Improving the quality of intensive care with social media

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Antonija Petosic, RN, CCN, MSc

UNIVERSITY OF OSLO

Institute of Health and Society

Faculty of Medicine, University of Oslo

Department of Postoperative and Intensive Care Nursing

Division of Emergencies and Critical Care

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The ultimate goal is to manage quality. But you cannot manage it until you have a way to measure it, and you cannot measure it until you can monitor it.

-Florence Nightingale

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SUMMARY

Critically ill patients may receive suboptimal care in the intensive care unit (ICU) because personnel may be unaware of or lack knowledge, skills, or attitudes regarding the best available, current knowledge. Widespread adoption and adherence to evidence-based clinical guidelines are lagging, and research evidence may take several years to reach clinical practice. Thus, active implementation strategies are needed to improve the quality of care, but it is indeed challenging. Social media (SoMe) has changed how we communicate worldwide. Its user-friendly, fast and easy way of communicating through smartphones may be a novel way to communicate about local quality of care in busy ICUs. Therefore, this thesis aims to describe the use of SoMe among ICU nurses and physicians, evaluate a multifaceted quality improvement campaign using closed Facebook groups, and explore ICU nurses' and physicians' experiences with this novel use.

In an anonymous web-based survey (Paper I), most ICU nurses and physicians reported using smartphones and different SoMe platforms, with Facebook being the most popular. A Facebook profile was more common among those under 40, whereas daily use was more common among females and nurses. Compared to physicians, more nurses were members of their local ICUs' Facebook groups. In the subsequent intervention study (Paper II), professional content consisting of feedback on audited quality indicators, e.g. pain, agitations/ sedation and delirium (PAD) assessment, was provided through four ICUs' closed Facebook groups. Facebook was part of a multifaceted intervention, including educational events and support from local opinion leaders that received monthly feedback via e-mail. The proportion of nursing shifts with documented PAD assessment in an eight-month period before intervention initiation (Before) was compared to eight monthly data points in the intervention period (Intervention). Overall, documented assessment of PAD increased during Intervention vs Before. Most of the Facebook group members had seen the posts, indicating exposure to the Facebook posts and professional content. Few of the group members liked or commented on the post. The following post-intervention focus group interviews study (Paper III) revealed ambivalence towards using Facebook for professional purposes. The participants described being motivated by the professional content provided through Facebook, especially the feedback on quality indicators. However, professional content appearing on Facebook in a mixup of content in their free time was considered inappropriate and could even be deemed disruptive and provocative, as 'Matter out of place'. More appropriate SoMe for professional communication were suggested and deemed the employers' responsibility. Regarding quality

improvement and implementation, the participants expressed a general need for several strategies based on varying factors and personal preferences, illustrating that ‘One size does not fit all’. This applies to Facebook as well, as it did not suit all.

In conclusion, SoMe is in daily use by most ICU personnel, and strategic use of SoMe may improve the quality of intensive care. However, the ICU personnel may experience the usage of SoMe intrusive, especially after office hours. Applicable and more appropriate hospital communication platforms are needed according to the ICU personnel.

SAMMENDRAG

Kritisk syke pasienter kan få suboptimal behandling og pleie på intensivavdelingen fordi personell ikke er klar over eller mangler kunnskap, ferdigheter eller holdninger om den beste tilgjengelige, nåværende kunnskapen. Utbredt implementering og etterlevelse av retningslinjer mangler, og det kan ta mange år å implementere kunnskap fra forskning inn i klinisk praksis. Det er derfor behov for aktiv implementering med effektive strategier for å forbedre behandling og pleie i tråd med retningslinjer. Men dette kan allikevel være utfordrende. Sosiale medier (SoMe) har endret måten vi kommuniserer på i hele verden. Den brukervennlige, raske og lettvinte måten å kommunisere på via smarttelefoner kan være en innovativ måte å kommunisere på om kvalitet i avdelingen i travle intensivavdelinger. Målet med denne avhandlingen var derfor å beskrive bruken av SoMe blant intensivsykepleiere og leger, evaluere en mangefasettert kvalitetsforbedringskampanje som inkluderte bruk av lukkede Facebook-grupper, og utforske intensivsykepleieres og legers erfaringer med denne nye bruken.

I en anonym nettbasert undersøkelse (Artikkel I) rapporterte de fleste intensiv-sykepleiere og leger at de brukte smarttelefoner og forskjellige SoMe-plattformer, der Facebook ble rapportert som den mest populære. En Facebook-profil var mer vanlig blant de under 40 år, mens daglig bruk var hyppigere blant kvinner og sykepleiere. Sammenlignet med leger var flere sykepleiere medlemmer av deres lokale intensivavdelings lukkede Facebook-gruppe. I den påfølgende intervensjonsstudien (Artikkel II) ble faglig innhold bestående av tilbakemelding på målte kvalitetsindikatorer, bl.a. vurdering av smerte, agitasjoner/sedasjon og delirium (PAD), formidlet i fire intensivavdelingers lukkede Facebook-grupper. Facebook var en del av en multifasettert intervensjon, som inkluderte undervisning og møter, samt støtte fra lokale ressurspersoner som mottok månedlige tilbakemeldinger via e-post. Andelen sykepleiervakter med dokumenterte vurderinger ble sammenlignet i to perioder, åtte måneder før intervensjonsstart (Før) og åtte måneder etter intervensjonsstart (Intervensjon) Dokumentert vurdering av PAD variabler økte totalt i løpet av Intervensjonsperioden sammenlignet med perioden Før. De fleste av Facebook gruppemedlemmene hadde sett innleggene, noe som indikerer eksponering for Facebook-innleggene og det profesjonelle innholdet. Få av gruppemedlemmene likte eller kommenterte innlegget. Etterfølgende post-intervensjons fokusgruppeintervjuer (Artikkel III) avdekket ambivalens mot å bruke Facebook til profesjonelle formål. Men, deltakerne beskrev at de ble motivert til forbedring av det faglige innholdet gitt via Facebook, spesielt tilbakemeldingene på kvalitetsindikatorene.

Profesjonelt innhold som uventet dukket opp på Facebook ble imidlertid ansett som upassende og kunne til og med betraktes som forstyrrende og provoserende, som "malplassert materie". Mer passende SoMe for profesjonell kommunikasjon ble foreslått, og dette var ansett som arbeidsgivernes ansvar. I kvalitetsforbedring og implementering, uttrykte deltakerne et generelt behov for flere strategier basert på ulike faktorer og personlige preferanser, noe som illustrerer at "en størrelse passer ikke alle". Dette gjelder også for bruk av Facebook.

SoMe brukes daglig av de fleste intensivpersonell, og strategisk bruk av SoMe kan forbedre kvaliteten på intensivbehandlingen. Intensivpersonellet kan imidlertid oppleve bruk av SoMe påtrengende, spesielt etter arbeidstid. Personalet etterspør mer anvendelige og passende sykehuskommunikasjonsplattformer.

LIST OF PAPERS

Paper I

Petosic, A., Sunde, K., Beeckman, D., Flaatten, H. K., & Wøien, H. (2019). **Use of social media for communicating about critical care topics: A Norwegian cross-sectional survey.** Acta Anaesthesiologica Scandinavica, 63(10), 1398-1405.
DOI (digital object identifier): 10.1111/aas.13449

Paper II

Petosic, A., Småstuen, M.C., Beeckman, D., Flaatten, H., Sunde, K., Wøien, H. (2021). **Multifaceted intervention including Facebook-groups to improve guideline-adherence in ICU: A quasi-experimental interrupted time series study.** Acta Anaesthesiolgica Scandinavica, 65(10), 1466– 1474.
DOI: 10.1111/aas.13969

Paper III

Petosic, A., Berntzen, H., Beeckman, D., Flaatten, H., Sunde, K., & Wøien, H. (2023). **Use of Facebook in a quality improvement campaign to increase adherence to guidelines in intensive care: A qualitative study of nurses' and physicians' experiences.** Intensive and Critical Care Nursing, 78, 103475.
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ABBREVIATIONS

A&F	Audit and Feedback
BPS	The Behavioral Pain Scale
CAM-ICU	The Confusion Assessment Method for the ICU
CCN	Critical Care Nurse
CI	Confidence Interval
CPOT	The Critical- Care Pain Observation Tool
DOI	Digital object identifier
ECMO	Extracorporeal Membrane Oxygenation
EM	Early Mobilisation
EN	Enteral Nutrition
ESICM	European Society of Intensive Care Medicine
FGI	Focus Group Interview
HCP	Health Care Personnel
HRQoL	Health Related Quality of Life
ICDSC	the Intensive Care Delirium Screening Checklist
ICU	Intensive Care Unit
IQR	Interquartile Range
ITS	Interrupted time series
LOS	Length Of Stay
NAS	Nursing Activities Scores
NIR	Norwegian Intensive care Registry
NRS	Numeric Rating Scale
OUH	Oslo University Hospital
PAD	Pain, Agitation/ Sedation, Delirium
PAD-QIs	Pain, Agitation/ Sedation, Delirium - Quality Indicators
PDA	Personal Digital Assistants
PI	Pressure Injury
PVO	Data Protection Officer
Q	Quartile
QDAS	Qualitative Data Analysis Software
QI	Quality Indicator
QoL	Quality of Life
RCT	Randomised Controlled Trial
RASS	The Richmond Agitation Sedation Scale
REK	Regional Ethics Committee
SAPS	Simplified Acute Physiology Score
SD	Standard Deviation
SoMe	Social Media
SPSS	Statistical Packages for Social Sciences
TA	Thematic Analysis
UiO	University of Oslo
web	World Wide Web

INTRODUCTION

My career as a nurse started in 1999 when I, at the age of 22, was employed at the Neurosurgical Postoperative and *Intensive Care Unit (ICU)* at Ullevål Hospital (later Oslo University Hospital Ullevål), directly from nursing school. Following a mentoring and educational programme, I independently cared for critically ill patients, which I found rewarding, engaging, and challenging, but also frightening and frustrating. Being young, curious and eager to learn more, I frequently asked questions and discussed professional topics with colleagues and other professionals. During the years, I experienced that intensive care depended very much on the nurse and physician in charge, which could seriously affect vulnerable patients and their relatives. I early signed up for several professional development groups in the ICU, such as the 'organ donation group', where I was assigned to count realised and potential organ donors in the hospital, and a group developing local clinical practice guidelines for the management of external ventricular drainage, before taking the formal critical care nurse (CCN) education from 2005 to 2008.

In 2010, I was employed as a nurse responsible for professional development in the ICU. Improving the quality of *intensive care* according to current guidelines was challenging and time-consuming. *Quality of care* implies safe, effective, and efficient treatment where nursing and medical decisions adhere to evidence-based recommendations. Developing and implementing evidence-based *clinical practice guidelines (guidelines)* may improve the quality of care by supporting clinical decision-making, promoting education and improvement of care processes, reducing unwanted variation in healthcare delivery, and improving efficiency and cost reductions. However, I soon experienced what the literature describes: guidelines are not automatically implemented due to barriers related to several issues, such as the guideline itself, healthcare professionals, patients, and the environment. Furthermore, it was frustrating to experience and realise that informing all colleagues was time-consuming and difficult.

My frustration, curiosity and search for better and more effective *implementation strategies* to improve the quality of intensive care led to my master's thesis, where a multifaceted intervention, including *audit and feedback (A&F),* classroom education, multi-professional collaboration and posters in the ICU was tested in a before-and-after study design. It resulted in improved adherence to guidelines for nutrition in the ICU. [1] This made me eager to enhance the quality of care and treatment in other intensive care areas. Auditing ICU *quality indicators (QIs)*, in general, and specifically for improving local intensive care,

caught my attention. I questioned whether A&F on QIs to the ICU personnel was an effective strategy, which indicators to choose, and where to provide feedback to reach the large multi-professional group of personnel working shifts. At that time, *social media (SoMe)* had changed how we communicate worldwide with its availability via smartphones, and I assumed SoMe could serve as a novel medium to reach ICU personnel. SoMe were increasingly used at congresses, by medical societies, journals, and in hospitals, and my ICU had a closed Facebook group for social content and shift swapping. The use of SoMe among ICU personnel and improving the quality of intensive care had previously never been described.

