying a standardised procedure in a physical and cultural infrastructure that allows it to function properly. Studies outside hospital settings have found issues with the use of EWS systems and the need for adjustments related to different patient groups and contexts (Brangan et al., 2018; Downey et al., 2017; Foley & Dowling, 2019; Fox & Elliot, 2015).

In many situations, MEWS recommendations for measures were not possible to implement in the context of home nursing care service or did not comply with the clinical judgement, which in turn resulted in the RNs' trusting their clinical judgement and ignoring MEWS recommendations. Although the RN's clinical judgement is an important part of assessments in clinical care, it could be unsafe for RNs to rely solely on their clinical judgement and knowledge of their patient without a EWS adjusted to the patient population. The opposite practice—to trust solely objective measurements in MEWS—could also, according to both the RNs and the GPs, lead to misjudgements. According to Timmermans and Almeling (2009), a standardised procedure like MEWS must strike a balance between flexibility and rigidity in order to function well. The MEWS' normal range and trigger recommendations have a rigidity that calls for adjustments or even disregarding the MEWS trigger recommendations entirely in many situations.

In general, very few standardised procedures work as intended when used in contexts other than those for which they were designed (Timmermans & Epstein, 2010), and the need for adjustments is often pressing and prominent. The present study has identified both the utility of MEWS in home nursing care and the need to adjust the MEWS normal range and triggers for the context of a home nursing service caring for older people. In order to increase the support of RNs' comprehensive assessment of acute functional decline in older home nursing care patients, we encourage future research to explore the characteristics of the vital signs of older home nursing care patients experiencing acute functional decline in order to adjust the evidence-based MEWS normal range to the older patient group and the context of home nursing care.

5.1 | Methodological considerations

A number of criteria must be addressed to ensure the trustworthiness of the findings reported in this paper (Green & Thorogood, 2014). We have aimed for transparency, which relates to the explicitness of the method used and how clearly this is outlined through detailed descriptions of the process of analysis (Green & Thorogood, 2014). The process is outlined in this paper by giving several examples of coding the interviews, categorisations and main themes (Table 1). We recognise that, as researchers, we are part of the process of producing the data and interpreting their meanings. Our pre-understanding and experiences as health care personnel and researchers surely influenced the perception and interpretation of the data in this study. However, the use of rich quotes in this paper emphasises our aim of transparency and supports our interpretations of the data.

The study included both RNs and GPs and representativeness (Green & Thorogood, 2014) was enhanced by assuring variation in age and clinical experience, along with the representation of two health care professions and all sizes of Norwegian municipalities. One limitation was that nurses' assistants and unskilled workers were not included in this study. These groups could have contributed their experience with identifying acute functional decline, using and interpreting MEWS and sharing their experiences in collaboration with RNs in home nursing care.

6 | CONCLUSION

The results of this study show that MEWS used by the RNs and GPs in the home nursing care setting is potentially useful in support of clinical reasoning and decision-making. However, the usefulness of the tool is limited, because it is neither experienced as sufficiently adapted to the home nursing care setting nor to the older patient population. To improve the tool's usefulness the normal ranges of the vital signs should be adapted to the population and the trigger recommendations should be developed and adapted to the home nursing care setting.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Kristin Jeppestøl https://orcid.org/0000-0002-1932-8685
Line K. Bragstad https://orcid.org/0000-0002-9645-3770

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