



Turun yliopisto
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EVALUATION OF MOBILE TELEPHONE TEXT MESSAGE REMINDERS FOR PEOPLE WITH ANTIPSYCHOTIC MEDICATION

Kati Kannisto

University of Turku

Faculty of Medicine
Department of Nursing Science
Doctoral Programme in Nursing Science

Supervised by

Professor Maritta Välimäki, PhD, RN
Department of Nursing Science
University of Turku
Turku, Finland

Adjunct Professor Marita Koivunen, PhD
Hospital district of Satakunta
Satakunta Central Hospital
Pori, Finland

Reviewed by

Professor Päivi Åstedt-Kurki
School of Health Sciences
University of Tampere
Tampere, Finland

Associate Professor of Psychiatry
Dror Ben-Zeev
Center for Technology and Behavioral Health,
Dartmouth Psychiatric Research Center
Geisel School of Medicine at Dartmouth College
Lebanon, NH, USA

Opponent

Professor Kader Parahoo
Institute of Nursing and Health Research
Faculty of Life and Health sciences
University of Ulster
Londonderry, UK

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*To Martti, Erika, Arttu and Perttu
and my ever-growing nursing
science tree*

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ABSTRACT

Nonadherence to treatment is a worldwide problem among people with severe mental disorders. Patient treatment adherence may be supported with simple reminding methods e.g. text message reminders. However, there is limited evidence of its benefits. Intervention evaluation is essential in mHealth research. Therefore, this evaluative study was conducted.

This study aimed to evaluate text message reminder use in encouraging patients' treatment adherence among people with antipsychotic medication. The data were collected between September 2011 and December 2013.

First, a systematic literature review revealed that text message reminders were widely used in healthcare. However, its impacts were conflicting. Second, a sub-sample ($n = 562$) analysis showed that patients preferred humorous text message reminders and preferred to receive them in the morning, at the beginning of the week. Age, gender and marital status seemed to have different effects on the preferred amount and timing of the selected reminders. Third, a cross-sectional survey revealed that people with antipsychotic medication ($n = 408$) expressed overall satisfaction towards the reminder system. Finally, the evaluative design showed that patient recruitment for a randomised controlled trial concerning people with antipsychotic medication was challenging due to low rates of eligible participants. Follow-up drop-out rates varied depending on the data collection method. Participants' demographic characteristics were associated with the risk of dropping out from the trial.

This study suggests that text messages are a potential reminder system in healthcare services among people with antipsychotic medication. More research is needed to gain a comprehensive picture of the impacts and effectiveness of text message reminders.

Keywords: mobile phone, text message reminder, antipsychotic medication, severe mental disorder, evaluative study

Kati Kannisto

TEKSTIVIESTIMUISTUTUSTEN ARVIOINTI PSYKOOSILÄÄKITYSTÄ KÄYTTÄVILLÄ POTILAILLA

Turun yliopisto, Lääketieteellinen tiedekunta, Hoitotieteen laitos, Hoitotieteen tohtoriohjelma

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TIIVISTELMÄ

Huono hoitoon sitoutuminen on maailmanlaajuinen ongelma ihmisillä, joilla on vakava mielenterveyshäiriö. Hoitoon sitoutumista voidaan kuitenkin tukea yksinkertaisilla muistutusmenetelmillä, kuten tekstiviesteillä. Tekstiviestimuistutusten hyödyistä antipsykoosilääkitystä käyttävän potilaan hoitoon sitoutumisen tukemisessa tiedetään kuitenkin vain vähän. Interventioiden arviointi on olennainen osa mobiiliterveyden tutkimusta. Tästä syystä tämä arviointitutkimus toteutettiin. Tutkimuksen tarkoituksena oli arvioida tekstiviestimuistutusten käyttöä antipsykoosilääkitystä käyttävän potilaan hoitoon sitoutumisen tukemisessa. Aineisto kerättiin syyskuun 2011 ja joulukuun 2013 välillä.

Ensiksi, systemaattinen kirjallisuuskatsaus osoitti, että tekstiviestimuistutuksia käytetään laajasti terveydenhuollossa. Tulokset tekstiviestimuistutusten hyödyistä olivat kuitenkin ristiriitaiset. Toiseksi, osajoukon ($n = 562$) analyysi osoitti, että osallistujat pitivät humoristisista tekstiviestimuistutuksista ja halusivat vastaanottaa ne aamuisin alkuvuokosta. Osallistujien iällä, sukupuolella ja siviilisäädellä näytti olevan yhteys potilaiden valitsemien tekstiviestien määrään ja siihen, mihin aikaan osallistujat halusivat vastaanottaa viestejä. Kolmanneksi, kyselytutkimus toi esille, että antipsykoosilääkitystä käyttävät potilaat ($n = 408$) olivat yleisesti tyytyväisiä saamaansa tekstiviestipalveluun. Lopuksi, arviointitutkimuksen mukaan antipsykoosilääkityksen omaavien potilaiden rekrytoiminen randomoituun kontrolloituun tutkimukseen oli haasteellista johtuen muun muassa sisäänottokriteerit täyttävien potilaiden vähäisestä määrästä. Tutkimuksen keskeyttäneiden osallistujien määrä vaihteli riippuen seuranta-aineiston keruuseen käytetystä menetelmästä. Osallistujien taustatekijät olivat yhteydessä riskiin keskeyttää tutkimus.

Tutkimuksen mukaan tekstiviestit ovat mahdollinen muistutusjärjestelmä terveydenhuollossa antipsykoosilääkitystä käyttävien potilaiden keskuudessa. Lisää tutkimusta tarvitaan luomaan yhtenäinen käsitys tekstiviestimuistutusten hyödyistä ja vaikuttavuudesta.

Avainsanat: matkapuhelin, tekstiviestimuistutus, antipsykootin lääkehoito, vakava mielenterveyshäiriö, arviointitutkimus

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ABBREVIATIONS

A	Attitudes
ANA	American Nurses Association
BI	Behavioural intention
BIT	Behavioural intervention technologies
BMI	Body mass index
CI	Confidence Interval
CINAHL	The Cumulative Index to Nursing and Allied Health Literature
CONSORT-	Consolidated Standards of Reporting Trials of Electronic and Mobile
EHEALTH	Health Applications and onLine TeleHealth
CRD	Centre for Reviews and Dissemination
EHFG	European Health Forum Gastein
ETENE	The National Advisory Board on Social Welfare and Health Care Ethics
eHealth	Electronic Health
FEAM	Federation of the European Academics of Medicine
FITT	Fit between Individuals, Task and Technology framework
GAF	Global Assessment of Functioning
HILMO	Care Register for Health Care
HIMSS	Healthcare Information and Management Systems Society
ICD-10	International Statistical Classification of Diseases and Related Health Problems 10th Revision
ICT	Information and communication technology
ID	Identification
ILO	International Labour Organization
IMHSC	International mHealth Standards Consortium
ISRCTN	International Standard Randomised Controlled Trial Number

ITU	International Telecommunications Union
mHealth	Mobile Health
MeSH	Medical Subject Headings
MMAT	Mixed Method Appraisal Tool
NICE	National Institute for Health and Care Excellence
NIH	National Institutes of Health, US
NIMH	National Institute of Mental Health
OEC	Online Ethics Center
OECD	The Organisation for Economic Co-operation and Development
OR	Odds Ratio
PEOU	Perceived ease of use
PICO	Population, intervention, comparison, outcomes
PU	Perceived usefulness
RCT	Randomised controlled trial
SAS	Statistical Analysis System
SD	Standard Deviation
SMS	Short Message Service
SPSS	Statistical Package for the Social Sciences
SUS	System Usability Scale
TAM	Technology Acceptance Model
TUKIJA	National Committee on Medical Research Ethics
Turku CRC	Turku Clinical Research Centre
UTAUT	Unified Theory of Use and Acceptance of Technology
WHO	World Health Organization
WMA	World Medical Association

LIST OF ORIGINAL PUBLICATIONS

This doctoral thesis is based on the following publications, which are referred to in the text by their roman numerals I-IV:

- I Kannisto KA, Koivunen MH & Välimäki MA. 2014. Use of mobile phone text message reminders in health care services: a narrative literature review. *Journal of Medical Internet Research* 16 (10):e222.
- II Kauppi K, Kannisto KA, Hätönen H, Anttila M, Löyttyniemi E, Adams CE & Välimäki M. 2015. Mobile phone text message reminders: Measuring preferences of people with antipsychotic medication. *Schizophrenia Research* 168 (1–2), 514–522.
- III Kannisto KA, Adams CE, Koivunen M, Katajisto J & Välimäki M. 2015. Feedback on SMS reminders to encourage adherence among patients taking antipsychotic medication: a cross-sectional survey nested within a randomised trial. *BMJ Open* 5 (11):e008574.
- IV Kannisto KA, Korhonen J, Adams CE, Koivunen M, Vahlberg T & Välimäki M. Text message intervention for people with antipsychotic medication: lessons learned in patient recruitment and retention in a nationwide randomised controlled trial. *Submitted*.

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1. INTRODUCTION

Severe mental disorder is a major problem around the world (WHO 2015a). An estimated 13% of the global disease burden has been attributed to depression, alcohol use disorders and psychosis such as schizophrenia and bipolar affective disorder (Collins et al. 2011). Severe mental disorders cause challenges for the patients themselves, their families and caregivers, stigmatization and social exclusion (FEAM 2010). Severe mental disorders are also the main cause of disability and early retirement (De Hert et al. 2011, WHO 2015b). It has been estimated that 5% of the working-age population is affected by a severe mental disorder (OECD 2014a). The economic burden of severe mental disorders on society consists of direct costs (i.e. expenses on treatment) and indirect costs (e.g. a loss in productivity, increased social care and impacts of increased crime rates) (FEAM 2010). About 350 million people are affected by depression, about 60 million people are affected by bipolar affective disorder and 21 million people have schizophrenia worldwide (WHO 2015a). These numbers may be lower than the actual amount, due to a lack of standardised indicators and incomplete reporting (Baxter et al. 2013).

In Finland, the amount of severe mental disorders has not increased during the 21st century, but differences between social groups exist in mortality and mental health (Ministry of Social Affairs and Health 2013). In 2013, about two-thirds (69%) of people with severe mental disorders took an antipsychotic medication at some stage in their care (National Institute for Health and Welfare 2015). That year, the medicine costs for severe mental disorders (special refunded) totaled over 73 million euros (The Social Insurance Institution of Finland 2014). At the same time, nearly 110 000 people (48% of all disability pension recipients) retired, due to mental health disorders (47% of these were male) (Finnish Centre for Pensions 2015). There is clear geographic variation of prevalence of psychotic disorders in Finland; psychoses are more common in Northern and Eastern Finland than in Southwest Finland (Perälä et al. 2008).

Nonadherence to treatment is a major problem among people with severe mental disorders (WHO 2003, Haddad et al. 2014). Their daily routines are also often disturbed (Harvey & Strassnig 2012). About 50% of people with severe mental disorder do not adhere to the medication or treatment prescribed (Klingberg et al. 2008, Schennach et al. 2012). This may lead to worsening symptoms (Sajatovic et al. 2006), poor social functioning and dropping out of clinical appointments (Killaspy 2006), thus, increasing the risk of rehospitalization (Haddad et al. 2014). Moreover, difficulties in daily living skills, such as medication management or basic hygiene, may worsen patients' treatment adherence (Harvey et al. 2007).

It is possible to support patient treatment adherence among people with severe mental disorders (Thorncroft & Tansella 2003, Priebe et al. 2005). Therefore, more emphasis should be put on evaluating possible methods of improving their treatment adherence. Patients' preferences and feedback should be evaluated and their experiences should be considered when planning their treatment and health care services (Tandon et al. 2006, Daker-White & Rogers 2013, NICE 2014).

Recently, information and communication technologies (ICT), especially mobile Health (mHealth) technologies, have been recommended in various policy papers and guidelines (e.g. European Commission 2012, 2014, IMHSC 2015) and used in various contexts in healthcare (Klasnja & Pratt 2012). mHealth uses mobile phones and other wireless technologies for healthcare delivery and health research (WHO 2011a, HIMSS 2012). mHealth interventions can offer health care sciences, especially nursing, new insights into health promotion and health care delivery (Moore et al. 2015). The popularity of mHealth is evident, and short message service (SMS) is the most frequently used device to support treatment adherence among patients with chronic diseases (Hamine et al. 2015). Moreover, simple prompts, such as text message reminders, may encourage patient adherence to chronic medication in the short term (Vervloet et al. 2012), appointment attendance (Car et al. 2012), and patient self-management (de Jongh et al. 2012). Text message reminders as well as other mHealth interventions are used as behavioural intervention technologies (Mohr et al. 2014).

There is a lack of a coherent picture of which patient groups have been focused on and how text message reminders have been used in healthcare. Therefore, a systematic literature review was conducted to synthesise the information accumulated in the area of text message reminders use. Although the popularity of mHealth is evident (Hamine et al. 2015), there are discrepancies about its impacts (Farrington et al. 2014, Hamine et al. 2015). There is a shortage of studies focusing on people with severe mental disorders. Therefore, more evaluation of text message reminders used in psychiatric outpatient care is needed, since evaluation of interventions is a key concept of mHealth research (Ben-Zeev et al. 2015). However, conducting research with people with mental health problems may raise practical challenges (McCauley-Elsom et al. 2009). Patient recruitment may be a problem (Callard et al. 2014), and a relative proportion of participants tend to drop out from studies before completion in technology-based trials (Eysenbach 2005). It is important to study factors associated with engagement of text message-based intervention among people with severe mental disorders, to ensure the applicability of the data in clinical practice and to deeper understand what makes people adopt with these interventions (Price et al. 2012). Therefore, greater awareness is needed to understand the rates of attrition of these interventions (Price et al. 2012), since it may give hints for real-life implementation problems (Eysenbach 2005).

There has been a paucity of theories addressing the design and implementation of behavioural intervention technologies (Mohr et al. 2014), and therefore, the Behavioral Intervention Technology Model was developed (Mohr et al. 2014, Mohr et al. 2015). To form a concise picture of the evaluation of mobile telephone text message reminders use among patients with antipsychotic medication, the Behavioral Intervention Technology model was followed in this study.

The overall aim of this study was to evaluate the use of text message reminders in encouraging patient treatment adherence among people with antipsychotic medication. To achieve this goal, a four-phase study was conducted. First, a systematic literature review was carried out to provide an overall perception of text message reminder use in health care settings and to gain knowledge of what is already known about its use among people with severe mental disorders. Second, to evaluate a text message reminder system among people with severe mental disorder, patient preferences were explored. Third, patient feedback was studied to gain a deeper understanding about their perceptions regarding text message reminders. Finally, to further this understanding, an evaluative study was conducted to examine patient recruitment and attrition from an effectiveness study focusing on text message-based intervention. The target group of the study consisted of outpatients with antipsychotic medication (recruited from inpatient psychiatric care) and who were willing to participate.

This study is part of the Mobile.Net trial (ISRCTN: 27704027), which aimed to assess the effectiveness of text message reminders in improving treatment adherence among people with psychosis (Välimäki et al. 2012). Text message reminders were developed specifically for the Mobile.Net trial, and this doctoral study comprises the evaluation of the text message system.

This study was conducted in the discipline of nursing science. Patient in this study represents people with severe mental disorders with antipsychotic medication (De Hert et al. 2011). Health is related to an individual's ability to adapt and self-manage, and comprising three domains of health as follows: physical, mental and social health (Huber et al. 2011). Good mental health enables people to live normal lives, work and integrate into the community (WHO 2012). This everyday functioning, however, may be impaired among people with severe mental disorders (Harvey & Strassnig 2012, Świtaj et al. 2012). Nursing encompasses the promotion of individuals' health and care of the mentally ill. Moreover, it is understood as advocacy in the care of individuals, promotion of safe environments, research, participation in decision making in health policies, management and education (International Council of Nurses 2002). Environment is understood as psychiatric outpatient care in Finland, which aims to support patients' independent coping (Mental Health Act 1116/1190).