Thus, the study's idea in the present thesis arose from nearly 20 years of experience working in the ICU as a CCN at the bedside and as a professional development nurse focusing on developing and implementing guidelines and continuously improving the quality of intensive care. By conducting multiple methods, the thesis aimed to:

- describe SoMe usage among intensive care nurses and physicians;
- evaluate the use of established Facebook groups for providing A&F of QIs to optimise guideline adherence in four ICUs; and
- explore ICU nurses' and physicians' experiences with this novel use of SoMe.

BACKGROUND

The background sections consist of relevant definitions and an overview of the research related to SoMe and quality of care in intensive care units. The knowledge gaps are clarified at the onset of the studies in this thesis, based on literature published mainly until March 2017.

The intensive care unit (ICU)

Intensive care patients are defined as patients having, or at risk of developing, acute, life-threatening organ dysfunction, [2] or threatening or manifest, acute deficiency in one or more vital organ functions (e.g. central nervous system, lung function, cardiovascular system, kidneys). [3] Thus, they are indeed a heterogeneous group of patients, and their outcome depends substantially on the quality of care provided in the *ICU*. [4] An ICU is a highly specialised hospital department or system where intensive and specialised medical and nursing care is provided to intensive care patients. [2, 5] *Intensive care*, also known as critical care, is a multidisciplinary and interprofessional speciality dedicated to the comprehensive management of care provided to ICU patients, [2] and involves constant monitoring and support from specialised personnel, medical equipment and medication. [3]

The contemporary ICU's precursor was already established in 1854 when Florence Nightingale created a separate area in the military field hospital where more intensive nursing care could be provided to the most injured soldiers during the Crimean War. [2] During the polio epidemic in the 1950s, the first ICU with prolonged mechanical ventilation was established in Copenhagen, Denmark, in 1953 when the anaesthesiologist Björn Ibsen was brought out of the operating theatre to care for a girl suffering from polio. [2, 6, 7] ICUs and intensive care have continued to advance with technology, education, and professional knowledge. However, significant differences regarding what an ICU consists of, [2, 8] and the number of ICU beds and volume of admissions still exist worldwide. [8, 9] For instance, in 2012, Germany reported 29.2 ICU beds per 100.000 population, Portugal 4.2, and Norway 8.0. [9] The ICUs at Oslo University Hospital (OUH) had 8-12 ICU beds per ICU in 2017.

An ICU may be a medical, surgical or mixed ICU. [8] The ICUs can be categorised into levels 1, 2 or 3. [2, 5] According to the task force of The World Federation of Societies of Intensive and Critical Care Medicine, a level 1 ICU may provide oxygen, non-invasive monitoring and more intensive nursing care than a ward. A level 2 ICU provides invasive monitoring and basic life support for a short period. A level 3 ICU can provide all monitoring

and life support technologies and is a regional resource for critically ill patients. They also may play an active role in developing the speciality of intensive care through research and education. [2] In Norway, the definition of level 1 ICUs differs slightly from the international one in their ability to provide short periods of mechanical ventilation. [5] Furthermore, the three levels depend on the competency of available nursing and medical staff and the hospitals' ability to provide medical care 24 hours a day, seven days a week, 365 days a year. [5]

ICU personnel

ICU personnel may comprise a multidisciplinary team of nurses, physicians, physiotherapists, pharmacists and other allied health care personnel (HCP). [2, 5] The main stakeholders in Norwegian ICUs are the specialised critical care nurses in addition to intensivists (mainly anaesthesiologists) working full or part-time in the ICU. [5] According to the Norwegian ICU guideline, [5] the nurse-to-patient ratio in level 3 ICUs typically should be one to two nurses per ICU patient and one physician per three patients. [5] Other allied HCP, such as pharmacists, physiotherapists, speech therapists and social workers, are mainly employed in separate departments within the hospital, but work on a daily basis in close collaboration with the regular ICU staff. In addition, specialised physicians, such as, e.g. different surgeons, infection specialists/ microbiologists, pulmonologists, and cardiologists, among others, are involved in patient care depending on the patient's individual needs in collaboration with the intensivist and ICU team.

Intensive care in Norway

In 2017, when the studies presented in this thesis were planned and initiated, 13 737 patients were treated in Norwegian ICUs. This resulted in 16 332 ICU stays, comprising 61 843 ICU days in the 49 ICUs providing data to the Norwegian intensive care registry (NIR). [3] The median ICU length of stay (LOS) was 1,9 days, and 60 % of the patients were mechanically ventilated during the stay with a median time on invasive mechanical ventilation ranging from 0,5-3 days in the different ICUs. [3] ICU survival was 90%, and 80% of the patients were still alive 30 days after the ICU stay. [3] This was a relatively high survival rate compared to data from previous international studies with ICU mortality rates ranging from 8% to 33%, hospital mortality from 11% to 64% and 5-year mortality from 40% to 58 %. [10] However, interpreting outcomes and research findings in general from the ICU setting is challenging

due to the highly heterogeneous group of ICU patients and the variable intensive care provided worldwide. [8, 9] With increasing survival, other and more long-term outcomes of survivors have become increasingly more relevant, such as, e.g. quality of life (QoL) and Health Related QoL (HRQoL), but also a focus on reducing costs of intensive care with outcomes such as reduced time on mechanical ventilation and ICU length of stay (ICU LOS). [10] Findings from a more than twenty-year-old Norwegian study indicated that former ICU patients 12 years after their ICU stay still had significantly lower HRQoL scores than the general population. [11] Optimising the offered intensive care is paramount to improve patient outcomes (both short- and long-term) and reduce ICU LOS and costs. [4] The studies in the present thesis are about finding new strategies to optimise or improve intensive care according to evidence-based clinical practice guidelines. The ultimate goal is to improve patient outcomes through such strategies.

Evidence-based clinical practice guidelines in the ICU

Evidence-based clinical practice guidelines (guidelines) aim to promote clinical decision-making among HCP, promote education and improvement of care processes, reduce unwanted variation in healthcare delivery, and improve efficiency and reduce costs. [12-16] Guidelines are developed by including and translating research findings (evidence) into practical recommendations integrating clinical consensus by a group of experts in predefined processes [15] and including patient preferences. [17] Guidelines are especially needed in intensive care with its complex nature, extremely sick and vulnerable patients and high care costs. [15, 18] Some ICU guidelines refer to specific treatments relevant for a small specific group of patients, whereas others are considered essential for all patients. Few national Norwegian ICU guidelines exist, [19] but more than 250 international guidelines have been published. [15] "The Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2012", which includes recommendations to guide the clinician caring for a patient with severe sepsis and septic shock, is a typical, much referred and used guideline. [20] It includes a sepsis bundle and adherence to these guidelines has been associated with reduced hospital mortality. [21]

Guidelines for the management of pain, agitation and delirium

Another international guideline for ICU patients is the "Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit", also known as PAD guidelines. [16] This guideline recommends best practices for managing pain, agitation/ sedation, and delirium (PAD) to improve physical and psychological comfort and clinical outcomes in adult ICU patients, [16] and is regarded as very relevant for all ICU patients. Widespread implementation of the ICU PAD care bundle will likely result in large-scale improvements in ICU patient outcomes and significant cost reductions. [22]

The guidelines emphasise the psychometric aspects of PAD assessment tools and recommend routine use and monitoring. Pain should be assessed with self-reported pain, such as the Numeric Rating Scale (NRS), or with behavioural scales, such as the Behavioral Pain Scale (BPS) and the Critical-Care Pain Observation Tool (CPOT). Agitation/ sedation should be assessed with the Richmond Agitation and Sedation Scale (RASS). [16] For delirium, using valid and reliable delirium assessment tools, such as the Confusion Assessment Method for the ICU (CAM-ICU) and the Intensive Care Delirium Screening Checklist (ICDSC), should be assessed at least once per nursing shift. [16]

Pain assessment in mechanically ventilated patients has been reported to be independently associated with reduced duration of mechanical ventilation and length of ICU stay, [16, 23, 24] and reduction in the use of analgesic medications. [16] The use of sedation scales and protocols designed to minimise sedative use and non-benzodiazepine medications are associated with improved ICU patient outcomes, including shorter duration of mechanical ventilation, ICU- and hospital LOS, [16, 25-27] and decreased incidences of delirium and long-term cognitive dysfunction. [16] Delirium-monitoring adherence is independently associated with in-hospital mortality for ventilated patients. [28] Delirium monitoring conducted 50% or more of ICU days per patient indicated an in-hospital mortality reduction of 22%. The average ICU LOS of 46 days was estimated to be reduced by 19 days (P= 0.031) if patients were sufficiently monitored. [28]

Based on the PAD guideline recommendations and studies showing that PAD monitoring is associated with improved patient outcomes, [16, 28] PAD monitoring is a central issue in the present thesis and regarded as an important part of quality of care provided in ICUs.

Quality of care

The Institute of Medicine defines *quality in healthcare* as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge". [29] According to the Institute of Medicine and their report "Crossing the quality chasm", [29] quality in health care involves six dimensions: Safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity. [29, 30] In short, quality of care should be:

- *Safe* - avoid injuries and harm from care
- *Effective* - care should be based on scientific knowledge
- *Patient-centred* - provide care responsive to individual patient preferences, needs, and values
- *Timely* - reduce waits and harmful delays for those who receive and give care
- *Efficient* - avoid waste of equipment, supplies, ideas, and energy
- *Equitable* - provide care that does not vary in quality because of personal characteristics [29-31]

Evaluating quality in healthcare

The first step to improving quality is to measure it. [32] Avedis Donabedian is the creator of some of the most known and used theories and models on evaluating quality of care dating back to 1966. [33] According to Donabedian, [33] it seems likely that there will never be a single comprehensive criterion to measure quality of patient care. Furthermore, he states that even if outcomes remain the ultimate validators of effectiveness and quality of care, another approach is to examine the care processes rather than outcomes. A third approach is to assess the structure or setting in which care is provided. [33] Donabedian's model for evaluating the quality of care in the three categories, 'structure', 'process' and 'outcome', still significantly impacts quality measurement and research.

Quality indicators

QIs are healthcare quality measures readily available from hospital inpatient administrative data. QIs consist of a numerator and a denominator and may be screening tools to help flag potential healthcare quality problem areas that need further investigation. [34-36] Donabedian defines QIs as measures that assess a particular healthcare structure, process, or outcome". [4, 33, 37] *Structure indicators* describe the attributes of organisational structure, material, and

human resources. *Process indicators* describe the process of care and whether what is known to be good clinical practice has been applied. [33] *Outcome indicators* describe the effects of care on the health status of patients and populations, with mortality rates being the most frequently used outcome indicator, also in intensive care. [33, 37-40]

Characteristics of good quality indicators follow the RUMBA rule:

- **R**elevant - indicates that it is important for patient care improvement
- **U**nderstandable - indicates that the staff needs to understand it
- **M**easurable - involves that it needs to be measured, quantified, and hence assessed
- **B**ehavioural - means it needs to be changeable by behaviour and bring change to routine care
- **A**chievable - indicates that it needs to be reachable and feasible and that the aim must be possible to attain [41]

Pronovost et al. [42] were among the first to describe QIs in intensive care, and several others followed. [40, 43-51] The choice of ICU QIs varies between European countries, [4, 40, 43] and achieving consensus on outcome indicators seems easier than on process. [4] However, a problem with using outcome 'rates' is that they do not indicate what, if any, action is appropriate to improve care. [36, 52] According to Freeman, [52] QIs are only meaningful if they are markers of outcomes or processes under clinicians' influence. Therefore, using process indicators may be more appropriate to improve the quality of care according to evidence-based principles. This is why the, e.g. German QI set focuses more on process indicators than outcomes. [43, 44] The European Society of Intensive Care Medicine (ESICM) agreed upon nine QIs in a Delphi process: four outcome-, two process- and three structure indicators. [4]

In Norway, NIR aims to develop national QIs, provide annual reports about ICU activity, and provide a basis for research and treatment. [3] NIR has registered data from the year 2000 and includes data from 45 (90%) Norwegian ICUs. [3, 19] Per 2017, seven national QIs agreed upon by the multi-professional council had been implemented, of which five corresponded to the ESICM QIs (Table 1). [19] The NIR QIs had been presented in the yearly NIR reports published online and accessible digitally through "Rapporteket". However, to my knowledge, none of the ICUs used the data actively to improve their intensive care quality locally in 2017. The NIR QIs were patient-level outcome indicators and self-reported process- and structure indicators, which may be challenging to utilise in quality improvement interventions. In 2017, active use and communication of QIs to optimise local intensive care indeed needed more focus and better documentation.

Table 1: Overview of quality indicators in ESICM, Germany and NIR in 2017

Quality indicator and level	ESICM	Germany	NIR
Outcome			
Standardised Mortality Rates	X		X
Readmission rates	X		X
CVC blood infections	X		
Unplanned extubations	X		
Duration of mechanical ventilation			X
Process			
Multi-disciplinary daily clinical ward rounds	X	X	X
Standardised Handover	X		X
Monitoring sedation, analgesia, delirium		X	
Early Mobilisation			
Lung protective ventilation		X	
Weaning and other measures to prevent Ventilator Associated Pneumonia		X	
Early and adequate initiation of antibiotic therapy		X	
Therapeutic hypothermia after cardiac arrest		X	
Early enteral nutrition		X	
Documentation of structured relative-/ next of kin communication		X	
Hand disinfectant consumption		X	
Direction of the ICU by a specialist, presence of intensive care physicians and nurses over 24 h/ day		X	
Structure			
24-h availability of intensivist	X		X
ICU fulfils national requirements	X		
Adverse reporting system	X		
ICU reporting to NIR			X

ESICM; European Society of Intensive Care Medicine, NIR; Norwegian Intensive care Registry

Quality improvement and implementational strategies

Widespread adoption and adherence to evidence-based clinical guidelines are lagging, regardless of clear benefits. Studies suggest that research evidence takes an average of 17 years for to reach clinical practice. [53] Thus, active implementation strategies are needed to improve the quality of care but it remains challenging. [16]

Diffusion is the distribution of information and the unaided adoption of recommendations, *dissemination* is the communication of information to improve knowledge or skills, and *implementation* refers to active dissemination involving strategies to overcome barriers. [15, 54] Several quality improvement- and implementational strategies addressing guideline implementation have been described. There is moderate certainty evidence that the following professional-oriented interventions probably increase adherence to clinical practice

guidelines: clinical decision-support systems (including reminders), educational outreach visits (including "practice facilitation"), A&F, local opinion leaders, tailored interventions, and educational meetings. [55] The evidence regarding strategies such as internet-based learning, printed educational materials, and public release of performance data is very low. It is, therefore, uncertain whether these strategies improve guideline adherence. [55]

Audit and feedback

A&F involves the provision of clinical performance summaries to healthcare providers over a specified period and is a common strategy to promote the implementation of evidence-based practices. [56-58] The strategy is suggested to work by changing the recipient's awareness and beliefs about current practice and motivating HCP to improve care. [59] It is unlikely that any theory will provide a complete picture of how A&F may be optimised. [60]

A&F has been found to improve clinical practice but with variable effects. [56, 58, 59, 61] Furthermore, A&F is probably more effective when provided by a supervisor or senior colleague, repeated both orally and in writing, and presented with goals and a clear action plan. [55, 56] In addition, aims to decrease the targeted behaviour. [56] Best practice recommendations were provided and summarised by Ivers et al. [57] as follows:

Audit components:
- Data are valid
- Data is based on recent performance
- Data are about the individual/team's behaviour(s)
- Audit cycles are repeated, with new data presented over time

Feedback components:
- Presentation is multi-modal, including either text and talking or text and graphical materials
- Delivery comes from a trusted source
- Feedback has comparison data with relevant others

Nature of the behaviour change required:
- Targeted behaviour is likely to be amenable to feedback
- Recipients are capable and responsible for the improvement

Targets, goals, and action plan:
- The target performance is provided
- Goals set for the target behaviour are aligned with personal and organisational priorities
- Goals for target behaviour are specific, measurable, achievable, relevant, time-bound
- A clear action plan is provided when discrepancies are evident

A&F is the most used strategy related to QIs, and combining feedback with another implementation strategy seemed the most effective. [62, 63] The effectiveness of A&F through SoMe was, to my knowledge, prior to 2017 not investigated.

Educational meetings

Different educational meetings have traditionally been the most common strategy for continuing medical education to improve professional practice. Educational meetings alone or combined with other interventions can improve professional practice with subsequent improved patient outcomes, but the effect is likely small. [64] Strategies to increase attendance at educational meetings, using mixed interactive and didactic formats, and focusing on outcomes likely to be perceived as severe, may increase the effectiveness of educational meetings. [64] However, educational meetings alone are not likely to be effective for changing complex behaviours. [64]

Opinion leaders

Opinion leaders are likeable, trustworthy, and influential people who may be valuable for disseminating and implementing 'best evidence'. [65] They may help persuade HCP to use evidence when treating and managing patients. Opinion leaders, alone or in combination with other interventions, may successfully promote evidence-based practice, but effectiveness is reported to vary within and between studies. [65] It may be challenging to identify who the opinion leaders are, and they need sufficient time and a clear understanding of their tasks. [55]

Multifaceted interventions

Multifaceted interventions are interventions where two or more components or strategies are combined. [66] A rationale for using multifaceted interventions is that people respond differently to varying interventions, and these strategies can deal with different types of barriers simultaneously, both within one individual and among groups of individuals. [67, 68] Another rationale could be that multiple rather than single methods of guideline dissemination and implementation must be employed based on the premise that practitioners will be in varying stages of change and face various barriers to adhere to guidelines. [69] Whether multifaceted interventions are more effective implementation strategies than single-component interventions is supported [67, 68, 70, 71] and demarked [66] in systematic reviews. However, improved clinical outcomes (mortality and ICU LOS) were more likely with a higher number of implementation strategies when targeting ICU delirium assessment, prevention, and treatment in a systematic review from 2015. [70] Noteworthy, A&F was used in all studies that reported significant mortality reduction. [70]

Implementing quality indicators

Effective strategies to implement QIs to improve hospital care exist. Still, there has been considerable variation in the methods used and the level of change achieved. A&F was the most used strategy to implement quality indicators in hospital care, and combining feedback with another implementation strategy was the most effective. [62] HCP and managers have reported positive attitudes towards implementing QIs. [48] However, behaviour-related barriers such as time constraints followed by barriers related to knowledge and attitude were reported as most prominent. In addition, the barriers and facilitators differed among professions, age groups, and settings. The facilitating factor perceived as most important was administrative support for intensivists, education for nurses, and receiving feedback for health care managers. [48] Process of care measures were more positively influenced by feedback than outcome of care measures. [51]

Communication platforms for diffusing, disseminating, and implementing guidelines

New technological innovations may provide opportunities for dissemination and implementation of guidelines. For example, smartphones with their applications may provide quick access to user-friendly guidelines. [55] Smartphones and tablets were intended to be included in a systematic review of handheld computers in 2014, but all the included studies investigated only personal digital assistants (PDAs). The review concluded that HCPs' use of handheld computers might improve information-seeking, adherence to guidelines and clinical decision-making. [72]

In 2017, SoMe had, through smartphones, changed how we communicate worldwide, [73] but data was lacking on whether this could be a novel way to improve quality of intensive care.

Social media

Several definitions of SoMe exist, [74, 75], and in the present thesis, SoMe and social networking sites are used interchangeably. SoMe may be defined as "forms of electronic communication (such as websites for social networking and microblogging) through which users create online communities to share information, ideas, personal messages, and other content (such as videos)". [76, 77] Internet, technology and SoMe enable people to instantly connect and interact with each other. [77] Approximately 31% of all world's citizen are characterised as "active social media users". [77] Examples of popular SoMe are Facebook, Twitter (changed name to X, July 2023), Instagram, Snapchat, TikTok, and YouTube. [75] In the present thesis, previous generations of electronic collaboration technologies such as e-mail, electronic discussion boards, wikis and blogs are not regarded as SoMe. [75]

The history of SoMe, defined as being online, has a short history, starting with the internet. [74] The internet we use today, the World Wide Web (web), was created in 1991 by Tim Berners-Lee, and commercialisation followed in 1995. [78] The first SoMe, "Six Degrees", was launched in May 1997. It is deemed the first SoMe because it allowed people to sign up with their email addresses, make individual profiles, and add friends to their network with friends lists and instant messaging (even if many of the features already existed). [74, 79] Six Degrees got limited impact and was terminated in 2001. [79] Friendster was launched in 2002, and MySpace in 2003. MySpace was the most popular SoMe until Facebook took over in 2008. [74] With smartphones, people could now bring and access their SoMe anywhere with internet access. [74] From the history of SoMe (Figure 1), we can learn that SoMe will continue to change with technology and people's preferences. New companies will emerge, and others will close. [74]

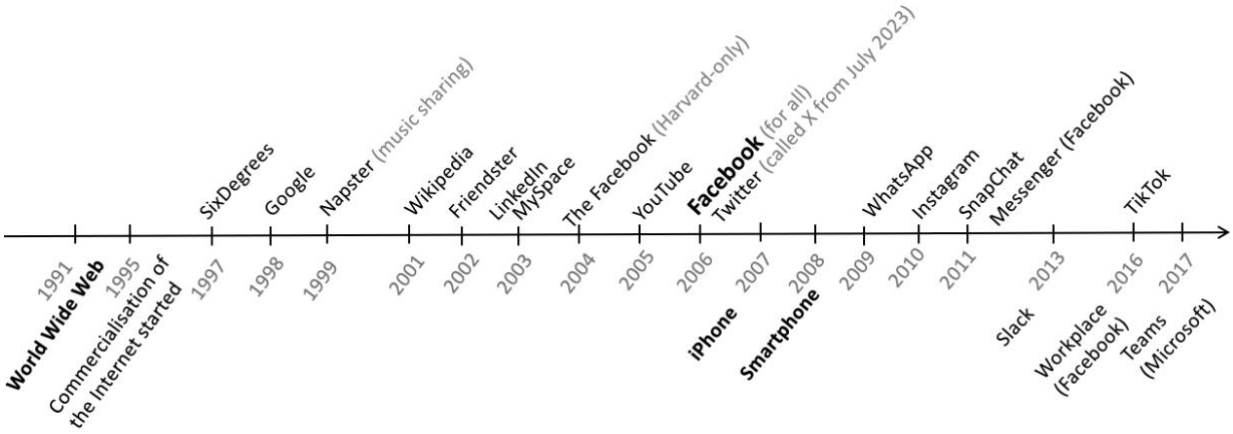

Figure 1: Timeline of relevant social media, technology and applications until 2017.