2. OVERVIEW OF THE LITERATURE

2.1 People with severe mental disorders

Severe mental disorder usually refers to illnesses where psychosis appears (Abbas 2015). However, there is no universal definition of severe mental disorder (Parabiaghi et al. 2006, Abbas 2015), and operationalisation and the classification of mental disorders vary according to different classification systems (Canino & Alegría 2008). Severe mental disorders may be defined as three- or two-dimensional. The three-dimensional definition is described as follows: 1) diagnosis of psychosis, 2) treatment duration over two years and 3) dysfunction (Ruggeri et al. 2000, Parabiaghi et al. 2006). Diagnosis of psychosis is based on the ICD-10 Classification of Mental and Behavioural Disorders (WHO 1993), and it usually refers to schizophrenia, bipolar disorder and severe depression (De Hert et al. 2011). Duration of treatment is defined as the time period between a person's first contact with psychiatric services and the current treatment event (Ruggeri et al. 2000). Dysfunction is based on an assessment with Global Assessment of Functioning (GAF scale) (Endicott et al. 1976). A GAF score ≤ 50 (scale 1–100) indicates severe dysfunction (Ruggeri et al. 2000). For this study, the two-dimensional definition of severe mental disorder (2D definition) suggested by Ruggeri and colleagues (2000) was adopted. The 2D definition is preferable to the three-dimensional definition, since it is based on duration (service contact ≥ 2 years) and functioning criteria (any mental disorder, GAF ≤ 50). (Ruggeri et al. 2000, Parabiaghi et al. 2006.)

Several symptoms are associated with severe mental disorders, such as schizophrenia, bipolar disorders or severe depression (De Hert et al. 2011, Gaebel & Zieslasek 2015). Symptoms of schizophrenia can be categorised as positive symptoms (such as hallucinations, delusions, thought or movement disorders) (Fresán et al. 2005), negative symptoms (such as anhedonia, apathy, alogia, withdrawal) (Mueser & McGurk 2004) or cognitive symptoms (such as distortions in thinking, working memory, perceptions and language, or trouble in paying attention) (Trivedi 2006, Insel 2010). Symptoms of bipolar disorder include variation in intense emotional states (manic episode or depressive episode), and drastic changes in activity, sleep or behaviour (Benazzi 2007). Symptoms of severe depression include, for example, angry outbursts, feelings of sadness, sleep disturbances, a loss of interest or loss of pleasure, and trouble thinking or concentrating (NIMH 2011). The symptoms of these severe mental disorders are commonly related to disturbed thoughts, perceptions, emotions and behaviour, and troubled social relationships with other people (WHO 2015a). Symptoms are chronic or long-lasting, leading to dysfunction in most areas of life (Świtaj et al. 2012).

Lifelong disability is often connected with severe mental disorders (Świtaj et al. 2012), and results from a cascade of multiple effects (Harvey & Strassnig 2012). Cognitive impairment may lead to problems with social and occupational functioning (Mueser & McGurk 2004, Harvey & Strassnig 2012). Often, people with severe mental disorders are socially isolated and lack friends, relatives or caregivers as well as support (Haddad et al. 2014). Cognitive deficits may lead to disruption of studies (WHO 2015c), low educational levels (Sharma & Antonova 2003) and further incapability to work (Harvey & Strassnig 2012). Given the higher risk of losing their jobs (Evans-Lacko et al. 2013), unemployment among people with mental health problems is six to seven times more common than among people without mental health problems (OECD 2011).

Problems with self-care are prevalent among people with severe mental disorders (Harvey et al. 2007, Chien et al. 2013), and they are prone to many physical health problems such as obesity, diabetes, and poor dental status (Leucht et al. 2007, De Hert et al. 2011, Harvey & Strassnig 2012). Poor physical health may lead to increased mortality (von Hausswolff-Juhlin et al. 2009, De Hert et al. 2011). People with severe mental disorders die about 20 years younger than people without mental disorders (Wahlbeck et al. 2011, Laursen et al. 2014). Moreover, high suicide rates lead to excess mortality among people with severe mental disorders (Saha et al. 2007, Hoang et al. 2011). About five percent of people with schizophrenia commit suicide during their lifetime (Palmer et al. 2005, Hor & Taylor 2010).

Daily routines are often disrupted among people with severe mental disorders (Harvey & Strassnig 2012, Galderisi et al. 2014). They may have difficulties in daily living skills (Harvey et al. 2007). These could include, for example, difficulties in getting up in the morning, cooking, having breakfast or lunch (Minato & Zemke 2004, Chien et al. 2013), performing self-care activities, such as medication management or basic hygiene (Harvey et al. 2007) or in going out or to work (Minato & Zemke 2004). Especially in outpatient care, these people need help coping with their daily activities and redesigning their lifestyle (Harvey & Strassnig 2012).

2.2 Treatment nonadherence among people with severe mental disorder

Nonadherence to treatment is a major problem among people with severe mental disorders (Velligan et al. 2009, Leucht et al. 2012, Offord et al. 2013, Shuler 2013). The World Health Organization (2003) defines treatment adherence as follows: “the extent to which a person’s behaviour – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider”. About 40% to 50% of the patients do not adhere to prescribed antipsychotic medication (Byerly et al. 2008, Klingberg et al. 2008, Schennach et al. 2012, Vassileva et al. 2014). Moreover, about 20% to 36% of patients miss their clinical outpatient

appointments (Mitchell & Selmes 2007, Sims et al. 2012). Nonattendance rates at psychiatric clinics are double that of other medical specialties (Filippidou et al. 2014).

Clinical implications of treatment nonadherence may include worsening symptoms (Sajatovic et al. 2006), poor social functioning, an increased chance of losing touch with clinical contacts (Killaspy 2006) and a high risk of rehospitalisation (Killaspy et al. 2000, Sajatovic et al. 2006, Haddad et al. 2014). Despite the indisputableness of the effects of antipsychotic medication, its effects in the treatment of mental disorders are modest, and some of the patients do not benefit from the medication (Optimisetriall 2013). Nonadherence to antipsychotic medication may be categorised as intentional or unintentional (NICE 2009). First, patients who respond well to the prescribed medication may discontinue their medication (Optimisetriall 2013). This may be due to the medication's side effects (Priebe et al. 2005, Haddad et al. 2014), stigma, or negative attitudes towards antipsychotic medication (Haddad et al. 2014). They may also feel that medication is no longer needed and therefore discontinue medication (Ascher-Schvanum et al. 2010). Second, a patient may forget to take medication (Bulloch & Patten 2010). Given this, supporting patient treatment adherence is essential for both economic and health related reasons (Haddad et al. 2014). Therefore, all available support may benefit people with severe mental disorders (Maneesakorn et al. 2007, Kane et al. 2013).

According to people with severe mental disorders themselves, treatment adherence can, in fact, be supported (Priebe et al. 2005, Kauppi et al. 2015a). Priebe and his colleagues (2005) found out that participant engagement with treatment can be supported by involving the patient in decision making concerning their care. Patients with mental health problems long for individual-based support, such as individually tailored treatment methods (Tandon et al. 2006, Kauppi et al. 2015a). Moreover, continuity of care (Burns et al. 2009) and supporting patients' daily living are of remarkable importance in relation to treatment adherence (Hautala-Jylhä et al. 2005, Harvey & Strassing 2012). Therefore, more emphasis should be put on patients' opinions and voices regarding the planning of their treatment and services (Health Research Institute 2013, Daker-White & Rogers 2013, Department of Health 2014), and their own experiences should be taken into consideration (Daker-White & Rogers 2013, NICE 2014).

2.3 Mental health services in Finland

Mental health services in Finland are decreed by the Health Care Act (1326/2010) and the Mental Health Act (1116/1190) (Ministry of Social Affairs and Health 2015). According to the Health Care Act (1326/2010, 27 §), the mental health services required for promoting resident health and well-being are to be provided by local authorities (i.e. municipalities). The Mental Health Act (1116/1190), as a skeleton law, regulates mental

health work, its concepts and contents, supervision and organisation of the mental health services (Harjajärvi et al. 2006).

The content and extend of mental health services have to be organised to correspond the needs of residents and arranged primarily as out-patient services (Mental Health Act 1116/1190, 4 §). The Constitution of Finland (731/1999) stipulates that the government must guarantee adequate health services for each person and promote citizens' health (The Constitution of Finland 731/1999) by respecting human rights (United Nations 1948). Moreover, international (e.g. WHO 2005, FEAM 2010, WHO 2013, European Union 2014, NICE 2014, European Union 2015) and national (e.g. Ministry of Social Affairs and Health 2001, National Institute for Health and Welfare 2009, Schizophrenia: Current Care Guideline 2015) guidelines and health policies guide the arrangement of mental health services in Finland.

Mental health services in Finland are mainly provided by the public sector (Ministry of Social Affairs and Health 2015). Public mental health services are generally arranged by primary social and health care services (Ministry of Social Affairs and Health 2015), which are provided by hospital districts ($n = 21$, including Åland) (Kunnat.net 2015a) and municipalities ($n = 317$) (Kunnat.net 2015b). Mental health services are also arranged under specialised health care (National Institute for Health and Welfare 2015) at psychiatric clinics and at psychiatric hospital care units (Ministry of Social Affairs and Health 2015). Public mental health services are supplemented by private and third sector services (e.g. associations and foundations) (Harjajärvi et al. 2006, Pylkkänen et al. 2012, National Institute for Health and Welfare 2014a). Private mental health services partly fill the resource gap in public services (Pylkkänen 2012). Mental health services are financed by general taxation (ILO 2000, Lehtinen & Taipale 2001, Vuorenkoski 2008). Public mental services are free of charge, which makes private mental health services rare (Pirkola et al. 2009). Only a small percentage of patients need hospitalised care, whereas the majority of the service users get help from outpatient services (National Institute for Health and Welfare 2014a).

Local authorities (i.e. the municipalities) are responsible for organising the Finnish mental health services, such as giving advice and guidance, psychosocial support and required examinations, and providing treatment and rehabilitation for their residents (Mental Health Act 1116/1190, Ministry of Social Affairs and Health 2015, National Institute for Health and Welfare 2014a, 2015). The services are arranged primarily as out-patient services (Mental Health Act 1116/1190, 4 §), so that the initiative of patients to seek help and self-manage is supported (Mental Health Act 1116/1190, 4 §, Partanen et al. 2010). Mental health outpatient services in Finland refer to actions supporting long-term psychiatric patients (Vuorenkoski 2008), and are multifaceted, consisting of day

care facilities (WHO 2011b), such as shared apartments, day hospitals and day care centres, residential or rehabilitation homes (Vuorenkoski 2008), sheltered or supported housing (Raitakari et al. 2015) and mobile services (Pirkola et al. 2009).

Municipalities can arrange mental health services by providing the service itself, working with another municipality, or by outsourcing services (e.g. buying from private sector) (Sahrman et al. 2008). The local health centres provide most mental health services (National Institute for Health and Welfare 2014a, Ministry of Social Affairs and Health 2015, Sotkanet.fi 2015). Outpatient mental health care services are mainly organised by local health centres, psychiatric hospital outpatient departments or mental health offices (Vuorenkoski 2008), such as psychiatric clinics (Ministry of Social Affairs and Health 2015). Mental health outpatient offices are commonly staffed by psychologists, psychiatrists (Vuorenkoski 2008), psychiatric nurses or depression nurses (Patana 2014), social workers, and other professionals (Vuorenkoski 2008). Continuing education and adequate health care personnel are a prerequisite to arranging effective outpatient services (Schizophrenia: Current Care Guideline 2015).

Structural changes have occurred in the Finnish mental health care system during the past decades (Pylkkänen 2012). The transition from inpatient mental health care to outpatient mental health care has been pivotal in Finland (Vuorenkoski 2008, Pylkkänen 2012, OECD 2014b). The amount of psychiatric inpatient beds has decreased by over four-fifths, from 20 000 beds in 1980 (Lehtinen & Taipale 2001) to 3500 in 2014 (National Institute for Health and Welfare 2014a), although it remains higher than, for example, that of OECD countries (OECD 2014b) and other Nordic countries (Wahlbeck et al. 2011). The average length of stay in inpatient mental health care has decreased from 49 days in 1997 (National Institute for Health and Welfare 2010) to 36 in 2013 (National Institute for Health and Welfare 2014a). At the same time, the amount of outpatient visits in psychiatry has risen from 520 000 in 1980 (ILO 2001) to 1.9 million in 2006 (Vuorenkoski 2008, Sotkanet.fi 2015) and to 2.4 million in 2014 (including primary and specialised medical care) (National Institute for Health and Welfare 2014a, b, Sotkanet.fi 2015). In 2013, schizophrenia, schizotypal and delusional disorders (F20–F29) (53% male) and mood (affective) disorders (F30–F39) (40% male), classified according to the ICD-10 classification (WHO 1993), were the main reasons for psychiatric outpatient visits in specialised medical care (National Institute for Health and Welfare 2014a).

International and national guidelines dictate the arrangement of the mental health services in Finland, addressing the promotion of mental health and the prevention of mental disorders and enhancing the importance of evidence-based practices (FEAM 2010, NICE 2014, Schizophrenia: Current Care Guideline 2015). Early intervention, the

development of the availability of services, the addition of low-threshold mental health services, and encouragement of individual responsibility for one's own health status and lifestyle are the key topics in the Finnish Government Programme (Prime Minister's Office 2015). Despite these guidelines there are still inequalities in mental health statuses (e.g. suicide rate) and in equal access to mental health care between countries, but also within countries (Thornicroft & Tansella 2004, OECD 2015). This is also the reality in Finland (Patana 2014). This may be due to heterogeneous development of outpatient services across the country (Lehtinen & Taipale 2001, Pirkola et al. 2009), substantial differences in mental health service provision (Vuorenkoski 2008, Ministry of Social Affairs and Health 2012) and waiting times between municipalities (Vuorenkoski 2008). It has also been stated that mental health care is under-resourced, under-prioritised (OECD 2014c) and under-funded (Lehtinen et al. 2006). It is worth noting that health systems have not yet adequately responded to the burden of mental disorders, leading to a gap between the need for treatment and its arrangement. Therefore, more effective leadership, outpatient-based mental health services, implementation of strategies to promote mental health, and strengthened evidence and research are needed (WHO 2015a).

2.4 Treatment for people with severe mental disorders

Treatment for people with severe mental disorders depends on the patient's stage of illness (NICE 2014). For example, treatment is different in the acute phase of schizophrenia than it is in the stable phase (Schizophrenia: Current Care Guideline 2015). Despite the stage of the illness, it is important that the patient adheres to the treatment (NICE 2014, Schizophrenia: Current Care Guideline 2015). Patient treatment adherence can be supported in psychiatric outpatient care (Thornicroft & Tansella 2003), which is a policy priority around the world (Mental Health Act 1116/1190, Caldas de Almeida & Killaspy 2011, Schizophrenia: Current Care Guideline 2015). People with severe mental disorders need diverse individual options to support their coping ability and self-management (Hogarty et al. 1997, Thornicroft & Tansella 2004, Shek et al. 2009, Harvey & Strassnig 2012) after discharge from psychiatric inpatient care to outpatient care (Hautala-Jylhä et al. 2005).

Antipsychotic medication and the combinations of antipsychotic medication and psychosocial interventions are essential in the treatment of patients with severe mental disorders (WHO 2012, NICE 2014, Schizophrenia: Current Care Guideline 2015). The aim of antipsychotic medication is to relieve the symptoms of the disorder (Leucht et al. 2011), which may be devastating for the patient's cognitive and social functioning (Harvey & Strassnig 2012). It is important to avoid the induction of adverse effects of antipsychotic medication (Tandon et al. 2006, Schizophrenia: Current Care Guideline 2015), as that may lead to medication discontinuation (Priebe et al. 2005, Haddad et al.

2014, Ascher-Schvanum et al. 2010). At its best, antipsychotic medication lowers the risk of rehospitalisation and discontinuation of medication (Gilmer et al. 2004, Tiihonen et al. 2006, Becker et al. 2007, Leucht et al. 2011). The combination of antipsychotic medication and psychosocial interventions (e.g. psychoeducation, cognitive behavioural therapy, family interventions, social skills training) is effective in the treatment of severe mental disorders (NICE 2014, Schizophrenia: Current Care Guideline 2015, WHO 2015a). The aim of psychosocial interventions is to supplement antipsychotic medication and help patients regain their capabilities (Pingani et al. 2013); this may enable them to lead a productive life and to be integrated into society (WHO 2015a).

Supporting motivation to perform skills needed in daily functioning is important among people with severe mental disorders (Harvey & Strassing 2012). In order for individuals to avoid losing their inclination to manage their daily routines or activities, their motivation should be supported (Minato & Zemke 2004). This may be possible, for example, through offering occupational therapy (Mintao & Zemke 2004), skills training and emphasising advocacy for better services through supporting patient engagement with mental health services (e.g. outpatient appointments, treatment plans or prescribed treatment) (Harvey & Strassnig 2012, Galderisi et al. 2014). Therefore, meaningful activities to maintain healthy living (Minato & Zemke 2004), and support in everyday functioning and daily routines are needed (Priebe et al. 2005, Harvey & Strassnig 2012). However, Tungpunkom and colleagues (2012) conclude in their recent systematic review that life skills programmes lack sufficient evidence to be proved effective among people with long term mental disorders.