Facebook

Facebook was founded on February 4, 2004, by Mark Zuckerberg and his co-founders Dustin Moskovitz, Chris Hughes, and Eduardo Saverin. Facebook started as "The Facebook" exclusively for Harvard students. Over 1000 students registered on the first day, and the platform quickly spread to the Ivy League, the highly recognised and prestigious Universities. [74] After 2006, Facebook was available to anyone with a valid e-mail address claiming to be above 13, and it soon became the most popular SoMe. [74]

In 2017, Facebook was the most popular SoMe, with an average of 1.28 billion daily active users. [80, 81] In Norway, 84% of the adult population had a Facebook profile, and 82% were daily users. [82]

Facebook´s mission was to:

> *"give people the power to build community and bring the world closer together. People use Facebook to stay connected with friends and family, to discover what's going on in the world, and to share and express what matters to them".* [81]

Since its founding, Facebook has constantly evolved and modified the platform enabling different features and possibilities. The News Feed has since 2006 been every user's homepage and highlights content posted to Facebook, selected based on algorithms. [83] The "Like" button, a thumbs-up icon, was introduced in 2009 and enabled users to interact easily with shared content. Who and how many had liked the content was displayed, and the content was more likely to appear in friends' News Feeds based on likes. In 2010, the "Like" button was extended to comments, and in 2016, and expanded into different "Reactions" (pre-defined emotions) such as "Love", "Haha", "Wow", "Sad", or "Angry". [83] Using emojis and asking for 'likes' or comments was usual to increase the spread of posts.

Facebook groups

Facebook groups were introduced in October 2010. [84] These groups are specific spaces where content can be shared with groups of people sharing a mutual interest or connection. [85] Facebook groups have today two privacy settings; 'private' and 'public'. 'Private' was previously called 'closed', and 'closed Facebook groups' have been used in the present thesis. Closed Facebook groups entail that only current members can view group-related content. Group membership may need to be approved by group administrators, depending on group settings. [85, 86] Content posted in groups appears with notification of posting and may appear in the group members' "News Feed" based on algorithms. [86]

Social media use in healthcare

SoMe offer a medium to be used by the public, patients, and HCP to communicate about health-related issues. [73] The described benefits of SoMe use in health communication have included increased interactions with others and more available, shared, and tailored information. Limitations have included quality concerns and lack of reliability, confidentiality, and privacy. [73]

HCP have reported high SoMe use in surveys, [87-93] including usage during working hours. [91] SoMe have mainly been used for personal and social purposes, but also for professional purposes. [88, 89, 92, 93] Professional purposes have included sharing and exchanging medical information and for continuous professional development among primary care physicians. [90] In addition, it has included general education, continuing medical education and other professional usages among continuous medical education course participants. [89] Totally 96% of health researchers and clinicians felt there was a role for SoMe in disseminating or obtaining research evidence in a survey and interview study from 2015. [93] Significant associations were found between professional use and age, gender, country of residence, and graduate status. [93] Moreover, 60% of primary care physicians have stated that SoMe improved the quality of their delivered patient care. [90] Also, perceived ease of use and usefulness were reported to influence SoMe use, and those with more positive attitudes towards SoMe were more likely to share medical information with others. [90]

In education, SoMe usage has been described in medical-, [94, 95] pharmacy-, [96] physiotherapy-, [97] and bachelor nursing education. [98] In medical education, systematic reviews have concluded that Facebook, Twitter and a custom-made website were employed without professionalism problems and positive feedback from learners, [95] and that using SoMe was associated with improved knowledge, attitudes and skills. [94] In nursing education, a Facebook group designed by the academic staff was perceived as helpful in enhancing the student's self-efficacy and could support learning to a deeper level. [98] Among physiotherapy students, 73% revealed that they had used Facebook and YouTube for educational purposes and believed SoMe could benefit their learning experience. [97] The qualitative data resulted in four key themes: peer collaboration, the need for separating personal and professional realms, complimentary learning and enhanced communication. [97]

According to a mixed methods study, [99] use of SoMe had positive effects on HCPs' self-reported knowledge, perceived changes and improved practice. The intervention included a two-week course with eight practice points provided to HCP through Twitter or Facebook.

Among those, 70% indicated that the course had changed their practice or how they intended to practice and increased their research use in clinical practice. [99] The impact on actual practice was not examined. Definitely, if and how SoMe might be used to promote quality improvement still needs to be explored.

Social media use in Intensive care

As far as I know, only two studies had until 2017 investigated SoMe use in the ICU. [100, 101] A poster publication from Baylor All Saints Medical Center, Fort Worth, Texas, [100] focused on educating nurses regarding professional boundaries when using SoMe. The post-intervention survey showed improved awareness about SoMe and professional boundaries after the educational program. [100] Another pilot study from Vanderbilt University Medical Center, Nashville, Tennessee, [101] investigated monthly clinical vignettes relevant to neurocritical care via 'Freeform', a password-protected, online discussion forum supported by Vanderbilt University. The authors concluded that the intervention was a feasible point-of-care learning opportunity that might help to overcome some of the traditional barriers to ongoing nursing education needs in a busy ICU. [101]

In 2017, data about SoMe use among ICU personnel, their opinion regarding its use for professional purposes and the impact of using SoMe to improve the quality of intensive care was lacking. In an editorial from 2013, [102] the authors speculated whether SoMe might bridge the gap between research and practice describing researchers updating study progress through SoMe. According to Piscotty et al., [91] there may theoretically be an impact on the results of care (outcome), considering SoMe is available (structure) and used (process).

The rationale for the present studies

At OUH, traditional ICU communication methods had been meetings, educational sessions, and sharing documents on paper or via e-mails. The availability and convenience of sharing information and content instantly via SoMe seemed appealing and promising, considering that most HCP were probably active SoMe users, even if use among ICU personnel was not described. Established closed Facebook groups for social content and shift-swapping were already actively used in all four study ICUs. However, whether the ICU nurses and physicians were positive towards using SoMe for professional purposes, and if and how SoMe usage may optimise intensive care according to international recommendations, was unexplored and very interesting to investigate.

AIM OF THE THESIS

This thesis aimed to explore, describe, and evaluate the use of SoMe for providing A&F of QIs to optimise guideline adherence and, thus, the quality of intensive care provided in the ICU. The thesis includes three studies with the following specific aims:

Paper I

The main aim was to describe ICU nurses' and physicians' use of SoMe in general and their perception of using closed Facebook groups for receiving professional content on critical care topics. The secondary aim was to describe habits of reading professional content and perception of the importance of the selected quality indicators.

Paper II

The main aim was to evaluate the impact of a multifaceted intervention, including A&F of QIs via Facebook groups and email, educational events, and engagement of opinion leaders to optimise adherence to the recommended PAD guidelines. We hypothesised that process PAD-QIs would increase in the intervention period compared to the period before. The secondary aim was to evaluate the Facebook intervention process, with the number/ proportion of 'seen', 'likes', and comments from the Facebook posts.

Paper III

The aim was to explore ICU nurses' and physicians' experiences with the use of their closed Facebook groups as part of the multifaceted intervention provided, aiming to optimise guideline adherence.

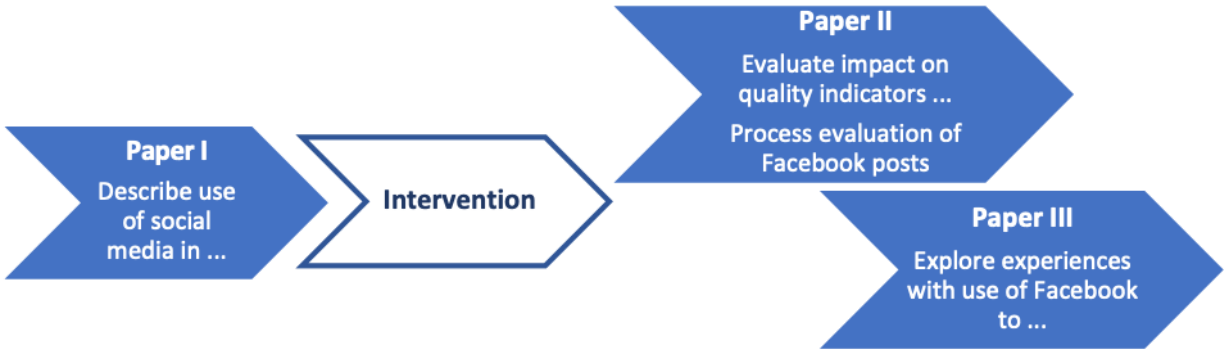

Figure 2: Illustration of the three study aims in relation to the intervention

METHODS

Study design

In a mixed design, two quantitative and one qualitative study were conducted to answer the overall thesis- and three study aims (Table 2 and Figure 3). The present thesis includes a multifaceted intervention using Facebook to target ICU nurses and physicians' adherence to current guidelines focusing on seven ICU QIs. Prior to intervention initiation, a quantitative pre-intervention survey was conducted to primarily describe the use of SoMe among ICU nurses and physicians and their perception of using closed Facebook groups for professional content (Paper I). The multifaceted intervention included A&F on QIs, provided in four ICUs established closed Facebook groups. A quantitative quasi-experimental interrupted time series (ITS) study was conducted to evaluate the multifaceted intervention's impact on documented PAD assessments in the medical chart (three of the seven QIs) (Paper II). The proportion of nursing shifts with a documented assessment of PAD was compared in the two time periods Before (January -August 2017) and Intervention (October 2017-May 2018). In addition, the reach of Facebook posts was evaluated through the proportion of group members who had seen and liked/commented on the posts. Following the intervention period, a qualitative post-intervention focus group interview (FGI) study was conducted to explore the ICU nurses' and physicians' experiences with the intervention and use of their closed Facebook group aiming to optimise intensive care (Paper III).

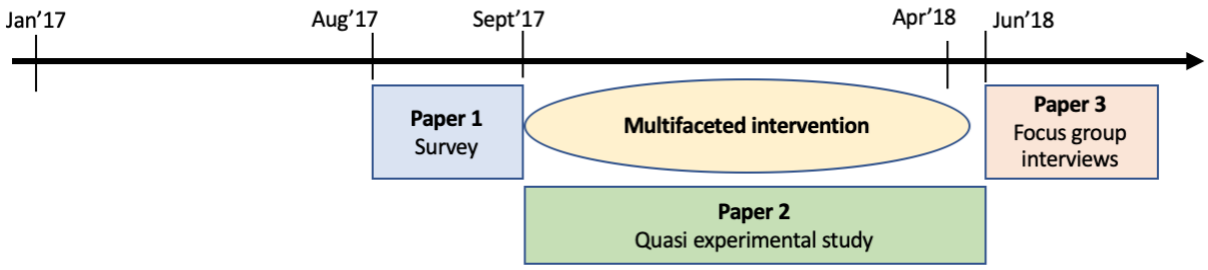

Figure 3: Timeline of the provided multifaceted intervention and the three papers.

Table 2: Thesis overview

	Paper I	Paper II	Paper III
Study aims	To describe ICU nurses' and physicians' use of SoMe in general and their perception of using closed Facebook groups for receiving professional content on critical care topics.	To evaluate the impact of a multifaceted intervention, including A&F of QIs via Facebook groups and email, educational events, and engagement of opinion leaders to optimise adherence to the recommended PAD guidelines. Process evaluation of the Facebook intervention.	To explore ICU nurses' and physicians' experiences with using closed Facebook groups in a multifaceted intervention aiming to optimise guideline adherence.
Study design	Prospective cross-sectional quantitative survey	Quasi-experimental, interrupted time-series study (and a process evaluation)	Focus group interviews
Study site		4 ICUs at OUH	
Intervention	Pre-intervention	Intervention	Post-intervention
Study period	Aug 2017-Sept 2017	Jan 2017- May 2018 - Before: Jan'17-Aug'17. - Intervention: Oct'17-May'18	June 2018
Data	Quantitative	Quantitative	Qualitative
Data sources	Electronical web-based survey via Nettskjema (University of Oslo)	Electronical patient charts, Norwegian Intensive Care Registry Facebook groups	Two semi-structured focus group interviews
Study sample	ICU nurses and physicians (n=253)	ICU patient-stays (n= 1049) Facebook posts (n=79) Facebook group members (n=78-160)	ICU nurses and physicians (n=12)
Outcomes	Nurses and physicians selfreported use of - SoMe & smartphones - Facebook & hosp comm. - professional literature and knowledge-dissemination - importance and quality of seven critical care topics	Nursing shifts with documented assessments of PAD Process evaluation: Group members (%) that had seen, liked and commented	None; Explorative design
Analyses	Descriptive statistics Bivariate analysis	Descriptive statistics Bivariate analysis Generalised mixed model for repeated measures with unstructured covariance matrix	Qualitative reflexive thematic analysis
Comparison	Professions, age groups, gender	Before vs Intervention	None
Approvals		2016/2281/REK sør-øst A*Departmental, OUH	
Informed consent from	ICU nurses and physicians	Patients or their relatives	ICU nurses and physicians

ICU; intensive care unit, SoMe; Social media, A&F; Audit & Feedback, QI; Quality indicators; PAD; Pain, Agitation/ sedation, Delirium, OUH; Oslo University Hospital, n/N; number, hosp; hospital, REK, Regional Ethics Committee, *REK additional approval Focus group interviews, May 2018

Study sample

In Paper I, the pre-intervention survey, all ICU nurses and physicians working in one of the four ICUs were invited via their hospital e-mail to answer an anonymous electronic survey.