A patient's daily activities and integration into society can be supported by community-based services, such as supported housing, assisted living or supported employment (Schizophrenia: Current Care Guideline 2015, WHO 2015a). A supportive social environment is crucial for the process of a patient's personal recovery (Castelein et al. 2015). Supporting the patient's daily activities is important, since people with mental disorders, despite the disability caused by the disorder, want to be independent, "as normal as possible" (Priebe et al. 2005). Occupational activities or supported employment may improve patient employment (Campbell et al. 2011, NICE 2014, Schizophrenia: Current Care Guideline 2015). This may further reduce financial difficulties and social exclusion (EHFG 2013). Community-based services are associated with high user satisfaction and promotion of continuity of care (Thornicroft & Tansella 2003).

Social support is central to patient self-management (NICE 2014). Social support is defined as support from family members, friends, non-kin or peers (Castelein et al. 2015). Peer support groups provide opportunities to reduce social isolation, improve

relationships with others and enhance the patient's personal recovery (NICE 2014, Schizophrenia: Current Care Guideline 2015, Castelein et al. 2015). Cognitive remediation combined with other psychiatric rehabilitation may lead to improvement in the patient's functional ability (Wykes & Spaulding 2011, Schizophrenia: Current Care Guideline 2015).

It is also important that the physical health of patients with severe mental disorders is supported (De Hert et al. 2011). This is due to high rates of comorbidity and mortality (Leucht et al. 2007, von Hausswolff-Juhlin et al. 2009, De Hert et al. 2011, Harvey & Strassnig 2012). Supporting physical health may be possible by offering, for example, programmes promoting healthy eating, physical activity or smoking cessation (NICE 2014, Schizophrenia: Current Care Guideline 2015). These programmes may be effective in reducing body mass index (BMI), waist circumference (McKibbin et al. 2010), increasing physical functioning (Chafetz et al. 2008) and reducing smoking (Baker et al. 2006). Physical exercises (e.g. strength exercises, aerobics and yoga) may improve the physical fitness of patients, reduce psychiatric symptoms, improve health-related quality of life, overall functioning and cognition, and have positive impacts on comorbidity (Pedersen & Saltin 2015).

Continuity of care should be ensured among people with severe mental disorders (Schizophrenia: Current Care Guideline 2015), since the treatment of these patients is mainly carried out in outpatient care (Ministry of Social Affairs and Health 2015). This is important, especially when the patient moves from one care-provider to another (e.g. from inpatient care to outpatient care) as well as during outpatient care (Ministry of Social Affairs and Health 2001). Patient monitoring and follow-up appointments offer opportunities for continuity of care by monitoring and observing changes in patients' symptoms (NICE 2014) and offering adequate treatment to avoid symptom worsening and rehospitalisation of these patients (Marshall & Rathbone 2011). Self-management is, however, at risk, if patients do not adhere to the treatment prescribed (Killaspy 2006, Barkhof et al. 2012). Therefore, it is essential that patient treatment adherence is supported (NICE 2014, Schizophrenia: Current Care Guideline 2015, WHO 2015a).

Recently, the use of information and communication technologies (ICT), especially mHealth (mobile Health) technologies (e.g. mobile phones and text messages), have been recommended in various policy papers and guidelines (e.g. European Commission 2012, 2014, IMHSC 2015). Text messages have been used in various contexts in healthcare (Klasnja & Pratt 2012) and provide an example of behavioural intervention technologies (Mohr et al. 2013a). Behavioural intervention technologies (BITs) are defined as mHealth (using tools such as mobile phones, SMS) and eHealth (using tools such as the Internet) interventions which are targeted to support patients in changing

their behaviour, cognition and achieving their goals related to their general health, mental health and overall well-being (Mohr et al. 2013a,b, Mohr et al. 2014).

Behavioural intervention technologies include both psychological and behavioural intervention strategies (Mohr et al. 2013a). These types of interventions enable users to change their current state of health or mental health (state at the moment) and achieve the intervention aims (desired future state). User's past state includes prior states and events, such as events that happened in the past hour, yesterday or before yesterday (e.g. forgetting medication or appointment). User's future state includes events that will happen in the next hour, tomorrow or after tomorrow (e.g. desired treatment adherence) (Figure 1). (Mohr et al. 2014.) Behavioural intervention technologies have been used in health care to implement behaviour changing strategies that include self-monitoring and self-assessment to support the self-management of patients with bipolar disorders (Hidalgo-Mazzei et al. 2015), goal setting to help people lose weight (Mohr et al. 2014), and motivation enhancement to support treatment adherence among youth with anaphylaxis (Anderson & Wallace 2015), to name some examples.

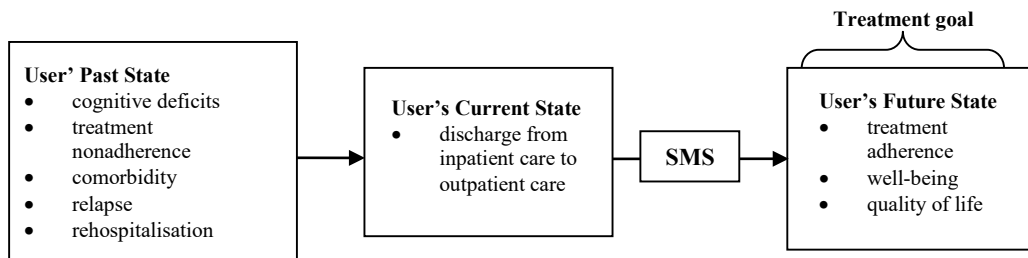


Figure 1. Pattern of how text message reminders assist goal achievements and future changes among people with severe mental disorders (modified according to Mohr et al. 2014)

Behavioural intervention technologies have many characteristics that make them suitable for health care and, specifically, mental health care. For example, mobile phones have become an important platform for delivering behavioural intervention technologies in health care (Klasnja & Pratt 2012). This has been possible because of their ubiquity (Atun & Sittampalam 2006, Klasnja & Pratt 2012), easy access and time-unlimited use (Alvarez-Jimenez et al. 2014). Mobile phone penetration is near 100% worldwide (ITU 2015); mobile phones are used in both developing (Zurovac et al. 2011, Déglise et al. 2012, Brian & Ben-Zeev 2014) and developed countries (Fjeldsoe et al. 2009). They also have the potential to be used in rural areas (Brian & Ben-Zeev 2014). Moreover, mobile phones are used among most social groups (Atun & Sittampalam 2006), including people with severe mental disorders (Ben-Zeev et al. 2013). These characteristics make the delivery of behavioural intervention technologies via mobile phones possible for people

who would otherwise not be able to access care (Mohr et al. 2013a, Brian & Ben-Zeev 2014).

The use of behavioural intervention technologies is very multifaceted; they may have been developed for single, short-term or longer-term use, or they may be used individually or connected to larger intervention systems (Mohr et al. 2013b). Behavioural intervention technologies delivered by text messages can be individually tailored (Fjeldsoe et al. 2009, Tran & Houston 2012) and pre-programmed to be sent automatically at predetermined times (Danaher et al. 2015). However, difficulties in the use and engagement with mobile technologies may restrict the effects of mHealth system-supported self-management (Jia et al. 2015).

Previous systematic literature reviews show that simple prompts, such as Short Message Service (SMS) reminders, may encourage patient adherence to chronic medication in the short term (Vervloet et al. 2012, Hamine et al. 2015), appointment attendance (Car et al. 2012) and patient self-management (de Jongh et al. 2012). Further, they have been proven to be acceptable and feasible among persons with severe mental disorders (Palmier-Claus et al. 2013, Ben-Zeev et al. 2014a). However, it is not enough to develop interventions for supporting patients' coping and self-management, although they are more than needed (Harvey & Strassnig 2012), if they are not feasible, acceptable or easy to use (Daker-White & Rogers 2013, Bauer et al. 2014). Moreover, the major aim of the use of mobile-based intervention in health care is to enhance citizens' participation in the management of their own health and well-being (European Commission 2014).

2.5 Theories related to the use of information technology

The theories related to the use of information technology are many. They have been developed to understand individuals' behavioural intentions related to information systems and their use (Oinas-Kukkonen 2013). The three theories related to the use of information technology that are probably the most prominent are described as follows: the Technology Acceptance Model (TAM) (Davis 1989, Davis et al. 1989), the Unified Theory of Use and Acceptance of Technology (UTAUT) (Venkatesch et al. 2003) and the Fit between Individuals, Task and Technology framework (The FITT framework) (Ammenverth et al. 2006). In addition, a novel framework titled the Behavioral Intervention Technology Model (BIT model) (Mohr et al. 2014) is described in this section.

The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was developed at the end of 1980s by Davis and Bagozzi (Davis 1989, Davis et al. 1989). It is one of the most popular and frequently employed theories related to the acceptance and use of technology (Yarbrough & Smith

2007, Surendran 2012). The theory postulates that the information technology use of an individual can be predicted by their intentions. The theory further suggests that the intention to use technology (i.e. the decision about when and how to use technology or reject its use) is related to an individual's perceived ease of use (PEOU) and perceived usefulness (PU) in regards to the technology (Davis 1989, Davis et al. 1989). The theory also indicates that the perceived ease of use and perceived usefulness of the intervention affects individual's attitudes (A) and enhances individual's motivation and behavioural intention (BI) to continue using the technological application (Davis et al. 1989). External variables, such as individual and organisational variables, may have an impact on the perceived ease of use and perceived usefulness (Davis 1989, Davis et al. 1989).

The Technology Acceptance Model (TAM) has been used in health care for many purposes and with different types of technology applications (Yarbrough & Smith 2007, Holden & Karsh 2010). It has been used in order to describe acceptance of computer technology among hospital personnel (Aggelidis & Chatzoglou 2009), telemedicine among physicians (Chau & Hu 2002, Kim et al. 2012), mobile health care systems among physicians and nurses (Wu et al. 2007), to describe adoption of social media use among physicians (McGovan et al. 2012) and medical personnel's intention to use clinical information systems (Melas et al. 2010).

Unified Theory of Use and Acceptance of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed at the beginning of the 21st century by Venkatesh and colleagues (2003). The objective of the theory is to explain user intention to use information technology and the subsequent use behaviour. Four key concepts of the theory are as follows: performance expectancy, effort expectancy, social influence and facilitating conditions. The first three are defined as the direct factors of usage intention and behaviour. The fourth is defined as the direct factor of use behaviour. Age, gender, voluntariness of use and experience are posited to decrease the impact of the four key concepts on usage intention and use behaviour. (Venkatesh et al. 2003.) The Unified Theory of Acceptance and Use of Technology (UTAUT) has been applied, for example, to analyse perceptions towards mobile services (Koivumäki et al. 2008), to study adoption of social media (Curtis et al. 2010) and to study computer use frequency (Verhoeven et al. 2010).

The Fit between Individuals, Task and Technology (FITT)

The Fit between Individuals, Task and Technology framework (The FITT framework) was established in the middle of 2010s by Ammenverth and colleagues (2006). The theory aims to analyse socio-organisational-technological factors that influence information technology adoption within the field of health care. The theory consists of three main concepts as follows: individual, technology and task. The FITT framework

postulates that information technology adoption in clinical situations depends on the optimal interaction (i.e. fit) between the characteristics of the individual users (e.g. information technology knowledge, anxiety towards a computer, motivation), technology (e.g. usability and functionality of technology) and clinical duties and processes (e.g. organisation of the tasks to be completed, complexity of tasks) (Ammenverth et al. 2006). The FITT framework has been used to explore case managers' conceptions on electronic clinical data systems (Schnall et al. 2012) and to analyse the adoption of information technology systems and eHealth services in healthcare (Tsiknakis & Kouroubali 2009).

The Behavioral Intervention Technology Model (BIT model)

The Behavioral Intervention Technology Model (BIT model) was developed by Mohr and colleagues (2014). The Behavioral Intervention Technology Model is a conceptual and technological framework for mHealth and eHealth interventions (Mohr et al. 2014, Mohr et al. 2015). It is a hybrid framework, which combines behavioural sciences (patients' behavioural principles) and technology (technological features) (Crutzen 2014, Mohr et al. 2014). The Behavioral Intervention Technology Model aims to offer information in designing and implementing behavioural intervention technologies into clinical practice (Mohr et al. 2014).

The Behavioral Intervention Technology Model answers the questions “why”, “what”, “how” (conceptual and technical) and “when”. The model includes two broad levels: 1) the theoretical action level, which reflects the intentions of the researcher or developer and 2) the instantiation level, which reflects the technological implementation (Mohr et al. 2014, Mohr et al. 2015). An illustration of the model is presented in Figure 2. (A more detailed description can be seen in Table 1.)



Figure 2. The Behavioral Intervention Technology Model (modified according to Mohr et al. 2015)

Theoretical action components consist of 1) intervention aims and 2) behavioural change strategies (Table 1). First, intervention aims refer to “why” the behavioural intervention technology exists (Mohr et al. 2014, Mohr et al. 2015). Clinical aims are defined as human changes in cognition, behaviour or motivation, and they refer to the clinical goals of the treatment or intervention. Clinical aims often include hierarchical sub-goals. Usage aims focus on maintaining user engagement with the behavioural intervention

technology offered. (Mohr et al. 2014.) Usage aims should not be mixed with clinical aims, but treated separately (Mohr et al. 2014), since they often provide early information about possible defects in intervention design and may be used as indicators for the further development of behavioural intervention technologies (Mohr et al. 2015). Clinical aims are nowadays studied by behavioural scientists and usage aims by technologists (Mohr et al. 2014), who use theories such as the Technology Acceptance Model (TAM) (Davis 1989, Davis et al. 1989) (see Paper III). Second, behaviour change strategies are the methods supporting patients in attaining their intervention aims required to achieve their treatment goal (Mohr et al. 2014). These strategies refer to “how” the behavioural intervention technology will achieve clinical and usage aims (Mohr et al. 2015).

Instantiation components consist of 1) elements, 2) characteristics and 3) workflow (Table 1). First, elements refer to “what” is offered to the patient (e.g. an individual message) (Mohr et al. 2015). Elements are the actual technical “instantiations” present in the behavioural intervention technology (Mohr et al. 2014). Second, characteristics refer to “how” elements are delivered to patients (Mohr et al. 2015). Characteristics refer to the media employed (i.e. text message), its complexity (i.e. the content of text message may be simple or more complex depending on the target population, user and the task) and personalization (ie. changing the content of the behavioural intervention technology to increase the relevance for an individual user) (Mohr et al. 2014). Third, workflow refers to “when” elements are delivered to the users (Mohr et al. 2015). Behavioural intervention technologies are developed to be delivered to users over time (Mohr et al. 2014) and designed for repeated interactions over an extended period of time (Mohr et al. 2015). Thus, the workflow specifies when elements are delivered: the timing, frequency and the length of the intervention (Mohr et al. 2014, Mohr et al. 2015). For example, user-defined workflow allows users to decide the sequence and timing of use (Mohr et al. 2015).

Table 1. Description of the levels, questions, components and examples of the Behavioral Intervention Technology Model (modified according to Mohr et al. 2014)

Level	Questions	BIT component	Examples
<i>Theoretical action components</i>	Why	Intervention aim	Clinical aims: human change in behaviour, reduction in depression symptoms Usage aims: maintenance of user engagement, use of intervention tool
	How (conceptual)	Behaviour change strategies	E.g. Motivation enhancement
<i>Instantiation components</i>	What	Elements	E.g. Text messaging, SMS
	How (technical)	Characteristics	Medium: text Complexity: simple/complex
	When	Workflow	User defined

Due to the novelty of the Behavioral Intervention Technology Model (Mohr et al. 2014) it has not been widely used yet. It has been applied, for example, in the development of smartphone applications for increasing adherence to anaphylaxis treatment (Anderson & Wallace 2015).

3. AIMS OF THE STUDY

The overall aim of the present study was to evaluate the use of text message reminders to encourage treatment adherence among people with antipsychotic medication. The study comprises four phases. The sub-goals are as follows:

1. To describe text message reminder use in health care services (Paper I)
2. To explore patient preferences in using tailored text message reminders in psychiatric care (Paper II)
3. To explore patient feedback on tailored text message reminders to encourage medication adherence and outpatient treatment among patients with antipsychotic medication and associations related to the feedback (Paper III)
4. To describe the challenges in patient recruitment and follow-up study in psychiatric care (Paper IV).

The phases of the study are described in Figure 3.

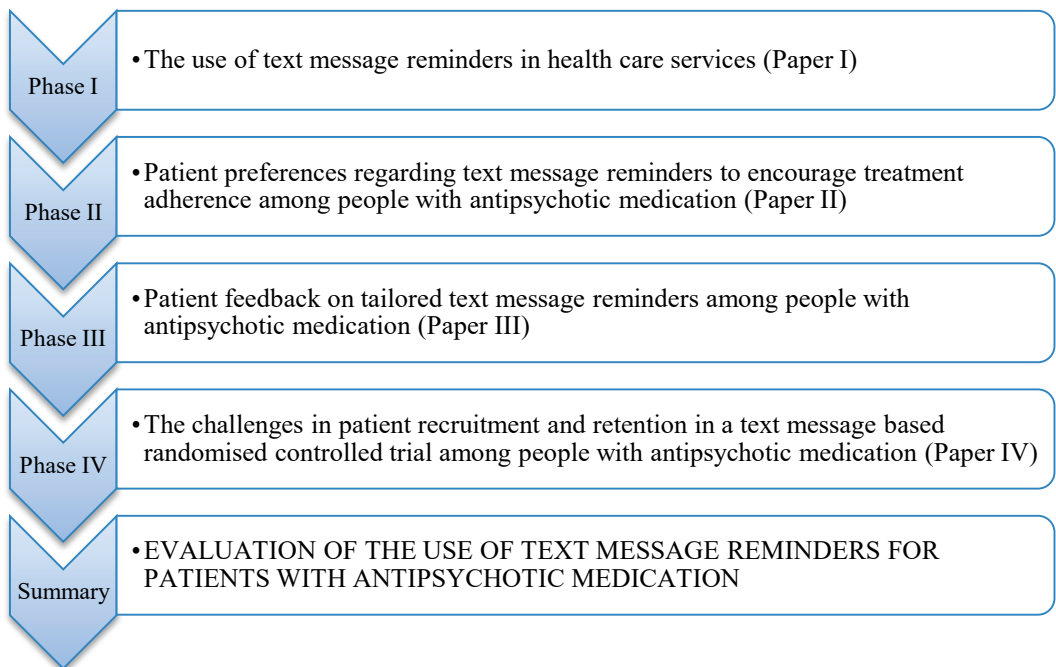


Figure 3. Phases of the study

4. MATERIALS AND METHODS

4.1 Theoretical and methodological approaches

4.1.1 Theoretical approach

The theoretical approach of this study followed the Behavioral Intervention Technology Model (BIT model) (Mohr et al. 2014) in order to characterise and evaluate text message-based intervention in psychiatric outpatient care. In the present study, behavioural intervention technology (i.e. text message reminder intervention) was used to motivate and support patients in their treatment adherence and in changing their behaviour towards a healthier life and well-being. The Behavioral Intervention Technology Model (Mohr et al. 2014) was used to summarise the results of evaluative research concerning text message-based intervention. Framework-based evaluation gives valuable information for the further implementation purposes of the intervention. Therefore, the Behavioral Intervention Technology Model (Mohr et al. 2014) was chosen as a theoretical framework for this study.

First, regarding the theoretical action components in this study (i.e. intervention aim and behavioural strategy) (Figure 4), “why” refers to the text message reminder use in health care services and asks the following: 1) For what reasons (why) have text message reminders been used in the context of health care? and 2) What are the impacts of text message reminder use? (**Phase I**). Clinical aim refers to increased treatment adherence among people with antipsychotic medication. Usage aim focuses on maintaining user engagement with the text message reminders and is evaluated through patient feedback on text message reminders after 12 months of use (**Phase III**). The behaviour change strategy in this study refers to the motivation enhancement (“how” to motivate patients to treatment adherence) (**Phase I**).

Second, in this study, the technical instantiation components are elements, characteristics and workflow (Figure 4), and represent “what” is offered to the patient, as well as “how” and “when” it is offered (Mohr et al. 2015). Motivation enhancement is delivered to patients via individual messages (what). The aim of the text message reminders (element) is to motivate and improve user ability to complete tasks, such as adhering to treatment (**Phases III and IV**). In this study, characteristics refer to the complexity or simplicity of text message reminders (how). The content of text message reminders was simple and depended on the target population and the task, and was personalised to meet the needs of the individual user. This was evaluated through patient feedback in **Phase III**. Workflow refers to “when” text message reminders (element) were delivered to the users (i.e. timing, frequency and the length of the intervention).

Participants were able to decide on the content, timing and frequency of the text message reminders to guarantee a user-defined workflow (**Phase II**).

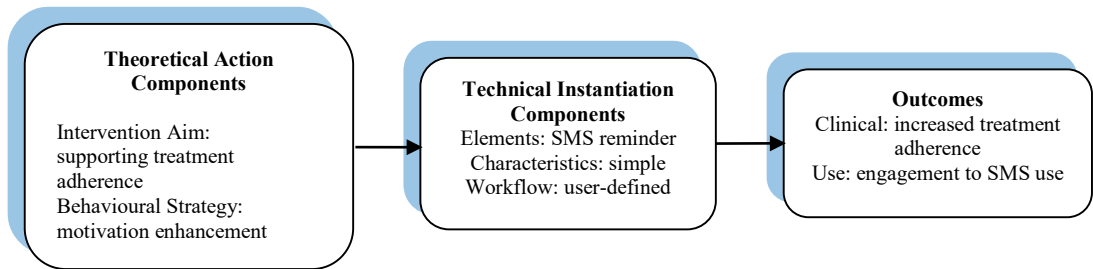


Figure 4. The Behavioral Intervention Technology Model in the context of this study (modified according to Mohr et al. 2015)

Third, the overall clinical aim of the text message reminder system in this study was to support and encourage treatment adherence and outpatient self-management among people with antipsychotic medication. Three of the sub-aims of the text message application were to promote 1) medication adherence, 2) outpatient follow-up appointment attendance, and 3) free time activities (e.g. daily activities such as maintaining hygiene, doing laundry, being physically active etc.). To achieve these goals, the major behaviour change principle used was motivation enhancement. That is, patient treatment adherence and self-management supported by 1) reminding people to take prescribed medication, 2) reminding them to attend their follow-up appointments with a nurse or doctor, and 3) promoting healthy activities during their free time.

4.1.2 Methodological approach

An evaluative methodological approach (Parahoo 2006, Gray 2014) with quantitative methods was used to systematically appraise (Parahoo 2006) the use of the text message reminder system in supporting treatment adherence among patients with antipsychotic medication. The implementation of behavioural intervention technologies, such as text message reminders, requires continuous evaluation of their actual use in clinical practice (Mohr et al. 2013b). Therefore, it is important to gain insight into the context where text message reminders have been used (Phase I), find out patient preferences (Phase II), ask for feedback (Phase III) and learn to what extent people with severe mental disorders participate in effectiveness studies (Phase IV). Intervention evaluation is an essential part of mHealth research, since the quality of mHealth interventions is linked to the improvement of health care via mHealth interventions (Ben-Zeev et al. 2015). Evaluation enables reflection and can lead to future improvements and system development (Rossi et al. 2004). According to Campbell (1997), evaluation consists of

three parts as follows: 1) planning the evaluation, 2) collecting and interpreting the data and 3) communication (preparing recommendations) (Rossi et al. 2004, Gray 2014).

In this study, the planning phase was based on international and national health policy guidelines and statistics indicating that people with severe mental disorders do not adhere to their treatment, which is harmful, not only for patients, but also for their caregivers and society as a whole. There is evidence that simple prompts, such as text message reminders, may encourage patient adherence to chronic medication in the short term (Vervloet et al. 2012), and may also boost appointment attendance (Car et al. 2012) and patient self-management (de Jongh et al. 2012). However, little is known about how the intervention might be integrated as part of outpatient care among people with severe mental disorders. Therefore, an evaluation of the text message reminder system is needed.

After the planning phase, a systematic data collection was conducted to evaluate the text message reminder system (Parahoo 2006, Gray 2014). The data sources were people with antipsychotic medication who participated in a randomised controlled trial. Methods relevant to and typical for evaluative approaches were used as follows: researching existing data bases (such as previous studies and register data) (Phases I and IV), conducting a cross-sectional survey (Phase III) and carrying out a structured analysis of a sub-sample (Phase II). The data were analysed by narrative and/or statistical methods.

Third, to communicate the evaluation results, study papers were published in scientific journals (Papers I–IV). This makes it possible to utilize the evaluation results. On the basis of the findings of this study, recommendations will be made to further develop the text message system, to stimulate the implementation of this technology in clinical practice and to guide health care managers and policymakers to support treatment adherence among people with severe mental disorders.

4.2 Design and setting

In **phase I**, a systematic literature review design with a narrative approach (CRD 2009, Grant & Booth 2009) was conducted to form a conception of text message reminder use in the context of health care (Paper I). The purpose of the literature review was to identify, sum up and consolidate the findings of previous research regarding text message reminder use in health care. This was done to identify gaps existing in the research literature and to build new research on the previous work (CRD 2009, Grant & Booth 2009) (Paper I).

In **Phase II**, an analysis of a sub-sample (e.g. Keding et al. 2015) of participants with antipsychotic medication in the Mobile.Net trial (Välimäki et al. 2012) was conducted. The analysis aimed to explore patient preferences regarding text message reminders meant to encourage patient treatment adherence, and gain an understanding of the relationship between the demographic characteristics of the participants and the text message reminders preferred. The study was conducted at 45 hospital wards in 24 organisations providing psychiatric care in Finland (Paper II).

In **Phase III**, a cross-sectional survey (Fitzpatrick & Wallace 2006) nested within a nationwide randomised clinical trial (Mobile.Net) was conducted to explore feedback on text message reminders meant to encourage treatment adherence among patients taking antipsychotic medication, as well as factors related to the feedback. A cross-sectional survey study design was chosen to describe the phenomena and the feedback (Thyer 2001) within a specific population (Polit & Beck 2012) (in this case, outpatients taking antipsychotic medication). This phase specifically focused on patients who had received text message reminders for 12 months. Therefore, this type of nested survey was chosen (Polit & Beck 2012). The study was conducted at psychiatric outpatient care facilities in Finland (Paper III).

In **Phase IV**, an evaluative design (Parahoo 2006, Gray 2014) was used to describe the patient recruitment and retention in a text message-based randomised controlled trial among people with antipsychotic medication. The study aimed to evaluate text message reminder intervention among people with antipsychotic medication. Evaluation of intervention is a key element in mHealth research (Ben-Zeev et al. 2015) and therefore, this type of design was used. The study was conducted at 45 hospital wards in 24 organisations providing psychiatric care, and at psychiatric outpatient care facilities in Finland (Paper IV).

4.3 Population and sampling

In **Phase I**, the study population in the systematic literature review consisted of research papers that focused on text message reminders within the context of health care. Studies with various methodological approaches were included, not only randomized controlled trials. A systematic sampling method was used to select certain studies and elements to be included in the literature review. The sampling method was based on predefined inclusion criteria for the literature review (Khan et al. 2003). All studies published in English, regarding the use of text message reminders sent from health care services, either manually or automatically, to patients' mobile phones, were included in the systematic literature review. Predefined inclusion criteria stemming from the research questions (Khan et al. 2003) stipulated that: 1) the study population was made up of patients of all ages with any diagnoses, 2) the intervention used was based on text message technology and 3) text

message reminders were sent directly to the patients. Studies were excluded if the reminder was sent by letter or email, if it was sent to a parent, friend or relative, or if text message reminders were used for something other than clinical purposes, such as recruiting study participants. After an explicit study selection (CRD 2009), altogether 60 studies were included in the systematic review (Paper I).

In **Phases II and III**, the study population consisted of adult outpatients with a prescription for continuous antipsychotic medication ($N = 569$). To be included in the study, a patient had to meet certain criteria. The patient had to: be 18–65 years old, be on a continuous prescription of antipsychotic medication, own a mobile phone, be able to use Finnish as a language of communication, and have been discharged from hospital into outpatient care. Patients having a planned treatment period such as respite care or forensic patients were excluded from the study. The population consisted of patients in the intervention group of the Mobile.Net trial, which means that a sub-set of data were used (see e.g. Cho et al. 2014, Keding et al. 2015). Only the intervention group of the parent study was included in these phases. Therefore, a sub-sample sampling method was used (Polit & Beck 2012, Grove et al. 2013) to randomly select participants to receive tailored text message reminders (Papers II and III).

In **Phase IV**, the study population ($N = 11530$) consisted of participants assessed for eligibility to participate in the Mobile.Net trial. All together 1139 participants were randomly selected for the trial. The sample consisted of participants who met the aforementioned inclusion criteria. Forensic patients and those having a planned non-acute treatment period were excluded from the study (Paper IV).

4.4 Data collection instruments

In **Phase I**, a specific data extraction grid, based on the CONSORT-EHEALTH checklist (Eysenbach et al. 2011), was used to collect information systematically from the studies ($n = 60$) included in the review. The data extraction grid consisted of the following information (Higgins & Green 2011): the names of the authors, the year of publication, the country where the study was conducted, the type of study, its purpose, setting, design and sample size. Additionally, it included a description of the text message-based intervention used, the goal and dose of the intervention, the outcome measurements and instruments used, and the outcomes themselves (Paper I).

In **Phase II**, a structured data collection instrument was used to measure patient preferences of text message reminders. The format of the data collection instrument was a paper booklet, containing a total amount of 85 text message reminder options. The text message reminders in the booklet were divided into three main topics as follows: 1) medication (6 messages), 2) appointments (12 messages) and 3) free time (67 messages).

The reminders did not include participants' name or information about their diagnosis. Examples of the reminders are given in Table 2. Preferred number of the reminders, timing (day of the week and time of day) and frequency were recorded in the booklet (Paper II).

Table 2. Examples of the text message reminders

Medication reminders (n = 6)	Appointment reminders (n = 12)	Free time reminders (n = 67)
Have you taken your medication – feel well	Please, remember your follow-up appointment	Get up, go out and exercise!
Please remember to take your medication	Please remember your follow-up appointment	Healthy food, better mood!
Time for medication!	You have an appointment	Night peace!

In **Phase III**, a five-item structured questionnaire based on the Technology Acceptance Model (TAM) (Davis 1989, Davis et al. 1989) was used to measure patient feedback on text message reminders. Based on a priori service user consultation (Happell & Roper 2007), the instrument was kept simple (Waltz et al. 2010) and short (Brueton et al. 2014, Land & Ross 2014), so it could be administered via telephone (Elsom et al. 2013). On the basis of TAM (Davis 1989, Davis et al. 1989), the instrument focused on four areas regarding patient feedback on the SMS reminders: satisfaction (1 item), perceived usefulness (1 item), perceived ease of use (2 items) and the intention of participants to use the text message reminder system in the future (1 item). Response options were dichotomous, “yes” or “no” (Pittman & Bakas 2010) (Paper III).

In **Phase IV**, specific monitoring sheets developed for the study was used to monitor patient recruitment and follow-up. First, recruitment monitoring sheet (based on Turku CRC 2012) was used to evaluate patient recruitment pace. The monitoring sheet included information about patients screened for eligibility (i.e. screener) as follows: the screener's initials, the last four digits of the screener's ID, admission and discharge dates, the scheduled discharge date, all inclusion criteria, whether or not the inclusion criteria were met, and information about the screener's consent or refusal to participation. Information was set to either + (plus), - (minus) or left empty, if information regarding the screener was not available. There was also empty space for additional comments regarding patient recruitment.

Second, in **Phase IV**, a follow-up monitoring sheet (based on Turku CRC 2012) was used to measure participant retention in the study and attrition level of the study. The follow-up monitoring sheet included participant follow-up information as follows: participant ID and phone number, dates for when follow-up was due, the documenting

of follow-up phone calls, mailing and receiving returned questionnaires, and information about how participants responded to the follow-up call (did they answer or not). In addition, participants' willingness to stop receiving text message reminders was recorded in a monitoring sheet, to measure intervention attrition (Paper IV).