In Paper II, the quasi-experimental intervention study, documented PAD assessment during ICU patient stays was collected in adult patients (>18 years) with an ICU stay for more than 48 hours in one of the four participating ICUs. All consecutively admitted ICU patients were included retrospectively from 01.01.2017-11.06.2017 and prospectively from 12.06.2017- 31.05.2018. In addition, the proportion of Facebook group members that interacted with the actual Facebook posts was collected.

In Paper III, the post-intervention FGI study, purposive sampling was used. [103, 104] ICU nurses and physicians working full time in one of the four ICUs and being members of one of the ICU closed Facebook groups during the intervention period were deemed eligible. Contact persons in each ICU were asked to recruit 14 participants, seven participants for each FGI, maximising variation in the profession, sex, age, experience, and workplace to ensure diverse perspectives.

Study setting

All three studies were performed at four level three ICUs at OUH, the largest hospital in Norway; 1 870 hospital beds and 1.2 million patient treatments per year. [105, 106] OUH consists of the four hospitals Ullevål, Rikshospitalet, Aker and Radiumhospitalet, which were merged into OUH in January 2010. [105] Still, there are differences in organisational structures and culture between the four hospitals and their respective ICUs. The two locations involved in this study were Ullevål and Rikshospitalet. Ullevål is a large trauma centre, with two ICUs participating; a general, surgical ICU that primarily treats patients with multiple-trauma or complications after severe surgery (mainly gastrointestinal), and the other a specialised ICU for Neurointensive care patients, mainly traumatic brain- and spinal cord injuries The two ICUs included from Rikshospitalet have national responsibilities regarding organ transplantation, offer Extracorporeal Membrane Oxygenation (ECMO) to patients with severe respiratory failure, and are general units treating both surgical and medical patients.

Communication platforms for the hospital staff at OUH consisted of hospital e-mail and the intranet site, requiring a login to the hospital server, available for most employees only when physically present. All four ICUs had their own closed Facebook groups prior to study initiation, administered by a nurse from each ICU. Group membership was voluntary,

and prior to the present campaign, the groups were exclusively used for social content or a mix of social content and shift swapping. Table 4 gives a closer overview of the different ICU structures.

Table 3: ICU structures and established closed Facebook groups

Intensive Care Unit (ICU)	No. of ICU beds	No. of staffed ICU beds	Regular Nursing staff FTEs*	Physicians dedicated to two ICUs in same location	Name of Closed Facebook group	No. of members in Facebook group[#]
General intensive care unit Ullevål, OUH-U	12	10	90	Approximately 10	*Generell intensiv Ullevål*	151
Neuro intensive care unit, OUH-U	8	6	55		*Nevrointensiv, OUS Faggruppe*	80
General intensive care unit 1, OUH-RH	11	10	92	Approximately 6	*Generell intensiv 1 (RH)*	160
General intensive care unit 2, OUH-RH	9	6	52		*Generell intensiv 2 (RH)*	110

FTE; Full-time equivalents, OUH; Oslo University Hospital, U; Ullevål, RH, Rikshospitalet
*Budget numbers for 2017 provided by head of department, [#]Groupmembers November 2017

Multifaceted intervention

A multifaceted intervention targeting the ICU nurses and physicians, as the main stakeholders of intensive care, was provided in the four ICUs. The intervention included involvement of local opinion leaders, educational events, and A&F of QIs weekly via closed Facebook groups and monthly via email (Table 5). Audits of the QIs were based on last month's practice in the local ICU. Feedback was provided orally and in writing, first during educational events where the QIs were explained, and thereafter results were compared to the other ICUs. At these educational events, the respective ICUs' professional development nurses (opinion leaders) were present and gave support to the project. Feedback was repeated and provided through Facebook posts for the following six months. In these posts, results from QI data were compared to the predefined overall goal of 70% of nursing shifts with documented PAD assessment, previous measurements within the same ICUs, or to the other ICUs. This was shown with tables, graphs or text. A Facebook post could also contain other relevant content such as, e.g. videos, images, podcasts and weblinks. Opinion leaders (heads of departments and professional development nurses) were provided with A&F through monthly e-mails.

They were encouraged to remind and support the staff in the clinical setting and to forward the e-mails and post the graphs physically in the ICU.

Table 4: Main components of the multifaceted intervention

Component/ timing	Description
Educational events (Sept.'17- Oct.'17)	▪ Three-hour lectures for nurses and one hour for physicians ▪ Quality in health care and QIs in general ▪ Presentation and explanation of the selected QIs related to topics of; pain, agitation/sedation, delirium, early mobilisation, early enteral nutrition, multiprofessional ward rounds and pressure injuries prevention ▪ and their importance ▪ A&F of QIs in the respective ICUs compared to the three other ICUs
Weekly A&F via closed Facebook-groups (Nov.'17-May'18)	▪ Weekly Facebook posts (26 posts) posted simultaneously in all four ICUs pre-existing Facebook groups ▪ ICU *topic focused on* (one post both on pain, agitation/sedation, delirium and mobilisation): - All topics (4 posts) - Pain, agitation/sedation and delirium (7 posts) - Early Mobilisation (4 posts) - Early enteral nutrition (3 posts) - Multi-professional ward rounds (1 post) - Pressure injury (4 posts) - None of the topics mentioned specifically (4 posts) o Feedback of QIs via SoMe in general o Ventilator-associated pneumonia o Silly Happy Holidays video o Facebook poll of preferred place of information ▪ Content related to the ICU topics (two posts had both picture and weblinks): - Image (11 posts) o Graph: development of QIs within the ICU (2 posts) o Table: QIs levels for all four ICUs (1 posts) o Algorithm from guideline (3 posts) o Picture (5 posts) - Video (11 posts) o Interviews (8 posts) o Educational (2 posts) o Silly Happy Holliday video (1 post) - Weblink (3 post) - Podcast (1 post) ▪ Call for likes and comments including prizes to one of them
Monthly A&F via e-mail (Dec.'17-April'18)	▪ Monthly feedback of QIs via e-mail (5 e-mails) ▪ E-mail text containing short version of A&F for the last month ▪ Attachment with graphs and tables of the QIs in all four ICUs ▪ Call for action (improving practice and forwarding, sharing, posting)
Involvement of local opinion leaders (Sept.'17- May'18)	▪ Meeting with staff leadership with emphasis on their engagement ▪ Meetings with the professional development nurses with emphasis on their involvement to improve the levels of measurement ▪ Meetings with physicians (March 2018)

Abbreviations: A&F; audit and feedback, ICU; intensive care unit, QIs; quality indicators

For the study intervention, a complete set of seven QIs were chosen by the multi-professional research team; six PIs and one OI (Table 1 and Table 2), inspired by the German ICU QIs. [43, 44] The domains were selected because they were considered relevant and essential to optimise critical care and cover all ICU patients, regardless of case mix. In addition, the QIs were based on the RUMBA rule: understandable, measurable, behavioural, and achievable. For Paper II, only the three PAD-QIs gained focus (Table 5).

Table 5: The set of Quality Indicators and formula for measurement and goal

Process Indicator	**Formula for measurement**	**QI level Standard/ Goal**
1. Multi-disciplinary ward rounds	Updated daily targets and goals / Days in ICU x 100	≥ 95%
2.-4. Monitoring pain, agitation/ sedation, delirium (PAD)	**Number of shifts with P/A/D assessments / Number of nursing shifts (>2h) in ICU x 100**	**≥ 70%**
5. Early mobilization (EM)	Number of patients EM within 72h / Total number of patients x 100	≥ 70%
6. Early enteral nutrition (EN)	Number of patients with EN initiated within 48h / Number of patients in whom EN is indicated x 100	≥ 70%
Outcome Indicator		
7. Pressure Injury (PI)	Incidence of PI / Number of patient ICU days x 1000	≤ 35 PI/ 1000 ICU days

Data collection procedure

Data were collected through a survey, patients' medical charts, NIR, Facebook and FGIs (Table 2 and Figure 4).

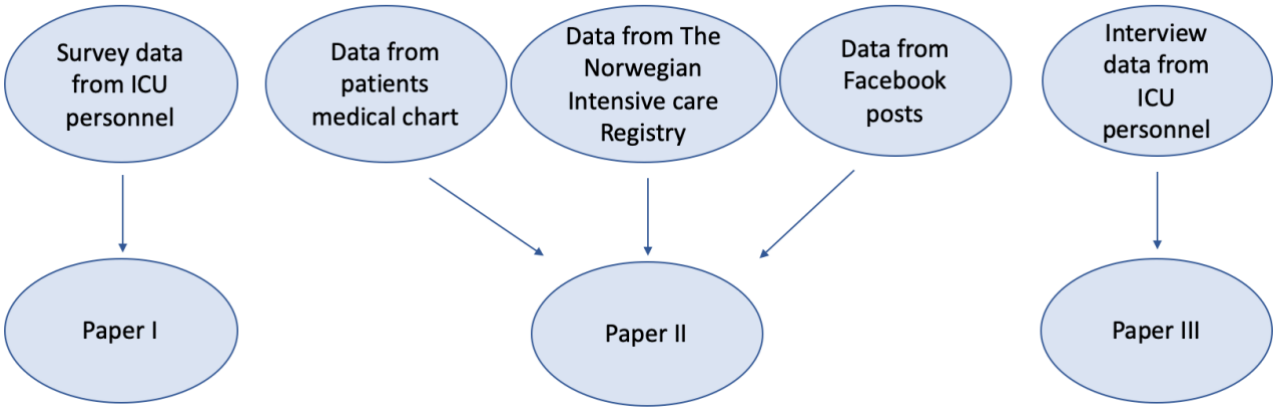

Figure 4: Data collected in the three papers

Paper I

Anonymous data were collected in an electronic web-based survey using Nettskjema by the University of Oslo (UiO). The questionnaire included 82 closed-ended items grouped into five sections:

1. Demographics
2. SoMe- and smartphone-habits
3. Use of Facebook, including closed Facebook groups and traditional hospital communication platforms
4. Frequency and preferences of reading professional literature and the perceived importance of eight methods of knowledge-dissemination aiming to optimise critical care
5. Perceived importance of seven critical care topics (multi-professional ward rounds, early enteral nutrition, pain-, agitation/sedation-, delirium assessment and management, early mobilisation and pressure injury prevention).

This questionnaire was developed based on a Norwegian survey studying media use in the general public. [107] The questions were adapted and modified to reflect the specific ICU context and also pilot-tested in a sample of five ICU nurses and fellow researchers. Modifications were related to the adaptation of the five-point Likert scale to the 11-point numeric rating scale (NRS), with 0 indicating "not at all" and 10 "very much." To complete the survey, all questions had to be answered.