4.5 Data collection

In **Phase I**, the following comprehensive electronic databases were used for data collection: PubMed (MEDLINE), CINAHL (Subirana et al. 2005), Proquest Databases/PsycINFO (Eady et al. 2008), Embase (Wong et al. 2006), Scopus (Falagas et al. 2008) and the Cochrane Library (Moseley et al. 2009). Search terms were based on the PICO strategy to focus on the research topic and maximise the finding of relevant publications related to the topic (Santos et al. 2007), and included both text words and MeSH terms. Electronic literature search was supplemented by a manual hand search scanning the content of JMIR journal (Higgins & Green 2011) and the reference lists of all included papers for additional publications (Khan et al. 2011). Study selection was carried out in two stages (CRD 2009). First, two authors independently screened all titles and abstracts of papers (N = 911) regarding the aim of the review. Abstracts of all relevant papers were screened for eligibility and discussed until a consensus was reached. Second, out of the included publications all full papers were obtained and screened. After the systematic study selection, we had altogether 60 publications to be extracted. The data were extracted from the included publications focusing on the research questions. The literature search was conducted on February 2013 comprising papers published between 2003 and 2013 (Paper I).

In **Phase II**, the data were collected at the time when patients were discharged from hospital in a total of 45 psychiatric wards. Patients, together with a nurse, selected the text message reminders they preferred from the text message paper booklet; they chose at least one "medication" and "appointment reminder" (both compulsory) and "free time" messages (optional). The message selection was recorded in the booklet using paper and pencil. The data were collected between September 2011 and November 2012 (Paper II).

In **Phase III**, the data were collected with a five-item structured questionnaire by telephone interview after 12 months of text message intervention (Elsom et al. 2013). A day prior to the telephone interview, the researcher sent a text message to participants informing them of the upcoming telephone interview so to allow time for participants to prepare themselves for the interview (Burke & Miller 2001, Woodall et al. 2011). During the phone call, participants were reminded of the study and its voluntary basis (Nijhawan et al. 2013). Answering the interview questions was interpreted as participants giving their consent to be included in the study (National Advisory Board on Research Ethics

2009). Participant feedback was recorded in the questionnaire by the researcher and saved later in the SPSS programme. The data were collected between September 2012 and December 2013 (Paper III).

In **Phase IV**, the data collection was twofold. First, participant recruitment data were collected at each study ward ($n = 45$) by Research Nurses, who performed chart reviews for eligibility assessment of each patient admitted to the study ward (Kim et al. 2014). Systematic tracking of each point of contact with admitted patients was conducted, and patient flow was recorded daily at the study wards. Recruitment data were collected between September 2011 and November 2012. Second, participant follow-up data collection started immediately after the recruitment period closed and continued until the 12 month follow-up period was finished. Withdrawals of recruited participants from the study and data from the 12 month follow-up were recorded, and saved first on paper sheets and afterwards using the SPSS programme. Data collection related to intervention attrition was based on participant's, relative's or Research Nurse's notification about participant's willingness to stop receiving text message reminders during the 12 month follow-up period. Follow-up data consisted of data recorded from telephone interviews, postal surveys and the Care Register for Health Care (HILMO) (National Institute for Health and Welfare 2014c). Follow-up data were collected between September 2012 and December 2013 (Paper IV).

4.6 Data analysis

In **Phase I**, the data were analysed using a narrative approach, incorporating statistical analysis (CRD 2009) to form a conception of the use of text message reminders in health care settings i.e. how the text message intervention works, why and for whom. The data were synthesised by collating, combining and summing up the findings of the individual included studies (CRD 2009). First, a clear descriptive summary of the characteristics of the included studies was constructed and the results were reported in the form of both text and tables (CRD 2009). Second, a narrative analysis was conducted instead of meta-analysis (Higgins & Green 2011), since the collected data turned out to be highly heterogeneous. Further, a statistical analysis, using frequencies, percentages and means, was carried out to calculate common outcome statistics for the studies (CRD 2009) (Paper I).

In **Phase II**, the data were analysed using descriptive and inferential statistics (Scott & Mazhindu 2005, Trochim 2006). Descriptive statistics (f , %, mean, sd) were used to reveal characteristics of the sample (Grove et al. 2013) such as demographic characteristics of the participants and their message selection (time, frequency, and the day of the week). A chi-squared test (χ^2) was used for categorical variables and independent samples, and a t test was used on continuous variables, to analyse participants' socio-demographic information and the number and timing of monthly text

message reminders selected. Inferential statistics were used to draw conclusions and inferences about the sample (Grove et al. 2013). The Poisson regression model (Lang & Secic 2006) was used to investigate associations between the patients' demographic characteristics and the number of selected text message reminders per month. Both SAS software, version 9.3 for Windows (SAS Institute Inc., Cary, NC, US) and IBM SPSS Statistics, version 21.0 for Windows (SPSS IBM Corp. 2012), were used to compute statistical analyses. P-value < 0,05 (two-tailed) was interpreted as a statistically significant difference (Lang & Secic 2006) (Paper II).

In **Phase III**, the data were analysed using both descriptive and inferential statistics (Scott & Mazhindu 2005, Trochim 2006). Descriptive statistics (*f*, %, mean, sd) were used to describe characteristics of the data (Trochim 2006) such as demographic characteristics (age, gender, marital status, vocational education, employment status, geographical region (Helsinki-Uusimaa, West Finland, South Finland, and North and East Finland), and age at first contact with psychiatric services). A chi-squared test (χ^2) for categorical variables and independent samples and a t-test for continuous variables were used to analyse demographic characteristics between those who answered the five-item survey and those who did not, and whether any selective dropout existed. Spearman correlation coefficients were used to analyse dependencies on age and age at first contact with psychiatric services. Binary logistic regression analysis (Lang & Secic 2006) was used to describe the relationship between demographic characteristics and a categorical dependent variable (fully vs. not fully satisfied). Stepwise multiple regression analyses (Lang & Secic 2006) were conducted to analyse if demographic characteristics could predict participant satisfaction with the text message reminders. This was done to build the most parsimonious prediction model (Bursac et al. 2006) using SPSS Statistics, version 21.0 for Windows. Imputation to manage missing values was not used at any stage of data analysis. P-value < 0.05 (two-tailed) was interpreted as a statistically significant difference (Lang & Secic 2006) (Paper III).

In **Phase IV**, the data were analysed using both descriptive and inferential statistics (Scott & Mazhindu 2005, Trochim 2006). Descriptive statistics (*f*, %, mean, sd) were used to reveal the basic characteristics of participants, recruitment and attrition metrics. The demographic variables examined included age, gender, marital status, vocational education, employment status, diagnosis (ICD-10; WHO 1993, National Institute for Health and Welfare 2012) and age at first contact with psychiatric services. Chi-squared tests and t-tests were used to analyse differences between patients who participated in the study and dropouts. Multiple logistic regression analysis was used in the 12-month postal survey follow-up to determine predictors of dropout.

A summary of the methodological approach of the study is presented in Table 3.

Table 3. Summary of the methodological approach of the study

Phase	Design	Setting	Sampling, sample	Instrument	Data collection	Data analysis
I	Systematic literature review	Electronic databases complemented by manual hand search	Systematic sampling	Data extraction grid	Systematic literature search	Descriptive statistics, narrative analysis
			Studies meeting inclusion criteria (n = 60)			
II	Structured analysis for a sub-sample	45 psychiatric hospital wards in 24 organisations	Sub-sample	Paper booklet containing text message options	Documentation of message selection	Descriptive statistics, Poisson regression model
			People with antipsychotic medication (n = 562)			
III	Cross-sectional survey	Psychiatric outpatient care	Sub-sample	Structured, five-item questionnaire	Telephone interview	Descriptive statistics, Chi-square test, Binary logistic regression, Stepwise multiple regression analysis
			People with antipsychotic medication (n = 558)			
IV	Evaluative design	45 psychiatric hospital wards in 24 organisations	Total sample	Recruitment monitoring sheet Follow-up monitoring sheet Register data	Systematic tracking of recruitment and follow-up Register data retrieval	Descriptive statistics, Chi-square test, Multiple logistic regression analysis
			People with antipsychotic medication (N = 11530, n = 1139)			

4.7 Ethical considerations

The main principles of research ethics (The Nuremberg Code 1949, WHO 2002, Finnish Advisory Board on Research Ethics 2009, Finnish Advisory Board on Research Integrity 2012, the WMA's Declaration of Helsinki 2013, TUKIJA 2015) and national legislation (Act on the Status and Rights of Patients 785/1992, Mental Health Act 1116/1990, Medical Research Act 488/1999, Personal Data Act 523/1999) were followed at every point (Phases I–IV) of this study, to ensure ethically sustainable research (The Finnish Advisory Board on Research Integrity 2012). Throughout the study, the researchers followed good scientific practice, a prerequisite for its ethical acceptability and plausibility and for its reliability (ETENE 2006).

During the handling of data, the researchers carried out all necessary technical and organisational actions to protect personal data so that no unauthorised individuals would have access to the data (Personal Data Act 523/1999). Participant privacy and confidentiality was guaranteed during the data collection and recording (Personal Data Act 523/1999) by handling the data anonymously (Finnish Advisory Board on Research Ethics 2009) by assigning a personal identification number (ID number) to each participant (NIH 2004). All data and memory sticks where the data were saved were stored properly (Archives Act 831/1994); the data were kept in a locked filing cabinet in a locked room which was accessible only to researchers. Data were handled only with computers protected with a password (The Research Ethics Guidebook 2015). Data were stored according to the law (Personal Data Act 523/1999). Results were reported in a respectful way (anonymously) without identification of individual participants (Finnish Advisory Board on Research Ethics 2009). Throughout the study, researchers maintained professional secrecy (Medical Research Act 488/1999, Personal Data Act 523/1999), following the principles of integrity, accuracy and meticulousness, without fabrication, falsification or misappropriation (Finnish Advisory Board on Research Integrity 2012) (Phases I–IV).

In **Phase I**, the process of the systematic literature review was planned, conducted and reported following the aforementioned principles of integrity, accuracy and meticulousness (Finnish Advisory Board on Research Integrity 2012). Publications included in the literature review were objectively analysed (Vergnes et al. 2010), and the authors of original publications were respected by citing their studies accurately, correctly, without plagiarism or falsification of their results (Wager & Wiffen 2011, Amos 2014).

This dissertation research is part of the Mobile.Net trial (Mobile.Net, ISRCTN: 27704027; Välimäki et al. 2012), which obtained a favourable ethical comment from the Ethics Committee of the Hospital District of Southwest Finland (ETMK 109/180/2010).

Permissions for the research were obtained from each study site (n=24). Informed consent was obtained from all participants (Phases II–III). In addition, in Phase IV, permission from the National Institute for Health and Welfare was obtained for the registry data retrieval.

In **Phase II**, participants agreed to receive text message reminders and reminders were sent to an established phone number (Finnish Data Protection Ombudsman 2010). Participant autonomy was respected (Beauchamp & Childress 2009) by giving each participant the possibility to totally decline to use the mobile phone technology (ETENE 2010). The participants were allowed to stop receiving text messages whenever they wanted (Medical Research Act 488/1999, the WMA Declaration of Helsinki 2013), and they had the right to refuse participation in the study or withdraw from the study whenever they wanted without any consequences (Finnish Advisory Board on Research Ethics 2009, the WMA Declaration of Helsinki 2013). Text message reminders did not include any information which led to the identification of participants, neither did they include information about participants' illnesses, to protect participant safety and privacy (Personal Data Act 523/1999). By sending text message reminders to the participants automatically through the electronic semi-automatic system, it was guaranteed that the administration of mobile phone numbers was systematic, justified and careful (Finnish Data Protection Ombudsman 2010).

In **Phase III**, participants were informed about the study, its purposes, methods and expected benefits both orally and written before the telephone interview and during the telephone interview, making sure participants had understood the information given. Participants had already given their written informed consent, and in this sub-study, their assent to the telephone interview or response to a questionnaire was interpreted as informed consent (Finnish Advisory Board on Research Ethics 2009). Telephone interviews were conducted with a phone specifically intended for interviews and kept locked, accessible only to researchers (Branson et al. 2013). Participant privacy during the telephone interview was ensured (Mealer & Jones 2014) by securing the identity of each patient, i.e. asking his name and address, and by making sure that the patient knew for what reason he was telephoned. In connection with the telephone interview the human dignity of all participants was respected (ANA 2015) by carrying out the interviews in a kind and encouraging tone (Waltz et al. 2010), since fears and suspicion towards the study or researchers, worries about the preservation of the confidentiality or fear of stigmatisation could have prevented patients from participating in the study (Woodal et al. 2010).

In **Phase IV**, participation based on voluntariness and informed consent was guaranteed to respect participants' self-determination and autonomy (Beauchamp & Childress 2009,

ANA 2015). Mentally ill patients were defined as vulnerable participants (OEC 2015), not only in regards to health status (Schrems 2014), but also because of the research context, i.e. they had been discharged from hospital into outpatient care (Gjengedal et al. 2013). Given this, ethically sustainable principles were followed during the process in which informed consent was obtained (Schrems 2014). It was important to study this vulnerable patient group, since exclusion of them from research would have disadvantaged them by not taking their needs into account (Schrems 2014). Furthermore, this would have violated the ethical principles of beneficence and justice (Beauchamp & Childress 2009, Schrems 2014). It was important to examine these patients in a vulnerable position, since the study was considered to utilise patients on antipsychotic medication (Roberts et al. 2001, ANA 2015), and it was assumed that the gathered knowledge would be useful in developing methods to implement in everyday health care. Research ethics concerning the use of Finnish national registers in research is regulated by the Personal Data Act (523/1999) and the Act on the Openness of Government Activities (621/1999).

5. RESULTS

5.1 Characteristics of study participants

The characteristics of the study participants in **Phases II–IV** are described in detail in Table 4. Study participants consisted of the participants from the Mobile.Net trial (Välimäki et al. 2012). Information of participants' diagnoses (F00–F99) is described in Table 5. About 70% of participants had a diagnosis of schizophrenia, schizotypal and delusional disorders (F20–F29) or mood (affective) disorders (F30–F39), other were minor.

Table 4. Characteristics of study participants in Phases II, III and IV

Demographic characteristics, mean (SD) or n (%)	Phase II N = 562		Phase III N = 558		Phase IV N = 1139			
	n		n		n	Intervention n = 569	n	Control n = 570
Age	562	38,6 (12,7)	558	38,5 (12,7)	569	38,5 (12,7)	569	38,0 (12,4)
Gender	562		558		569		570	
Male		267 (47)		266 (47)		268 (47)		292 (51)
Marital status	558		554		565		569	
Single		274 (49)		273 (49)		277 (49)		309 (54)
Others		284 (51)		281 (51)		288 (51)		260 (46)
Vocational education	554		550		561		564	
None		174 (31)		173 (31)		177 (31)		172 (30)
Primary vocational skill certificate		89 (16)		89 (16)		161 (29)		162 (29)
Others		291 (53)		288 (53)		223 (40)		230 (41)
Employment status	553		549		560		561	
Employed		106 (19)		105 (19)		108 (19)		99 (18)
Retired		266 (47)		263 (47)		269 (48)		277 (49)
Others		181 (34)		181 (34)		183 (33)		185 (33)
Age at first contact with psychiatric services	555	27,4 (11,7)	551	27,4 (11,7)	562	27,4 (11,7)	560	26,9 (11,4)

Table 5. Diagnoses (F00–F99) of study participants in Phases II, III and IV

Diagnosis (ICD-10), n (%)	Phase II N = 562	Phase III N = 558	Phase IV N = 1139	
			Intervention n = 569	Control n = 570
Schizophrenia, schizotypal and delusional disorders (F20-F29)	210 (37)	210 (38)	212 (37)	209 (36)
Mood [affective] disorders (F30-F39)	158 (28)	155 (28)	163 (29)	163 (29)
Disorders of adult personality and behaviour (F60-F69)	70 (12)	70 (12)	71 (12)	63 (11)
Others	124 (22)	123 (20)	123 (22)	135 (24)

5.2 The use of text message reminders in health care services

It was found that text message reminders were widely used in different health care contexts, mostly in outpatient care, and among a variety of patient groups, patients with HIV/AIDS (15%), diabetes (13%) and asthma (8%) being the three most popular patient groups. Six studies focused on patients with mental health disorders: four studies (7%) focus on patients with schizophrenia and two studies (3%) on patients at mental health clinics. The sample size (4–9959 participants) of the studies was found to vary dramatically (Paper I, Multimedia Appendix 2).

The use of text message reminders targeted to the improvement of patient treatment adherence (either medication or other treatment) and the increase in clinical appointment attendance. This was done either by using text message reminder as a single intervention or combining the reminders with another health intervention system (e.g. supportive text messages). The dose, frequency and timing of the text message reminders were found to vary, depending on the purpose of the reminders or depending on patient preferences or personal needs. Most commonly (in 35% of the studies) the text message reminders were sent daily. Reminders were sent once or several times per day and, in 22% of the studies, they were sent in morning hours (Paper I, Multimedia Appendix 2).