Paper II

Data collection included quantitative data from electronic medical charts, NIR, and Facebook. Data collected from the electronic medical chart was connected to data from NIR.

Data from electronic medical charts

Data were manually collected directly from the electronic medical chart MetaVision and entered into the statistical program. The following data were collected: number of nursing shifts with documented PAD assessment and number of nursing shifts lasting more than two hours. The QIs should not require additional documentation; rather, it should ideally be possible to collect them using routine documentation [44].

Data from Norwegian Intensive care Registry

Data from NIR was retrieved and connected to the data from the electronic patient chart. These data included demographic data such as sex, age, body weight, and The Simplified Acute Physiology Score (SAPS) II, the primary reason for ICU admission (Respiratory-, circulatory/cardiovascular-, gastroenterological-, neurological failure, sepsis, injury/trauma and other), treatment interventions (mechanical ventilation, tracheostomy, intracranial pressure monitoring, vasoactive infusion, extended hemodynamic monitoring, targeted temperature management, hemodynamic support, and renal replacement therapy), Nursing Activities Scores (NAS), time on invasive mechanical ventilation, LOS ICU, and ICU mortality.

Data from Facebook groups

Data from the Facebook groups were manually collected. The number of members who had viewed the posts was collected in addition to the number of 'likes'/ reactions and comments. In addition, data regarding topic of the post, timing of posting, and all related content (video, picture, web link) were also collected.

Paper III

Two FGIs were conducted in hospital meeting rooms (one at each location) in June 2018, one month after completing the Multifaceted intervention campaign, which included the Facebook posts.

A semi-structured interview guide was developed and discussed within the research group before initiating the FGIs. This guide aimed to capture all experiences using existing closed Facebook groups to provide professional content. The goal was to initiate discussions on their general experiences of implementing evidence-based recommendations with the use of Facebook.

The main supervisor (HW) conducted the interviews, with me as the observer. Considering that all participants knew one or both of us as colleagues and that I was responsible for the Facebook campaign, my presence during the FGIs may have hindered openness, especially about possible negative experiences. Thus, it was clearly emphasised that both positive and negative experiences were equally essential and valuable for the evaluation of the intervention. At the end of each session, a summary of the interviewer's understanding

was presented, and the participants were invited to confirm the statements and add additional comments. Finally, the audio-recorded FGIs were transcribed by me.

Data analysis

Data analysis included statistical analysis in Papers I and II and qualitative analysis in Paper III.

Paper I

With the Statistical Package for Social Sciences (SPSS) for Windows, version 25 (IBM Corp., Armonk, NY, USA), descriptive statistics and bivariate statistical analysis were performed. Response rate and descriptive statistics for categorical data were presented with numbers and percent or as percent with 95% Confidence intervals (CI). The 11-point NRS was treated as a continuous interval variable and was presented with median and interquartile range (IQR), with first (Q1) and third (Q3) quartiles.

Bivariate tests were used to evaluate the likelihood that any observed difference between the data sets arose by chance, calculated by the p-value. The level of statistical significance was set to a two-sided p-value of <0,05 in all analyses. Categorical data between independent groups were compared using *Pearson's chi-squared test. Fischer's exact test* was used for small sample sizes (expected count less than five in a contingency table). *McNemar's test* was used for categorical, paired data within a group (for example "daily Facebook use" vs "daily use of e-mail"). The non-parametric *Mann-Whitney U test* was used to compare continuous, skewed (not normally distributed) data between independent groups.

Paper II

The SPSS was used for descriptive statistics and bivariate statistical analyses. The *complex time series analysis and the generalised mixed model for repeated measures with an unstructured covariance matrix* were performed using MATLAB by MathWorks, Inc.

Descriptive statistics for continuous variables were presented with mean and ± standard deviation (SD) if normally distributed and with median and IQR for skewed data. Categorical data were presented with numbers and percentages.

Bivariate tests were used to evaluate the likelihood that any observed difference between the two groups 'Before' and 'Intervention' arose by chance, calculated by the p-value. Statistical significance levels were set to a two-sided p-value of <0,05 in all analyses. The *Independent samples t-test* was used to compare normally distributed continuous data between independent groups to determine if the means of the two groups of data were significantly different from each other. For continuous skewed data, the *Mann-Whitney U test* was used to evaluate whether one group had larger values than the other. *Pearson's chi-squared test* or *Fischer's exact test* were used as appropriate for categorical data.

In the ITS analysis, time was measured in months, with data from each ICU patient stay allocated to the appropriate month based on the discharge date. Data were depicted graphically using estimates of aggregated monthly averages (mean) with 95% CI.

A *generalised mixed model for repeated measures with an unstructured covariance matrix* was used to compare Before vs Intervention. Results were presented as estimated means at given time points (separately for each ICU) and overall estimated change (Before-Intervention) quantified as regression coefficient Beta (B) with 95% CI. The model unstructured covariance matrix was chosen not to impose constraints on the values.

Paper III

Reflexive thematic analysis (TA) using the six steps described by Braun and Clarke [108, 109] was used to identify themes (patterns of meaning) in qualitative data. [108, 109]

Qualitative data consisting of the transcribed text of the audio recorded two FGIs. Qualitative data analysis software (QDAS) NVivo: QSR International Pty Ltd., Version 12.7.0 for Mac, was used during the analysis to organise the data in the six steps of TA, starting with importing the transcribed data and coding (Table 6). As recommended, the analysis was recursive and iterative, moving back and forth throughout the phases, not linear or stepwise. Throughout the process, data extracts, codes and themes were taken from NVivo into tables and discussed with two co-authors (HB and HW) in several meetings to check for coherence. In reflexive TA, there is no expectation that another researcher may reproduce codes or themes. However, multiple coders may be beneficial in a reflexive manner (e.g. sense checking or exploring assumptions or interpretation of data. [110]

Patterns of meaning were reported at two of the three possible levels in TA: overarching themes, themes and subthemes. [111]. Overarching themes are not typical for TAs and were not used. Usually, a theme should not include contradictory meanings, but different

themes may contradict each other but not internally contradict. However, the theme may be about tension or contradiction, [111] as in our theme 'applicable, yet inappropriate'.

Table 6: Description of the six phases of Reflexive Thematic Analysis in Paper III

Phase 1:	Familiarisation with the data	Participating in the FGIs, listening, and transcribing the recordings, reading multiple times in an active way, making initial notes with ideas for coding.
Phase 2:	Generating initial codes (Coding)	Initial codes were generated inductively, coding for as many potential patterns as possible and preserving surrounding data in the coded data extracts. Data extracts could be coded multiple times. First manually on paper and then in the software NVivo.
Phase 3:	Generating themes	Codes were reviewed and collated into groups in the software NVivo. Initial themes were made by naming the groups of codes.
Phase 4:	Reviewing themes	Reviewing the themes by checking if they work with the codes and dataset.
Phase 5:	Defining and naming themes	Ongoing analysis to refine an define the themes. Going back to the collated data extracts for each theme, renaming the themes, and choosing data extracts.
Phase 6:	Producing the report	Final analysis and writing the report (Paper III). All co-authors contributed with substantial input in this and the previous phase.

The six phases were not followed linear and stepwise but recursively and iteratively, moving back and forth between the phases. Braun and Clarke (2006).
Abbreviations: FGIs, Focus Group Interviews

Ethical Considerations and Approvals

The studies included in this thesis were approved by the Norwegian Regional Ethics Committee for Medical and Health Research Ethics (REK) in the south-east of Norway (2016/2281/REK sør-øst A), the Data Protection Officer of OUH (PVO), and departments heads of the Department of Intensive and Postoperative Nursing and Department of Anaesthesia and Intensive care Medicine at OUH. REK also approved changes to the project in May 2018 and February 2020.

Permission was obtained to connect NIR data with data from MetaVision. All ICU patients included in the study received standard care throughout the study, and thus the risk of participating in the study was considered minimal. In addition, participation in the studies, - defined as allowing the use of documented data related to the selected topics of QIs, was voluntary and included the possibility of withdrawing. The studies were conducted according to the World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects, [112] specifically incorporating principles of informed consent, right to withdraw, privacy and confidentiality.

Consent

In Paper I, participation was voluntary and completing the survey implied informed consent.

For data encompassing the prospectively included patients' ICU stay (Paper II), written informed consent was obtained from the patient or their relatives during the ICU stay by a study nurse not actively involved in patient care. The possibility of withdrawing from the study was pointed out orally and through the signed form, which also included contact information for the PhD student. Consent from data encompassing the retrospectively included patients' ICU stay was achieved by a posted information letter to their home address requesting to use a defined set of their ICU data and including an open possibility to withdraw their study participation at any time point. Information about withdrawal was included in the letter, together with contact information and a pre-stamped envelope.

For Paper III, written informed consent was obtained from the ICU nurses and physicians participating in the FGIs at the beginning of each FGI.

Privacy, storage, and confidentiality

Data from the patient chart and NIR was securely stored during the study period on the hospital research server assigned to the project from the PVO. Data from the two sources were connected using the study number. Data between NIR's offices in Bergen and Oslo was transported on an encrypted memory stick (IronKey) with a personal courier. Data were deidentified and stored on the secured hospital research server. In contrast, the code list was stored on paper and on a separate encrypted memory stick in a locked cabinet in a locket office at OUH. Anonymous data was collected in the survey and from Facebook, and data from the FGIs were anonymised from the transcription. The audio-recorded files were kept in a locked cabinet in a locket office at OUH and on the hospital research server assigned to the project.

RESULTS

Table 7: Overview of the paper titles and main results of the three studies

Paper	Title of paper	Main Results
Pre-intervention		
I	Use of social media for communicating about critical care topics: A Norwegian cross-sectional survey	-Nearly all ICU nurses and physicians had a social media (SoMe) profile, and most had several SoMe -The majority used SoMe for non-professional purposes -Facebook was the most used SoMe (profile and daily use) -Usage was more common among those younger than 40, females and nurses -Most nurses were members of their ICUs closed Facebook group, whereas few physicians were -Nurses were more positive towards receiving professional content in closed Facebook groups versus physicians -'Use of SoMe for disseminating papers and other educational material' was rated lowest among eight strategies to optimising adherence to recommended clinical practice -Nurses read professional literature less frequently than physicians -The selected quality indicators were perceived as important by the participants
Intervention		
II	Multifaceted intervention including Facebook-groups to improve guideline-adherence in ICU: A quasi-experimental interrupted time series study	-Overall, all three PAD-QIs significantly increased in the Intervention period -Improvements in PAD-QIs differed in the four ICUs -Most group-members had seen the Facebook posts, whereas few commented and liked
Post-intervention		
III	Use of Facebook in a quality improvement campaign to increase adherence to guidelines in intensive care: A qualitative study of nurses' and physicians' experiences	Two main themes were identified: -'One size does not fit all' included the two subthemes: 'Simplifying practice or justifying change', and 'Targeting individual barriers' -'Matter out of place' included the three sub-themes: 'Content is key', 'Applicable, yet inappropriate', and 'Ensuring information'

Paper I

This anonymous, electronic web-based survey had a response rate of 64% (253/ 394) and included 253 participants; 210 nurses and 43 physicians. Overall, 74% were female, and 61% were older than 40 years of age. Age and sex were differently distributed between nurses and physicians, with more nurses being female (83% vs 33%) and younger than 40 years (42% vs 26%) compared to the physicians.

Overall, 99% had a smartphone, 93% a SoMe profile, and 77% on multiple sites. Facebook was the most used SoMe, with 87% having a profile and 68% reporting daily use (Figure 5). Only 13% reported using SoMe for professional development.