The use of text message reminders had impacts on treatment adherence, appointment attendance or non-attendance and patient satisfaction. Impacts were assessed with multiple methods, such as existing databases, questionnaires, physiological measures or electronic monitoring. Treatment adherence, appointment attendance and patient satisfaction were reported to improve in three-quarters (77%) of the studies. At the same time, treatment discontinuations and missed medication doses decreased and patients' attitudes towards medication improved. Patients were satisfied with the text message reminders; they were regarded as useful, easy to use and acceptable. Text message reminders were reported to have advantages over other reminding systems. This was due

to their cost-effectiveness, ubiquity, simultaneous delivery and reduced numbers of health care personnel required, compared to other methods. However, text message reminders neither increased appointment attendance at orthodontic or diabetes clinics nor improved adherence to acne or lupus erythematosus treatment or contraceptive pill use. Despite the beneficial characteristics of text message reminders, some limitations for their use in health care settings came up, such as privacy concerns (e.g. lost mobile phones, the possibility of someone other than the intended recipient reading personal messages), technical problems (e.g. changed mobile phone numbers, undelivered messages) and adaptation to the reminders (e.g. a patient who quit reading the reminders) (Paper I).

5.3 Patients' preferences regarding text message reminders in encouraging patient treatment adherence

Participants ($n = 562$) taking antipsychotic medication selected, on average, 10 text message reminders per month (range 2–25) from the three message categories offered (medication, appointment and free time). Patients preferred text messages with slightly humorous content (Figure 1 in Paper II). They also preferred to receive text message reminders at the beginning of the week (Monday and Tuesday) and in the mornings (6am–12pm) (Paper II).

Participant preferences considering the amount and timing of the text message reminders (on the monthly level) were related to their sociodemographic characteristics (two factor interactions were detected) (Table 6) (Paper II). Participant preferences (statistically significant) are presented as up (↑) or down (↓) arrows, indicating the preferred amount of text message messages. For example, older men preferred fewer messages [arrow down (↓)] than older women [arrow up (↑)].

Table 6. Summary of associations between the sociodemographic characteristics of patients and their preferred text message reminders

Type of preference	Participants	Preference	Participants	Preference
Number of preferred reminders	Older women	↑	Older men	↓
	Older men at first contact with psychiatric services	↑	Older women at first contact with psychiatric services	↓
	Younger married, widowed, and divorced	↑	Older married, widowed, and divorced	↓
	Older single	↑	Younger single	↓
	Older married, widowed, and divorced at first contact with psychiatric services	↑	Older the single came at first contact with psychiatric services	↓
Number of preferred morning reminders	Older	↑	Younger	↓
	Younger at first contact with psychiatric services	↑	Older at first contact with psychiatric services	↓
Preferred afternoon reminders	Single	↑	Married, widowed, and divorced	↓

↑ = Participant preferred more messages compared to others

↓ = Participant preferred fewer messages compared to others

Preferences regarding the amount, timing or content of the text message reminders changed a little over time. Around 6% of the patients (33/562) were not satisfied with the timing or content of the text message reminders and wanted to stop or change specific messages. Incorrect text message reminders were entered into the semiautomatic system in 98 cases. Reasons for stopping to receive text message reminders during the study included, for example, that the patient felt the reminders were not useful anymore due to improved health conditions or that the messages were annoying. Of the 562 participants, 4% (n = 23) wished to stop receiving text messages during the study period (Paper II).

5.4 Patient feedback on text message reminders

A total of 403 participants (N = 558) with antipsychotic medication gave feedback on text message reminders after 12 months of intervention. Of these participants, 72% reported that they were satisfied with the intervention. They found the reminders easy to

use (98%), harmless (87%) and useful (61%), and further, 64% were willing to receive text message reminders in the future. Fewer than 10% of participants expressed their satisfaction with the intervention at the beginning of the study, but their satisfaction decreased over the course of the trial (Table 2 in Paper III).

Nearly half (46%) gave 100% positive feedback on text message reminders, and it was interpreted that these participants were ‘fully satisfied’. A total of 51 participants (69% female), expressed that the text message reminders caused them harm (e.g. irritation, disturbance). These participants were around 40 years old, single (47%) and retired (55%). Participants who did not give their feedback on text message reminders significantly differed in their demographics ($p < 0.05$) from those who gave feedback; those who did not give feedback were younger, were most often male, had no vocational education, and were younger at the time of first contact with psychiatric services (Paper III).

Also, of the participants who gave feedback, statistically significant associations between their sociodemographic characteristics and their feedback on text message reminders were found. Divorced participants found the reminders useful more often than participants in other marital status groups ($\chi^2 = 13.2, p = 0.040$), and women were more often of the opinion that text message reminders caused harm, when compared to men (16% vs. 9%, $\chi^2 = 4.0, p = 0.045$). Job seekers ($\chi^2 = 10.8, p = 0.029$), and participants recruited in hospitals located in Western Finland ($p = 0.048$) were more often fully satisfied with text message reminders than patients in other sociodemographic groups. The age of participants at first contact with psychiatric services was found to be a statistically significant ($p = 0.007$) predictor of patient satisfaction with text message reminders (OR = 1.02, 95% confidence interval 1.01 to 1.04). The older people were, the more often they were fully satisfied (Paper III).

5.5 Patient recruitment and retention in a text message-based trial

Patient recruitment was structurally mapped and evaluated. A total amount of 11 530 screeners were completed during the 15 month recruitment period. Of the candidates who completed a screener, 36% were eligible ($n = 4184$). Consent was requested from 3417 eligible participants, and 2278 of those individuals refused to participate in the study at that point of contact in the psychiatric ward, meaning there was a refusal rate of 67%. After the screening, eligibility assessment and refusals, a total of 1139 participants (27%) gave consent, were enrolled and then randomised (Figure 1 in Paper IV). The average recruitment speed was 76 participants per month and 2,5 participants per day (Paper IV).

Participant retention was evaluated through intervention attrition (i.e. treatment attrition) and follow-up attrition (i.e. measurement attrition). The results were presented as dropout rates (Table 7) (Paper IV).

Table 7. Dropout rates of intervention and follow-up attrition

Dropout rate, n (%)	Intervention attrition	Follow-up attrition			
	SMS ¹ intervention (n = 563)	Telephone interview (n = 558)	Withdrew from follow-up (n = 1123)	Postal survey (n = 1123)	Register data (n = 1123)
Total	27 (4,8)	155 (28)	35 (3)	589 (52)	4 (0,4)
Intervention group	27 (4,8)	155 (28)	31 (5,5)	294 (52)	0 (0)
Control group	N/A ²	N/A	4 (0,7)	295 (53)	4 (0,4)

¹SMS = Short Message Service (text message)

²N/A = not available

Demographic characteristics were associated with who was likely to be recruited and also who dropped out. First, non-eligible patients were older (43,7 vs. 39,2 $p < 0.001$) and more often male (56% vs. 44% $p < 0.001$) than eligible patients. Patients, who refused to participate, were older than patients who consented (40,2 vs. 38,3 $p = 0.001$). Second, participants who dropped out ($n = 27$) from the text message-based intervention were more often female ($n = 21$) than male ($n = 6$) (78% vs. 22%, $p = 0.009$). Third, younger, male, participants with no vocational education as well as those who were younger at the time of contacting psychiatric services for the first time were detected as statistically significant differences related to dropping out from the telephone interviews (for more details, see Papers III and IV). Fourth, participants who left the study early were more often female than male (77% vs. 23% $p = 0.002$). Fifth, demographic characteristics (age, gender, marital status, vocational education, employment status, diagnosis and age of first contact) were also detected as being statistically significant regarding dropping out from the postal survey (see more detailed: Table 3 in Paper IV). Finally, the register data of 4 participants out of 1123 (0,4%) could not be retrieved. Due to the small number of dropouts ($n = 4$) in the register data any statistical calculations between participants and dropouts could not be performed (Paper IV).

According to the logistic regression analyses, the participants with the following characteristics were detected as having a higher risk to not participate in the postal survey: older, female, having no or only primary vocational education, and being retired. Differences were statistically significant ($p < 0.05$) (Paper IV).

5.6 Summary of results related to the Behavioral Intervention Technology Model (BIT model)

The Behavioral Intervention Technology Model (BIT model) answers the questions “why”, “how”, “what” and “when” (Mohr et al. 2014, Mohr et al. 2015), aiming to

characterise behavioural intervention technology interventions (Mohr et al. 2014). First, the question “why” was answered in Phases I, III and IV. Based on the literature review, the clinical aim of the included studies were to describe the use of text message reminders in the context of health care (Phase I). Usage aims were evaluated with the patient feedback on text message reminders (Phase III) and by evaluating attrition and retention in a text message-based trial and intervention (Phase IV). In Phases II–IV the clinical aim was to support treatment adherence among people with antipsychotic medication. Second, the question “how” was answered in Phase I, which aimed to describe the use of text message reminders. Third, the questions “what”, “how” and “when” were answered in Phases II and III. Patient feedback reflected on the elements and characteristics of text message reminders (Phase III), and patient preferences encompassed the workflow of the text message reminders (Phase IV). Finally, clinical outcomes will be assessed later with a randomised controlled trial. A summary of the BIT model (Mohr et al. 2014) in the study context is described in Table 8.

Table 8. Summary of the Behavioral Intervention Technology Model (Mohr et al. 2014) in the study context

Level	Questions	BIT component	BIT model in the study context
<i>Theoretical</i>	Why	Aim	Clinical aim: to support treatment adherence among patients with antipsychotic medication → For what purposes have SMS reminders been used? (Paper I) Usage aims: maintenance of user engagement, use of intervention tool → Patient feedback on SMS reminder use (Paper III) and retention vs. attrition (Paper IV)
	How (conceptual)	Behaviour change strategies	Motivation enhancement → For what purposes have SMS reminders been used? (Paper I)
<i>Instantiation</i>	What	Elements	Text messaging, SMS → patient feedback on SMS reminder use (Paper III) and retention vs. attrition (Paper IV)
	How (technical)	Characteristics	Medium: text, Complexity: simple → patient feedback on SMS reminder use (Paper III)
	When	Workflow	User defined → patient preferences regarding amount, timing and frequency of SMS reminders (Paper II) and retention vs. attrition (Paper IV)

Detailed description of study results related to the Behavioral Intervention Technology Model (Mohr et al. 2014) are presented in Figure 5.

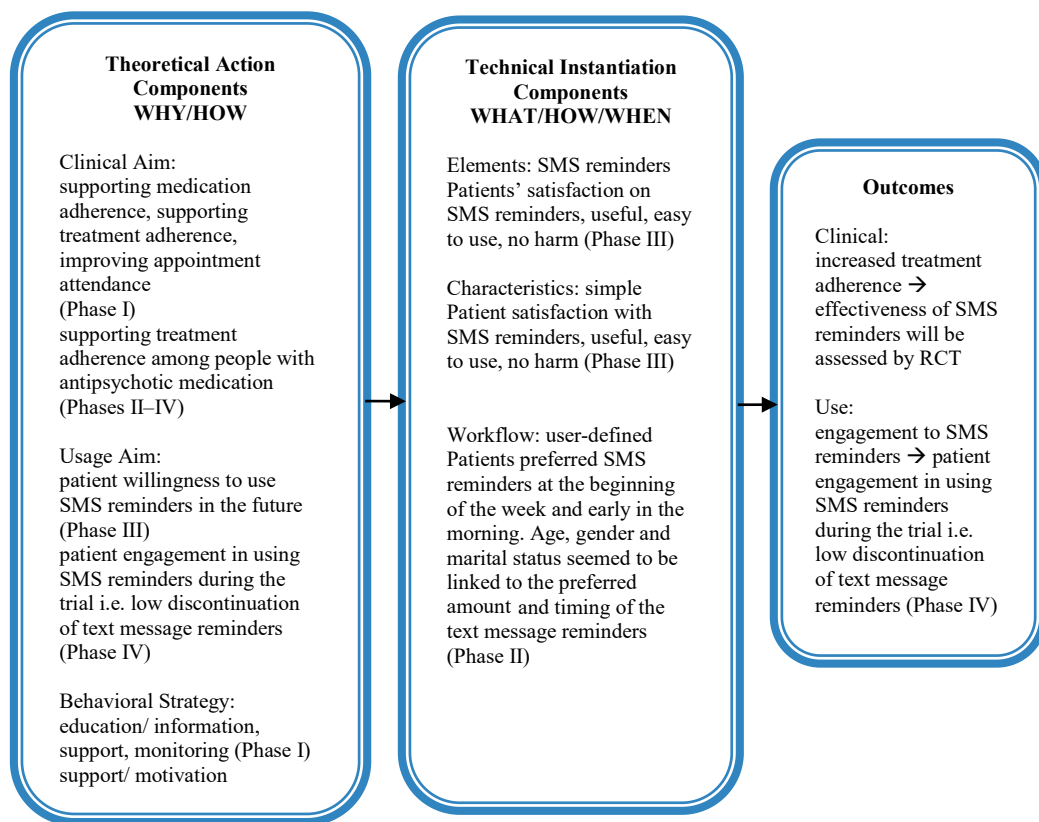


Figure 5. Description of study results related to the Behavioral Intervention Technology Model (modified according to Mohr et al. 2015)

6. DISCUSSION

6.1 Validity and reliability of the study

Validity and reliability of each study phase (Phases I–IV, respectively) are discussed on the basis of the research methods used.

In **Phase I**, the validity and reliability of the systematic literature review was critically appraised according to the criteria posed by Booth and colleagues (2012). These criteria focused on external validity of the systematic literature review, internal validity and reliability of the methods used. External validity of the literature review is defined as generalisability of the results in other participants or settings. Internal validity, on the other hand, is defined as the degree to which the literature review is conducted to prevent bias (Booth et al. 2012). Internal validity was further divided into four key areas concerning review questions, literature search, inclusion and exclusion criteria and the methodological quality of the studies included in the review (Thompson et al. 2012). Reliability of the literature review encompasses the trustworthiness of the literature review (Booth et al. 2012).

External validity of the systematic literature review was critically appraised for the generalisability of the results (Booth et al. 2012). Inclusion criteria were not limited to a specific patient group, which may not have provided a deep understanding of the use of text message reminders among a particular patient group, but rather gives general knowledge of various contexts in health care. Studies related to, for example, patients in psychiatric care were found, but they were scarce. Given this, more specific knowledge is needed regarding people with severe mental disorders. Moreover, based on the present literature review, firm conclusions cannot be drawn and strong recommendations for clinical practice cannot be made. However, the literature review formed a perception of text message reminder use in the context of health care, and therefore, the selection of this design can be justified.

Internal validity of the systematic literature review was critically appraised using four key areas that are used to determine the existence of bias (Thompson et al. 2012). First, the review questions were set up based on the PICO strategy to delineate the literature search (Santos et al. 2007, Schardt et al. 2007), which increased the internal validity of the review. However, the search terms were set to focus only on text messages and reminders or reminding systems, instead of using the whole PICO strategy. It is possible, that search terms were too wide, restraining the literature search to focus on relevant literature. On the other hand, the literature search was not purposely limited to a specific patient group in order to form a comprehensive conception of its use in health care.

Second, a comprehensive literature search from six relevant electronic databases supplemented by a manual hand search was conducted to find all relevant studies concerning the use of text message reminders in health care. However, there were no attempts to contact any experts on text message reminders to inquire about any unpublished research. It is possible, that relevant data regarding the use of text message reminders was missed. In addition, the literature search was restricted to English language studies only, which may have limited our study findings and biased the interpretation of results (Egger et al. 1997). On the other hand, contradictory results have also been revealed regarding English language restriction, stating that language restriction does not cause systematic bias on systematic reviews (Morrison et al. 2012). In this light, we are reluctant to consider language restriction to have decreased the internal validity of the systematic review.

Third, inclusion and exclusion criteria were defined a priori on the basis of the research questions. Inclusion criteria were not specified to a particular study design, patient group or diagnosis group, leading to heterogeneity of the included studies, which further decreased internal validity of the literature review (Harris et al. 2014). However, more specified inclusion criteria would not have met the review questions posed and would have restricted study findings to a specific patient group, which was not the aim of the review. Finally, to further improve internal validity of the systematic literature review, the methodological quality of the included studies was appraised using the Mixed Method Appraisal Tool (MMAT) by Pluye et al. 2011. The MMAT appraisal tool was chosen since it was designed for the quality appraisal of both qualitative and quantitative studies and confirmed to be an efficient appraisal tool (Souto et al. 2015). Studies were not excluded on the basis of the quality appraisal, so the quality of included studies varied. Given this, it was difficult to synthesise results of included studies and draw firm conclusions. This may have biased our findings (Khan et al. 2011).

Reliability of the systematic literature review was critically appraised in order to describe the trustworthiness of the results (Booth et al. 2012). First, the literature review process was conducted systematically and was reported in detail to be reproducible, thus increasing the reliability of the literature review (Figure 1 in Paper I). Second, the study selection was based on the independent assessment of two separate authors, but data extraction was done by only one author. This may impacted results and decreased the reliability of the review. On the other hand, the CONSORT-EHEALTH checklist (Eysenbach et al. 2011) was used to improve consistency of the data extraction, further improve reliability (CRD 2009). However, all items of the checklist were not usable among all included studies, since studies other than randomised controlled trials were also included. Third, heterogeneity of the included studies (related to study design, population, sample size, intervention description and outcomes measured) made the data

synthesis challenging. No statistical methods were used (Shamseer et al. 2015). This may have decreased the reliability of the review. Therefore, a narrative approach was justified and chosen over a meta-analysis (CRD 2009).

In **Phase II**, validity and reliability of the structured analysis of a sub-sample were considered through a list of criteria posed by Peat et al. (2002) (also e.g. Pittman & Bakas 2010, Polit & Beck 2012). These criteria included external validity of the study results, internal validity of the study and reliability of the methods used.

First, external validity of study results was subjectively assessed regarding the sample, which included a variety of people with antipsychotic medication (not only people with schizophrenia). Participants chose their text message reminders with a nurse in the psychiatric hospital at the time of their discharge process. It is significant to remember that the locations where participants chose their text messages, i.e. the various hospitals participating in the study, may have differed from each other (e.g. in how personnel related to patients), which may have threatened the external validity of the study. The study was conducted at 45 hospital wards in 24 organisations providing psychiatric care in Finland in the hopes that bias due to location would be minimal. Even so, a degree of caution is necessary when generalizing the results of people in psychiatric outpatient care, since the message selection occurred in hospital and people with severe mental disorders tend to be inconsistent with their preferences over time (Gard et al. 2011). This was taken into account, and patients' requests for changes regarding the text messages were analysed. According to the results, the changes were minor, which did not confirm the statement about the participants' inconsistent preferences. This can further be interpreted as strengthening the external validity of the results. Participant preferences do not shed light on long term use of text message reminders, and therefore, it is important to study participant feedback on using the reminders.

Second, internal validity of the data collection instrument (i.e. the paper booklet consisting of text message options) used to analyse patient preferences was assessed, since it is important to estimate the extent to which the data collection instrument fulfills its objective to collect accurate data (Peat et al. 2002). Due to a lack of existing text message reminder interventions intended for people with severe mental disorders in Finland, a specific text message selection was developed. The development of text message items (e.g. content of the messages) in the paper booklet was based on an expert review, which included patients, members of the research group and health care personnel (face validity). The adequacy of text message items was improved based on previous literature relating to factors affecting patient treatment adherence and their need for support in daily activities (content validity). This improved the internal validity of the instrument. However, no statistical measurements were used to assess the validity of

the instrument (Peat et al. 2002). Items related to medication and follow-up appointments were compulsory, restricting participants' text message selection. At the same time, free-time messages were optional. This may have skewed the results regarding patient preferences and restricted interpretation of the results. Preferences were analysed on the basis of 562 ($N = 569$) participants, which represents 99% of the total sample.

Third, reliability (also known as repeatability) of the instrument used was reviewed. The paper booklet was standardised, and items were the same for all participants. Each participant's text message selection was documented in the booklet. This improved accuracy and repeatability of the instrument. Research Nurses who assisted participants with the text message selection were trained beforehand to avoid response bias and to increase the reliability of the instrument. Given this, the equivalence of the instrument at the various locations was guaranteed and allowed for reliable results despite the multicentred nature of the study (interrater reliability) (Pittman & Bakas 2010).

In **Phase III**, validity and reliability of the cross-sectional survey were evaluated based on criteria described by Peat et al. (2002) (also e.g. Pittman & Bakas 2010, Polit & Beck 2012). These criteria included the external validity of the study results, the internal validity of the study and the reliability of the methods used.

First, the external validity of the study results was subjectively judged regarding a sample consisting of a variety of people with antipsychotic medication (not only people with schizophrenia) in various locations across the country. This may have extended the generalisability of the result to apply to people treated in psychiatric outpatient care in Finland. A degree of caution is necessary, since men (44%) were slightly under-represented in this study, when compared with the statistics, which state that the proportion of men was 53% of those on antipsychotic medication, in 2013 (National Institute for Health and Welfare 2015). However, the generalisability of the study results is further confirmed when considering the distribution of the participants' age, marital statuses, education, and employment situations, which can be seen as similar to those of Perälä et al. (2008). On the other hand, 28% of the participants did not give feedback on the text message reminders, and, statistically, they differed significantly ($p = 0.05$) from those who gave their feedback (Table 1 in Paper III). Given this, the generalisability of study results is diminished, since we do not know why these people did not give feedback. It is possible that they were not interested, motivated or capable of using mobile technology. This may even harm the perception that people with severe mental disorders are confident in using mobile technology (Ennis et al. 2012).

Second, the internal validity of the study was reviewed regarding its measurements and methods, since the robustness and soundness of the study depend on the quality of the

data collection (Peat et al. 2002, Pittman & Bakas 2010). A self-developed five-item questionnaire was used instead of a previously validated instrument, which may have decreased the internal validity of the study (Grove et al. 2013). However, we tried to improve the internal validity by: 1) having the appearance of the set of items (e.g. wording) in the instrument approved by an expert review board, which consisted of members of the research group (face validity); 2) improving the adequacy of the items (content validity) by basing the questionnaire on the Technology Acceptance Model (TAM) (Davis 1989, Davis et al. 1989) and on the basis of an expert review and a priori service user consultation. Despite these improvements no statistical measurements were used to assess the validity of the instrument. It is notable that an already existing instrument (e.g. System Usability Scale [SUS]) by Brooke 1986) could have been selected. Despite this, the self-developed instrument ended up being used in order to keep the data collection simple and appropriate for the target population, keeping in mind the impact of this decision on the internal validity of the study. Study results regarding participant feedback on text message reminders are consistent with the previous literature, indicating that the instrument measured what it was expected to measure (Peat et al. 2002). This is an important point in justifying the use of this subjective self-developed measurement tool. Due to the 12 month study period, it is difficult to assess the impact of extraneous variables (Flannelly et al. 2014), but considering the study results, it may be assumed that patient responses were not biased due to misunderstanding the questionnaire items or maturation, for example.

Third, to determine the reliability of the study, its methods i.e. the precision of the survey questionnaire, were reviewed. The questionnaire was standardised (Boynton & Greenhalgh 2004) so that the questions were the same for everybody. Items were posed logically in the same order for all participants, and a predefined interview protocol was followed to avoid response bias. This made it possible for the members of the research group to get consistent measurement results during telephone interviews (interrater reliability) (Pittman & Bakas 2010). A Kuder-Richardson 20 (KR-20) coefficient value of 0,68 indicated the internal consistency of the instrument (minimally acceptable according to DeVellis 2012). According to this, the selection of more accurate and previously validated instrument would have improved the reliability and validity of the study, and further enhanced the objectivity of the study results (Pittman & Bakas 2010).

In **Phase IV**, criteria described by Gray (2014) were used to assess the validity and reliability of the evaluative design. These criteria included validity, reliability and objectivity. Gray (2014) defines validity as the extent to which data are credible and accurate. Reliability is defined as the intensity to which the data collection instrument

gives identical results at different points in time. Objectivity is defined as the credibility of the evaluator and the degree to which justice is addressed (Gray 2014).

First, the validity of the evaluative study was assessed based on the research instruments used, since they must measure what they are intended to measure (Gray 2014). The recruitment and follow-up monitoring sheets were developed based on Turku CRC (2012) guidelines to improve the validity of the study. The research group assessed the face validity of the monitoring sheets, and made corrections if needed. Face validity of an instrument is often considered to be the weakest form of validity (Grove et al. 2013). However, in evaluative studies it may have some value, since it may help people responsible for implementing evaluation results to have confidence in the evaluation measurement and results (Gray 2014). Therefore, existing guidelines were used in the development of the monitoring sheets. Predictive validity is understood as the degree to which the evaluation findings are able to predict impacts of a certain programme on participant performance (Gray 2014). In the present study, patient recruitment and follow-up was evaluated to gain knowledge about challenges and characteristics of participants that affected who would likely drop out and who would stay in the trial. This knowledge can be important considering future implementation of text message reminders as part of mental health care in Finland. However, no data about the participants' skills in using mobile phones or text message reminders were gathered. This may hamper the predictability of text message reminders use in the future.

Second, the reliability of the evaluative design was assessed through research instruments used (Gray 2014), i.e. recruitment and follow-up monitoring sheets and register data. Recruitment and follow-up monitoring sheets were developed based on Turku CRC (2012) guidelines to improve reliability of the study. Research Nurses at each study ward were instructed how to fill recruitment monitoring sheets in order to improve consistency between Research Nurses within wards and between organisations (interrater reliability) (Pittman & Bakas 2010). It is possible that all Research Nurses were not motivated to recruit participants, since, for example, consent was not asked from 18% (769/7186) of possible participants. There were also differences between study sites. This is surprising, since monitoring calls were made regularly to motivate research nurses to recruit patients and to find out if any difficulties related to recruitment existed in the wards. Moreover, this is concerning, since a substantial proportion of possible participants were not given the chance to participate, and this may have biased the results. Similarly, research staff was trained to fill in follow-up monitoring sheets to improve the reliability of the study. The reliability assessment of the register data is based on previous literature, which suggests that the accuracy and completeness of the register varies from satisfactory to very good (Sund 2012). Only 0,4% (4/1123) of the

participants' data was not found from the register due to possible mistakes in documenting social security numbers.

Third, the objectivity of the evaluation was assessed by the evaluator herself (Gray 2014). Data collection instruments based on guidelines (Turku CRC 2012) and a national register were used so as to keep the evaluation as credible as possible. However, no external consultants were used during the evaluation process.

6.2 Discussion of the main findings

6.2.1 The use of text message reminders in health care services

We found that text message reminders are widely used in various health care settings to improve patient medication adherence and to reduce clinical appointment attendance. This finding is in line with the previous literature, in which mobile technologies are seen to be an important platform for delivering health interventions (Klasnja & Pratt 2012, Ben-Zeev et al. 2013). Moreover, the literature review showed that text message reminders are useful, easy to use, and that patients are generally satisfied with the reminders and willing to receive the reminders in the future. This is consistent with previous studies, where text messages are considered as a flexible and acceptable intervention method (Klasnja & Pratt 2012). However, concerns related to patient privacy were reported. Similar concerns have been expressed in previous studies (e.g. da Costa et al. 2010, Branson et al. 2013). This may restrict the wider implementation of text message reminders in health care in the future. Given this, it is essential to keep the content of the text message reminders neutral and anonymous in order to protect patients' privacy and avoid stigmatisation. On the other hand, it has been stated that it is safe to use text messages in health care (Finnish Data Protection Ombudsman 2010), which encourages the findings of this literature review. Moreover, findings of the literature review highlight the use of text message reminders among multiple patient groups, for example, among patients with schizophrenia. However, studies related to this patient group were not so common.

Text message reminder use was detected to have overall positive impacts on medication adherence and appointment attendance, although a meta-analysis was not conducted in the literature review. Previous literature reviews are, however, in disagreement when it comes to the impacts of text message use in health care interventions. Some literature reviews suggest that text message reminders may have a positive impact on patient adherence to chronic medication (Vervloet et al. 2012), antiretroviral therapy (Horvath et al. 2012) and appointment attendance (Car et al. 2012), whereas others reported very limited evidence that text message use improves medication adherence (Free et al. 2013a, Kauppi et al. 2014) or only modest improvements in appointment attendance

(Free et al. 2013b). Discrepancies concerning the impacts of text message reminders are often due to the paucity of high-quality data (Nglazi et al. 2013), which was the case in the present literature review. Therefore, on the basis of these findings, firm conclusions about the impacts of the use of text message reminders are difficult to draw. Given this, more rigorous and high-quality studies are needed. Research concerning the use of text message reminders among people with schizophrenia was also incoherent. For this reason, more studies are needed to evaluate if text message reminders are feasible and acceptable, especially among people with severe mental disorders.

6.2.2 Patient preferences regarding text message reminders in encouraging patient treatment adherence

A wide variety of text message reminders were chosen from all (both compulsory and optional) text message categories offered (i.e. medication, appointment and free-time). Participants preferred slightly humorous and encouraging messages, which is in line with previous literature (Curioso et al. 2009, Gold et al. 2010). This may indicate the acceptability and feasibility of mobile-based interventions in encouraging patient treatment adherence (Alvarez-Jiménez et al. 2014). Furthermore, our study findings concerning the diversity of the chosen text message content may reflect patients' individual needs related to their self-management, although preferences and needs should not be mixed. However, it has been suggested in previous literature that health-related technologies are often developed without analysing users' needs (Thielke et al. 2012). Still, it is important to take patient preferences into consideration in order to ensure the benefits of the text message reminders, since without a patient's own interest in mobile health technologies, they will not benefit from the technology offered (Bauer et al. 2014).

Our study findings showed that most of the participants prefer to receive text message reminders at the beginning of the week and early in the mornings. This is an interesting finding, since previous literature suggests that the daily routines of people with severe mental disorders are easily disrupted often interfered (Minato & Zemke 2004, Harvey & Strassnig 2012, Galderisi et al. 2014). However, according to the findings of the present study, it is possible that participants wanted to get more support for their daily routines and daily living skills, such as getting up in the morning. Consequently, this supports the assumption that people with severe mental disorders need help in coping with their daily activities (Minato & Zemke 2004, Harvey & Strassnig 2012) and support in the integration to the community (Beresford et al. 2005). The findings of the present study are significant, since people with severe mental disorders are more likely to lose their jobs than people without mental health disorders (OECD 2011). The fact that they preferred to receive reminders supporting their daily routines may indicate their willingness to be independent and 'as normal as possible' (Priebe et al. 2005), despite

their illness. By respecting patient preferences concerning text message reminders, it is possible that their acceptance of text message-based interventions can be strengthened, which is important in their integration into the patients' everyday life (Vervloet et al. 2012). Given this, we may further assume that patients in our study were able to integrate text message reminders as part of their daily life, since the amount of discontinued text message reminders was low.

Age, gender and marital status seemed to have various associations on the preferred amount and timing of the selected text message reminders, though the evidence was not so robust. For example, younger singles preferred less text message reminders than older singles, while older women preferred more text message reminders than older men. This was surprising, and our study results did not unequivocally confirm the fact that younger people, who are generally more familiar with the technology (Smith 2011), would prefer more reminders than older participants, who may be tentative to use mobile phones (Kurniawan 2008). This is an important finding and may demonstrate the possibility of text message reminders use among a wide variety of patients, regardless of age, gender or marital status. Accordingly, this further emphasises the need to tailor interventions respecting patient preferences (Evans et al. 2007), develop the content of text messages depending on the target population, personalise the text message reminders according to patient preferences (Mohr et al. 2014), and utilise user-driven workflow, which allows the user to decide the sequence and timing of reminders use (Mohr et al. 2015). At the same time, user engagement with reminders can be improved when they find the messages relevant (Mohr et al. 2014), and patients benefit from the reminders as is intended (Bauer et al. 2014). Therefore, it is essential to study patient feedback on text message-based interventions.

6.2.3 Patient feedback on text message reminders

Participants gave very positive and encouraging feedback on their use of text message reminders, which is in line with previous studies (e.g. Branson et al. 2013, Palmier-Claus et al. 2013, Ben-Zeev et al. 2014a, Bogart et al. 2014). Moreover, as previous literature asserts that people with severe mental disorders are confident using mobile technologies (Ennis et al. 2012), it was not surprising that almost all participants found text message reminders easy to use in our study. However, it has been expressed that patients with severe mental disorders do not interact with technology to the same extent as people without mental disorders (Harvey & Keefe 2012). Ben-Zeev and colleagues (2013) found out, for example, that barriers to mobile phone ownership among mobile phone non-users (28%, 444/1568) in this patient group were costs, lack of interest or necessity and a patient not knowing how to use a mobile phone. Available research, however, suggests that people with severe mental disorders are familiar with mobile phones and generally have easy access to them (Ennis et al. 2012). Moreover, they are able and

willing to use mobile-based interventions when given the opportunity, and they learn quickly and remember how to use mobile technology with the help of appropriate training (Ben-Zeev 2012, Ben-Zeev et al. 2014a). Given this, on the basis of our study findings and confirmed with previous literature, severe mental disorders themselves cannot be regarded as barriers for the use of text message-based interventions in health care meant to improve patient self-management. This is further supported in our study, since only a minority of participants reported that text message reminders caused them harm (e.g. irritation or disturbance). In this light, our study findings are very promising, demonstrating that text message reminders are a feasible and acceptable reminder system among people with severe mental disorders. In order to develop text message reminder systems further and increase their acceptability even more, it is essential to explore what kinds of harm text message reminders can possibly cause, since there is a lack of studies reporting this type of damage (Gurol-Urganci et al. 2013).