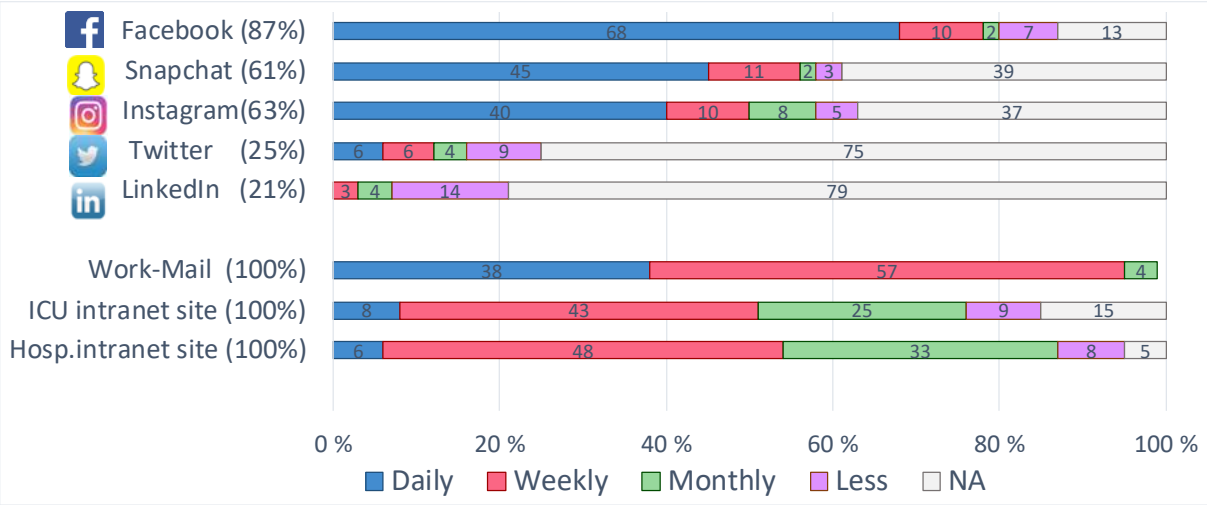

Figure 5: Social media and traditional platform usage among nurses and physicians.

Reprinted after modification such as colour from Petosic et al., 2019. Use of social media for communicating about critical care topics: A Norwegian cross-sectional survey. Acta Anaesth Scand, 63(10), 1398-1405. CC BY License: http://creativecommons.org/licenses/by/4.0/

A Facebook profile was more common among those younger vs those older than 40 years (97% vs 81%, respectively, p= <0.001). Daily usage was more common among females vs males (81% vs 68%, respectively, p= 0.047) and nurses vs physicians (81% vs 60%, respectively, p= 0.006).

In total, 98% of the 186 nurses with a Facebook profile were members of their ICUs' closed Facebook group. Among the 35 physicians with a Facebook profile, only 31% were members of their ICUs' closed Facebook group. The group members were relatively positive towards receiving professional content on critical care topics in the groups (nurses vs physicians: median NRS 7 (3-9) vs 5 (1-8), respectively, p= 0.117). Nurses were more positive than physicians (median NRS 9 (6-10) vs 6 (3-9) respectively, p= 0.014) toward being members of closed Facebook groups specifically aiming to exchange content on critical care topics.

In addition, the nurses reported a lower rate of reading professional literature versus the physicians (daily and several times per week; 28% vs 72%, respectively, p= <0.001). 'Use of SoMe for dissemination of papers and other educational material' was rated lowest among the eight listed methods for disseminating knowledge aiming to increase guideline adherence, but was rated higher among nurses than physicians (median NRS-scores 6 (4-8) vs 3 (2-6), respectively, p <0.001). The participants generally perceived the selected quality indicators as important on an NRS scale.

Paper II

To evaluate the impact of the multifaceted intervention on the PAD-QIs, data from electronic medical records of 1049 ICU patient stays were analysed; 534 in Before and 515 in Intervention. The two groups had some different demographic- and clinical characteristics. More patients in Before received invasive mechanical ventilation, tracheostomy, and vasoactive drugs vs Intervention. Additionally, patients in Before had a longer mechanical ventilation period and a higher mortality rate. However, mean SAPS II scores were similar in the two groups.

The PAD-QIs were organised into 16 individual monthly data points, including data from 53 to 80 ICU patient stays at each data point, as depicted in Figure 6. Overall, the ITS analyses showed an increase in all three PAD-QIs in Before vs Intervention (Figure 6). The three PAD-QIs significantly increased in Intervention by 31% (B = 30.7, 95%CI (25.7 to 35.8)), 26% (B = 25.8, 95%CI (19.4 to 32.2)) and 34% (B = 33.9, 95%CI (28.4 to 39.4)) in pain, agitation/ sedation, and delirium, respectively.

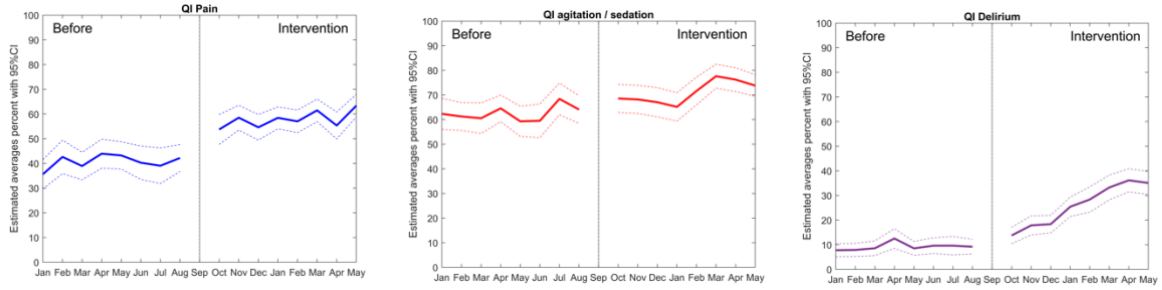

Figure 6: Interrupted Time Series of Quality Indicators (QI); nursing shifts with a documented assessment of pain, agitation/ sedation and delirium.
Reprinted from Petosic et al., 2021. Multifaceted intervention including Facebook-groups to improve guideline-adherence in ICU: A quasi-experimental interrupted time series study. Acta Anaesth Scand, 65: 1466– 1474. CC BY License: http://creativecommons.org/licenses/by/4.0/

The results differed in the four individual ICUs. Compared with Before, all QIs improved in Intervention in three ICUs. In ICU 3, however, only the QI for delirium improved, whereas pain and agitation/ sedation remained unchanged with already high pre-existing activity in Before.

Process evaluation of the Facebook posts was performed 24 h after posting on 79 of the 104 (76%) posts. The four closed Facebook groups had 78–160 members, of which approximately 70% of the members had ‘seen’ the posts, whereas only 7% and 3% ‘liked’ and commented on the posts, respectively.

Paper III

This qualitative FGI study, exploring experiences with SoMe as part of a quality improvement campaign, included 12 participants from all four ICUs, both nurses and physicians, male and female, and aged from 32 to 53 years. Of the 14 initially recruited, two participants were unable to attend on the day of the first FGI.

Two main themes were identified; 'One size does not fit all' and 'Matter out of place'. 'One size does not fit all' described that implementation and quality improvement generally was affected by different factors and personal preferences. Implementation was more likely when leading to a more simplified practice. Otherwise, a professional justification was needed. Several strategies were required during implementation due to various barriers and personal preferences, illustrating that one size does not fit all. The theme included two subthemes: 'Simplifying practice or justifying change' and 'Targeting individual barriers' (Table 8).

'Matter out of place' described conflicting experiences of being offered or exposed to professional content on Facebook. Although the provided A&F of QIs from Facebook motivated improvement, Facebook was regarded as inappropriate and ‘Matter out of place’. Instead of Facebook, better and more applicable hospital communication platforms were suggested. The theme included the three sub-themes: 'Content is key', 'Applicable, yet inappropriate', and 'Ensuring information' (Table 8).

Table 8: Overview of main themes, sub-themes and description

Main Themes	Sub-themes	Description
One size does not fit all	Simplifying practice or justifying change	Implementation and adherence to updated guidelines in general was more likely when leading to a more simplified practice, otherwise a professional justification was needed.
	Targeting individual barriers	Several barriers had to be addressed during the implementation process, and various strategies were needed to serve different purposes and meet individual needs. However, to please all was deemed impossible.
Matter out of place	Content is key	The provided audit and feedback on quality indicators presented on Facebook motivated improvement by increasing awareness.
	Applicable, yet inappropriate	Describes conflicting experiences of being offered or exposed to professional content on Facebook.
	Ensuring information	Better and more applicable communication platforms for hospitals were suggested.

DISCUSSION

The discussion is divided into three main parts. First, a discussion of relevant methodological considerations followed by a discussion of the main findings and finally clinical implications and future perspectives.

Methodological considerations

The present thesis includes two quantitative and one qualitative study conducted to inform different aspects of the overall aim. Quantitative and qualitative research traditions have different approaches to assessing quality. Therefore, the two quantitative studies' validity and the qualitative study's trustworthiness are discussed separately.

Discussion of validity - Paper I and II

A quality criterion of a quantitative study is validity, which is related to whether the right (accurate and well-founded) inferences from a study have been made. [113] Validity may be divided into internal and external validity. [113]

Internal validity

Internal validity of the present papers assesses whether the survey questions (Paper I) adequately address the study aims and if the observed outcomes in the quasi-experimental study (Paper II) can be attributed to the multifaceted intervention and no other uncontrolled factors. The internal validity of the two studies is discussed related to research design, selection bias, and statistical analysis.

Research design elements affect the inferences that may be made and, thus, the internal validity of a study. [113] The survey (Paper I) and the quasi-experimental ITS study (Paper II) are supposed to be acceptable designs to answer the aims of the studies. However, both designs are susceptible to many sorts of biases that may distort the results of the study and thus threaten the internal validity. Eliminating, reducing, or controlling these biases was therefore prioritised in the study planning. According to Polit and Beck, [113] it is not a question of whether a study has biases, but rather which ones and how extensive and systematic they are.

The cross-sectional survey (Paper I) was conducted to describe SoMe use among the study population and their perception of using closed Facebook groups for professional content. Self-reported data were collected, with the participants answering a series of questions to describe the prevalence, distribution, and interrelations of SoMe usage within the population. [113] A survey was deemed a cost-effective way to collect data from many participants in a short period of time. However, surveys are susceptible to several threats to internal validity, such as response bias, where people tend to present a favourable image of themselves and thus provide biased answers, e.g. congruent with social values. [113] Use of SoMe for professional purposes may be viewed as socially unacceptable, [93] and thus, to reduce information bias, the survey was made anonymous. Another threat to internal validity is using a non-validated questionnaire that may include ambiguous or unclear questions, leading to confusion among respondents and making it difficult to obtain accurate or relevant data. The questionnaire was inspired by Deloitte [107] and pilot-tested among five ICU nurses and fellow researchers to enhance its content. Unfortunately, a validated questionnaire was not found before the study's commencement. After the survey was completed, similar studies using non-validated questionnaires among HCP were discovered. [87-93] Using a pre-existing questionnaire from another survey could have improved the quality of the study.