Age, gender and employment status tended to play roles related to participant feedback on text message reminders. First, contradictory to previous studies that suggest young people are familiar with using ICT (Pew Research Center 2014), our study results revealed that participants who were older at the time of their first contact with psychiatric services were most often fully satisfied with text message reminders. This may indicate that a simple reminder based on already existing technology may be acceptable for older people (Mitzner et al. 2010), whereas younger groups may want more action and interactive systems (Baranowski et al. 2008). Second, women reported text message reminders causing harm more often than men. This was unexpected, since women have been reported to use text messages more than men (Cellular News 2011, Miller et al. 2014). On the other hand, women tend to be less confident when using mobile phones than men (Ennis et al. 2012). Miller and colleagues (2014) found that people with schizophrenia reported feeling paranoid when using computers (women more often than men) (Miller et al. 2014). In this light, our study findings suggest that using text message reminders instead of computers may be a more feasible and acceptable type of intervention among people with severe mental disorders. Third, job seekers were more often fully satisfied with the text message reminders compared with other groups. This is a promising result, indicating that people with severe mental disorders may be willing to cope and improve their daily activities (Priebe et al. 2005), especially since unemployment is common among these people (Evans-Lacko et al. 2013, OECD 2011). To conclude, despite differences in the patients' feedback related to their sociodemographic characteristics, text message reminders seem to be a feasible and acceptable method, but indicate that there is a desire tailored intervention.

Moreover, participants in West Finland reported greater satisfaction with the text message reminders than participants in other areas of Finland. This finding may reflect

mental health services in general, since equal access to mental health care is a problem in Finland (Patana 2014, OECD 2015). The use of mental health services has decreased slightly in West Finland, which may refer to problems in the availability of mental health services (Wahlbeck et al. 2015). This may indicate that people who may not have access to mental health services found text message reminders as an aid to cope and self-manage, and were satisfied. This is encouraging, and text message reminders may be a potential intervention to supplement mental health services in the areas where the availability of mental health services has been decreased. This further encourages text message reminder use for people who would otherwise not be able to access care (Mohr et al. 2013a, Brian & Ben-Zeev 2014). These results are a remarkable value for policy makers, managers in health care and health care personnel, when considering future development of text message reminders, tailoring (Evans et al. 2007), personalising and while planning the implementation of text message reminders in clinical practice (Mohr et al. 2014). Patient feedback is needed if there is to be user-driven utilization of mobile technology as a part of patient treatment and their daily life (Department of Health 2014).

We lacked 28% of the participants' feedback on text message reminders. In previous literature, low survey questionnaire rates among people with mental health problems have been an issue of concern (Kessler et al. 2005, Perälä et al. 2007, Jørgensen et al. 2014, Wahlbeck et al. 2015). One possible reason for this lack of feedback may be that these people were not active technology users, compared to those who responded to the questionnaire, and therefore did not give their feedback. This may also indicate that these participants were not satisfied with the text message reminders offered. On the other hand, we did not reach all study participants by phone due to, for example, an unobtainable telephone number or a given telephone number not being in use (Paper III). This may be due to prepaid airtime (Ben-Zeev et al. 2013) or a broken mobile phone (Branson et al. 2013). Our study results do not show how many participants actually used the text message reminder system offered. Mobile phone ownership is common among people with severe mental disorders (Firth et al. 2015). However, smart phone ownership is lower than that of the general population, mostly due to cost (Glick et al. 2015). This needs to be taken into consideration when developing interventions to encourage patient treatment adherence. Existing technology should be made use of, since it can be seen as an underutilised resource in mental health care (Farrington et al. 2014).

6.2.4 Patient recruitment and retention in a text message-based trial

Less than ten percent (9,9%, 1139/11530) of patients screened for eligibility to participate in the study were recruited to the multicentre randomised trial. This was not surprising, as previous studies have reported also having difficulties in recruiting adequate amounts of participants with severe mental disorder (Gilbody et al. 2002, Jørgensen et al. 2014). Finding eligible participants was also a challenge in our study.

Less than 40% of patients appeared eligible, which is lower than, for example, in the study of Jørgensen and colleagues (2014), which had a 47% eligibility rate. It is possible that eligibility criteria were set to be too tight in our study, since one-third of participants were not eligible due to not being on an antipsychotic medication at the time of the recruitment (Figure 1 in Paper IV). Having too strict eligibility criteria may lower the amount of recruited participants (Treweek et al. 2010). On the other hand, having too broad eligibility criteria may have decreased the generalisability of the results. Again, if we had restricted our eligibility criteria to consider only people with schizophrenia, we could generalise our study result for this population only.

During the recruitment, some screeners expressed their inability to use mobile phones or text messages, which excluded them from participation. We found this surprising, since mobile phone text messages have been proven to be feasible (Ennis et al. 2012, Palmier-Claus et al. 2013, Ben-Zeev et al. 2014a) and easy to use (see Paper III) among people with severe mental disorders. On the other hand, it has been suggested that 20% of people with severe mental disorders do not have the ability to use mobile phones (Ben-Zeev et al. 2013), and they do not use technology as much as other people (Harvey & Keefe 2012). However, given the reported familiarity (Ennis et al. 2012) and risen popularity of mobile phone use among people with severe mental disorders (Firth et al. 2015), it is still correct to assume that mobile phones and text messages are a possible medium for delivering health care interventions.

On the other hand, patients who refused participation were older than those who consented ($p = 0.001$). This may indicate that younger patients who have good technology skills (Coward et al. 2014) are more willing to participate in research, especially technology-based research. This is, however, not supported by previous studies. For example, during the research, adolescents with depression identified reasons for under-usage of the technology-based intervention, such as a lack of time, doubts about its usefulness (Lillevoll et al. 2014, Manicavasagar et al. 2014), and technical problems (Manicavasagar et al. 2014). As in Phase II, younger participants preferred fewer messages than older participants. Similarly, in Phase III, participants who did not answer the questionnaire concerning feedback on the text message reminder system were younger than those who completed the questionnaire. This may actually indicate that younger participants do not engage with technology during research or that they are not satisfied with the technology used. It is promising, however, that in our results, no statistically significant differences between genders were detected related to patient refusals from the trial.

During the 12 month follow-up period, it was found that drop-out rates differed depending on the source of data collected. The drop-out rate from the postal survey was

48%, telephone interviews 28%, participants' notification 3%, and register data retrieval 0,4%. This was an important finding, indicating that it is important to consider alternative data collection methods during the trial follow-up periods to ensure adequate information. This is indeed significant, especially among people with severe mental disorders, since dropout rates from trials are high among this patient group (Jørgensen et al. 2014). For example, telephone interviews had a dropout rate of 28%, which is quite satisfactory when compared with previous studies (e.g. Agyapong et al. 2013, Keding et al. 2015). This may be due to its convenient nature, there are no costs for participants, and they do not need to travel or try to fill in the questionnaire by themselves. In addition, the interviewer has a possibility to motivate participants to respond to the questionnaire (Polit & Beck 2012). However, technical problems occurred during the telephone interviews and one-fourth (23%) of the participants could not be reached by phone. Reasons included, for example, that the participant did not answer the phone, the dialed number was not in use, or the dialed number could not be reached. This is also important to take into account when planning follow-up data collection methods.

Low engagement and discontinuation are major problems in intervention studies (Eysenbach 2005, Villeneuve et al. 2010, Thompson et al. 2011). Therefore, low intervention attrition rate (4,8%) reached in this study is a promising result regarding future text message reminder use in health care and among people with severe mental disorder. However, knowledge about participants' actual text message reminder use was not gathered. Intervention attrition measurement was based on participants, their relative or Research Nurse informing the researcher about participant's willingness to stop receiving text message reminders. Thus, we do not know, if participants really read all the reminders they received or acted on them. We lack knowledge about participants' true engagement with the text message reminder intervention. Therefore, the estimated intervention attrition of 4,8% may be too optimistic, and therefore, firm conclusions about participants' engagement with the SMS intervention cannot be drawn.

The demographic characteristics (age, gender, vocational and educational status) of the participants were associated with the level of risk of leaving studies early and, subsequently, not participating in the follow-up. This finding echoed previous studies, which report that participants who leave the studies early differ from those who are retained (Brilleman et al. 2010, Villeneuve et al. 2010, Mein et al. 2012).

6.2.5 Summary of results related to the Behavioral Intervention Technology Model (BIT model)

The Behavioral Intervention Technology Model (Mohr et al. 2014) was used to summarise the results of this evaluative study concerning text message-based intervention. The novelty of the model made it impossible to use during the development

process of the intervention. For example, thorough laboratory testing of the text message intervention was not conducted, which would have been necessary (Mohr et al. 2015). However, we relied on already existing technology that was familiar, feasible, acceptable and easy to use among our study population (Ennis et al. 2012, Palmier-Claus et al. 2013, Ben-Zeev et al. 2014a, b). Our study results confirmed these attributes of the existing technology.

Intervention evaluation is an essential part of conducting mHealth research (Ben-Zeev et al. 2015). To evaluate the text message reminder intervention, it was useful to use a framework, which helped to review study results from the theoretical and technical perspectives. With the framework, we could analyse why and how (conceptual) text message reminders have been used in the context of health care (Phases I, III and IV), what elements are delivered to the study population (Phases III and IV), how (technical) the text messages are delivered (Phase III), and when they are delivered (Phases II and IV). Given this, the framework worked and served this study well during the evaluation process. However, it was difficult to fit technological components into the framework, since pre-existing technology was used. Despite this and encouraged about the structure of the Behavioral Intervention Technology Model (Mohr et al. 2014), there is potentiality in using the model in the planning, development, evaluation and implementation of text message-based and other mHealth interventions into mental health care.

6.3 Implications of the study

Clinical practice

- There is a strong emphasis on supporting patient treatment adherence among people with severe mental disorders. Treatment nonadherence is a remarkable problem, and the burden of severe mental disorders affects not only patients, but also their caregivers and society as a whole. People with severe mental disorders are in opinion that their treatment adherence can be supported. This study indicates that text message reminders may be a feasible and acceptable reminding system as part of the treatment of mental disorders. Moreover, patients expressed willingness to use text message reminders in the future, which indicates the possibilities for this kind of intervention to be integrated into the everyday lives of patients.
- To integrate the text message reminder system as part of the everyday lives of individuals, it is important to take patient preferences and feedback into consideration. When offering a text message-based reminder system to support treatment adherence for a patient, nurses need to find out what kind of messages patients prefer in order to maximise the impacts of the reminders and patient

engagement with the system. It is also essential to consider possibilities and resources that enable patients to change their text messages (e.g. content, timing or frequency), since preferences may change over time. Moreover, patients may be satisfied with the text message reminders at the beginning, but then the interest may lessen over time. In these cases, resources are needed to keep up patients' motivation to read the text message reminders.

Nursing science

- As the present study results show, mHealth interventions, such as text message reminders, have shown its potentiality in supporting patient treatment adherence. This study resulted in a new understanding of text message reminder use in the context of health care. The present study provides new knowledge about patient preferences and feedback on text message reminders among people with antipsychotic medication. As treatment adherence is a major problem among people with antipsychotic medication, new insights to tackle nonadherence are needed. Therefore, in the discipline of nursing science, it is essential to take into consideration the potentiality of text message reminders in health promotion and health care delivery, to produce evidence-based knowledge in the field.
- The study results revealed that text message reminders were feasible and acceptable among people with antipsychotic medication. Although impacts of text message reminders were not studied among this patient group, results of the literature review expose that impacts of text message reminder use are still inconsistent. Given this inconsistency, more research is needed on the effectiveness of text message reminders to gain stronger evidence for implementing them in nursing, affecting the field at the practical, decision-making and education levels of health care. However, conducting research among people with antipsychotic medication is not without challenges. Therefore, extra emphasis should be put on considering how to recruit and retain participants in the study, to avoid biased study results.
- The present study has been conducted in the discipline of nursing science and it has produced new knowledge about text message reminder use in health care and among people with antipsychotic medication. It was important to study this phenomenon in this discipline, to produce knowledge especially for nursing, and by means of study results, to help people with antipsychotic medication to improve their treatment adherence. However, at its best, the study results may

benefit other sciences as well, such as technology or computer sciences, and open new opportunities for multidisciplinary research.

Nursing education

- As mHealth interventions are growing in the field of health care, future nurses need knowledge about their possibilities in health care, as part of health promotion and health care delivery. Therefore, it is important that nurses have knowledge of what patient groups and in what contexts text message reminders have the potential to be used. Every nurse should also be aware that patient preferences and feedback on text message reminders affect the acceptability of this type of system and its expected impacts. Moreover, they should be aware that a patient's interest in using text message reminders may lessen over time, and have knowledge on how to engage patients in using text message interventions in order to maximise their impacts on supporting patient treatment adherence.
- This study has shown that there are feasible ways of supporting patient treatment adherence. This offers nurses new possibilities of informing patients to choose reminding systems to improve their adherence. Moreover, results of the present study offer nurses the possibility to emphasise the benefits of the already existing technology while informing patients about its use as a reminding system.

Health care administration

- As international and national guidelines emphasise promotion of mental health, equal access and low-threshold mental health services, this study reveals the possibilities of deploying text message reminders as part of supporting patient treatment adherence among people with antipsychotic medication. Therefore, the study results can be referred to in decision making, not only at wards and outpatient clinics, but also at the organisational and regional levels, when planning methods to improve patient treatment adherence. Text message reminders as a method to support treatment adherence may be a possibility to alleviate the challenges caused by the heterogeneous development of outpatient services across the country.
- Given the financial burden of severe mental disorders, this study generated new knowledge based on nursing management about possibilities to use already existing technology in supporting treatment adherence among people with

antipsychotic medication. Therefore, it is important to allocate resources on supporting patient treatment adherence in mental health outpatient services. Finally, adequate health care personnel are a prerequisite to arrange effective outpatient services. Therefore, resources are also needed to inform patients about text message reminder systems, maintain the reminder system, and respond to the patients' requirements about message changes.

6.4 Conclusions

Text message reminders have the potential to be used in health care and psychiatric outpatient care. Text message reminders were widely used, but their impacts are uncertain. Patients preferred slightly humorous text message reminders delivered at the beginning of the week, in the mornings. Patients were satisfied with the text message reminders, found them useful, easy to use and were willing to use the system in the future. Only a few participants (more often female) expressed that text messages caused them harm. Patient recruitment for a multicentre randomised controlled trial concerning people with antipsychotic medication was challenging, due to low rates of eligible participants. Follow-up drop-out attrition rates when it came to the telephone interviews, participant notification, postal survey and register data retrieval were as follows: 28%, 3%, 48% and 0,4% (respectively). The Behavioral Intervention Technology Model (Mohr et al. 2014) was a useful framework for evaluating text message reminder-based intervention to encourage patient treatment adherence among people with antipsychotic medication.

6.5 Recommendations for the future

1. It is worth considering the use of mobile telephone text message reminders to encourage treatment adherence in psychiatric outpatient care. Policy makers and health care administrators should take all possible methods into account when considering the encouragement of patient treatment adherence.
2. It is essential to take into account patient preferences and feedback on text message reminders in order to guarantee user motivation to use text message reminders, so that they will benefit from the reminders and will be engaged in the reminder system.
3. Text message reminders are recommended to be sent at the beginning of the week and in the morning hours. This may improve patients' daily activities and keep them in the "normal rhythm" of the week. Therefore, text message reminders should be developed to be able to fit this schedule, and to suit patients' personal preferences (flexibility).
4. There should be a possibility to change the content, timing and frequency of text message reminders over time, according to patient feedback.
5. It is essential to keep the content of the text message reminders neutral and anonymous to protect patient privacy, since privacy concerns exist. In addition, accuracy is required when dialing a patient's mobile phone number for delivering the reminder or entering patient data into the automatic text message delivery system.
6. In mHealth research, special attention should be given to overcoming barriers occurring during the recruitment phase, supporting participant engagement in the study intervention, and avoiding high dropout rates.

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