A quasi-experimental design with ITS was used to evaluate the impact of the multifaceted intervention (Paper II). Quasi-experimental studies are especially susceptible to threats to internal validity. To evaluate the effects of an intervention, a double-blinded randomised controlled trial (RCT) would be the most appropriate design because of the high internal validity due to manipulation and randomisation, which allows researchers to rule out most alternative explanations for the result. [113] However, it was not possible to randomise personnel within an ICU or the four ICUs within one department due to the threat of contamination between groups. Blinding ICU personnel and study investigators was also impossible. Therefore, ITS, with eight monthly data measurements before and after intervention initiation, was chosen to assess the impact of the campaign. The ability to attribute the change to the intervention is strengthened with ITS, including multiple measurements, by reducing the uncertainty of unstable measurements at only two-time points. [114, 115] ITS is increasingly used to evaluate the impact of quality improvement interventions when randomisation and assessing who received the intervention or not is impossible. [115] In addition, it was difficult to add a comparable ICU as a control. Thus, this was a single ITS and not a controlled ITS. A single ITS assumes that the level and trend in a given outcome

measure in the group exposed to the intervention would have remained the same without the intervention. [115] Furthermore, the ITS design was supplemented with a process evaluation to shed light on the mechanisms responsible for the result obtained. This included assessing exposure to the intervention and exploring the experiences of those exposed. [116] Typical ITS limitations are the history threat, the Hawthorne effect, autocorrelation, and seasonality. The *history threat* refers to conflicting external events that occur simultaneously with the intervention, and that may affect outcomes. It is possible that factors other than the intervention may have contributed to the improvement in PAD-QIs, as the history threat cannot be entirely ruled out. However, I am unaware of any structural changes in the ICUs that may explain the improved PAD assessments. The *Hawthorne effect,* when study subjects improve their behaviour because of their awareness of being observed, [113, 117] is, on the other hand, indeed present. This effect was partly aimed at during the quality improvement campaign by providing feedback on QIs. The impact of the multifaceted intervention was only evaluated during an ongoing intervention period, and if the outcome was sustainable over the years or just represented a short-term Hawthorne effect is unknown. [113, 117] Still, the finding is interesting, considering that providing content through Facebook was feasible and could easily have been continued after the campaign. Quality improvement and implementation initiatives are generally ongoing processes that take many years. [53] More follow-up is usually needed to maintain and further improve practice. [114] *Autocorrelation* was adjusted using the appropriate statistical methodology, and *seasonal changes* are not expected in the PAD-QIs except for weekends and holidays with more use of temporary staff. [114, 115] The Before period included the summer holidays, with expected lower guideline adherence, but this was not reflected in the ITS figure, including several monthly data points.

Selection bias threatens a study's internal validity because differences between groups may externally affect the dependent rather than the independent variable, such as the intervention. [113] In Paper I, the survey was sent out via Nettskjema by UiO to the e-mail addresses of all ICU nurses and physicians working in the four study ICUs. Polit and Beck (2012) suggest that the risk of bias may be minimised with response rates greater than 65%, which was strived for. [113] To increase participation, we used several options enabled by Nettskjema. The survey was anonymous, but entering the nurses' and physicians' individual e-mails enabled tracking the response rate and sending out automated reminders (up to three) to those who had not responded. Additionally, I sent out a reminder from my hospital e-mail address, urging them to complete the survey.

I also asked opinion leaders in each ICU to remind and motivate their colleagues. As an incentive, I promised a cake to the ICU with the highest response rate. With all these efforts, the response rate achieved was 64%. A higher response rate would have been desirable, but lower response rates are common in electronic surveys. [113] The anonymous survey made an analysis of whether the non-responders differ from the responders impossible. The survey was distributed via e-mail, and those who rarely read their e-mail might be under-represented in the study. However, oral reminders during shift reports were provided to increase survey participation. Moreover, the main aim of Paper I was to describe SoMe use among ICU nurses and physicians, and very few responders were without SoMe profiles. Few physicians were females younger than 40 years, and few nurses were males older than 40. To summarise, the sample was deemed representative of the two professions in the study ICUs, but the lower number of physicians and skewed groups provided statistical challenges, also affecting statistical validity. [113]

Regarding selection bias in Paper II, documented PAD assessments during adult patients' ICU stays were compared between the two groups named Before and Intervention. Thus, major concerns were whether the two groups were comparable. Data were collected in the same way in both groups, but the ICU patient stays were included differently. In Before, ICU patient stays were included both pro- and retrospectively, whereas, in Intervention, the ICU stays were only included prospectively. Retrospectively collected data may have several limitations, such as incomplete data, and lack of control, making accurate conclusions and establishing causality difficult. [113] There was no missing data on outcomes, as missing documentation of PAD assessment was defined as no adherence. Furthermore, REK required different approaches for inclusion. Prospectively included ICU stays were included based on the patient or family's informed consent, whereas the retrospectively included ICU stays were included based on information through regular mail to the patient/ next of kin, with a possibility to decline participation. These inclusion differences resulted in several different characteristics for the two groups. In Before, ICU mortality was higher, mechanical ventilation, tracheostomies and vasoactive infusions were more common, and time on mechanical ventilation was longer. How and whether these differences affected documented PAD assessments are unclear. The difference in patients' characteristics between the two groups was the main reason why only the PAD-QIs and not all the other QIs were assessed with ITS. Patients' characteristics may affect how patients were mobilised, [118, 119] the initiation of early enteral nutrition, [120] and the incidence of pressure injuries. [121] However, all

patients should be assessed for PAD according to the guidelines, [16, 122] regardless of mechanical ventilation, tracheostomy, vasoactive infusion and if they are dying. The observed stability of personnel in the two time periods was deemed more important for the documented PAD assessment, and no major changes in the group of personnel were registered.

The *statistical analysis* may also affect internal validity, specifically whether correct inferences can be drawn about the true relationship between key variables. [113] No power calculation was performed to estimate the needed sample size to reduce false negative or positive errors. The intention was to include all ICU nurses and physicians in the four ICUs in Paper I and all consecutively admitted ICU patients with ICU length of stay of more than 48 hours in Paper II. As previously mentioned, statistical challenges occurred in Paper I. In Paper II, advanced statistical analysis was used to evaluate the intervention and the analysis was done by a statistician. The study included 1049 observations sorted into 16 monthly data points, eight in each period. However, it is difficult to assess whether this is adequate or if a different sorting strategy would improve the study quality. Shadish et al. [114] indicate that a large number of observations, typically 100, is needed to assess autocorrelation. However, fewer are usual, with most studies using a median of 18-20 monthly data points. [114, 115] Contrary, Penfold and Zhang [123] state that a minimum of eight monthly data points is needed. Bernal et al. [124] argue that there are no fixed limits regarding the number of data points, as the power depends on various other factors, such as, e.g. the distribution of data points before and after an intervention and variability within the data.

External validity

External validity is related to which degree the study results from Paper I and II apply or can be generalised to other circumstances/ populations, times and contexts other than the ones studied. [113] The generalisability of these two quantitative studies is indeed limited, considering both are single-centre studies. OUH differ from other Norwegian hospitals. Even if four ICUs at two different locations were included, the included ICUs still belonged to the same department at OUH, limiting external validity. The nurse-to-patient ratio was 1:1, and comparable to other Norwegian ICUs, but considerably higher than in most other countries ranging from 1:2-1:6. [125]

Another factor affecting the external validity is how the participants were selected and included. In Paper I, all ICU nurses and physicians in the four ICUs were invited to participate in the survey. However, the sample size (n=256) was relatively small,

encompassing a single hospital, which limits the generalisability of the results to a larger population. The response rate overall was 64%, but it was only 56% among the physicians, even further reducing the generalisability of the results to this group. Generalisability among the nurses may also be reduced, considering that most participating ICU nurses were older than 30 years, whereas the majority of ICU nurses in other European countries are reported to be younger than 30 years. [126] This is relevant and needs to be kept in mind because SoMe use has been shown to be higher among younger age groups. [93] However, the study results regarding the fact that Facebook was the most popular platform and the younger being more active SoMe users correspond well with other studies. [93, 127] This may increase the generalisability of these results. Moreover, another aspect limiting generalisability is the fact that different platforms may be more popular in different countries. [93]

Other aspects also reduce generalisability in Paper II. All consecutively admitted adult patients with an ICU LOS longer than 48 hours were intended to be included. However, REK demanded informed consent from all prospectively included patients, which obviously made the inclusion of all ICU patients very difficult. Overall, 78% of the eligible ICU stays were included; 90% of the retrospectively included patient stays and 74% of those included prospectively. In addition, the generalisability of the study is also related to other contextual aspects of the included ICUs, such as the number of employed ICU nurses and physicians as well as the local culture. Information about the study setting and context aimed to ensure the ability to assess whether the study findings may be generalisable to other settings and contexts.

Discussion of trustworthiness - Paper III

A quality criterion in qualitative studies is the trustworthiness of the study. Establishing trustworthiness is crucial to ensure that the study's results accurately represent the phenomenon under investigation. To achieve trustworthiness, transparency about the research process and choices made is important. [128] Trustworthiness may be described by using the Lincoln and Guba framework [129] addressing the criteria of credibility, transferability dependability and confirmability, [129, 130] which will be further described below. The constructs correspond to the terms used in quantitative methods; internal validity (credibility), external validity (transferability), reliability (dependability) and objectivity (confirmability). [129, 130]

Credibility

Credibility refers to how the findings agree with reality. Ensuring credibility is one of the most important factors in establishing trustworthiness. [130] To ensure transparency and credibility, information is provided about the methods used, the context of the study, sampling, data collection, analysis, and the researchers.

Purposive *sampling* was used to include information-rich participants. [103, 104] Recruitment was organised by a contact person in each ICU to avoid researchers' bias in selection, and they collected a heterogeneous group of informants to triangulate the different types of informants from different sites. Adequate information power was strived for and achieved based on the five items described by Malterud et al. [131] The study aim was relatively narrow, and the sample was specific (participants who experienced the multifaceted intervention). In addition, the interviewers had in-depth prior knowledge of the topic, the groups were active, and conflicting feelings about the topic were uncovered. The exploratory analysis strategy aimed to uncover selected patterns relevant to the study objective rather than the full range of phenomena. [131] Credibility may be enhanced by prolonged engagement between the researchers and participants to gain adequate understanding and familiarity with the culture and social setting. [130] Several of the researchers worked in the study ICUs, and the researchers and participants knew each other as colleagues. However, a balance is needed because the researchers may become so immersed in the culture that this influences their professional judgement. [130]

During the *data collection*, to ensure honesty, informants were encouraged to be frank and were told that all information was equally valuable. Iterative questioning and a summary of the interviewer's understanding were presented to the participants at the end of each interview to ensure the comprehension of their descriptions. Member checks by presenting data for new discussions and debriefing at the end of the data collection may enhance credibility. [129] Credibility was further sought by describing the nurses' and physicians' discussions during the interviews, including the use of quotations in the findings section.

During the *data analysis*, to ensure a comprehensive analysis and diverse perspectives, To enhance the credibility of the study, I closely collaborated with two experienced qualitative *researchers* (HB and HW). [129] Triangulation of researchers and peer debriefing were used to e.g. reduce effects of investigator bias by having other research group members participate in data analysis and interpretation.

Transferability

Transferability in qualitative research refers to the applicability of the findings to other subjects or contexts. [129, 130] Some argue that it is impossible to demonstrate that qualitative project findings and conclusions apply to other situations and populations because they are specific to a small number of environments and individuals. Lincoln and Guba [129, 130] have suggested that the investigator is responsible for ensuring that sufficient contextual information about the sites is provided to enable the reader to make such a transfer. In the present study, transferability was sought by providing relevant contextual information about the study ICUs, the participants, the use of the already established ICU Facebook groups, and the use of Facebook being part of a larger intervention. In addition, a detailed description of the findings may have enhanced the study's transferability.

Dependability

Dependability is closely linked to credibility and relates to consistency and whether a study could be repeated based on the information of how the study was conducted. [129, 130] Demonstrating credibility demonstrates in practice also dependability. [129, 130] Dependability was sought by transparency through detailed descriptions of the research process, from data collection and analysis, allowing the reader to assess the research practice.

Reflexive thematic analysis by Braun and Clarke [108] was partly chosen due to the detailed description of the phases during the analysis and their procedure being deemed suitable for novice qualitative researchers. However, the process of analysis is recommended to be reflexive, recursive, and iterative across the six phases and maintaining a complete audit trail is therefore challenging. As recommended in qualitative analysis, comprehensive notes about the analysis progressions were made from all meetings with the research group. Decisions during the six phases were typically made in these meetings.

Confirmability

Confirmability refers to objectivity in the research process and that the study data represent participants' views and experiences thereby not invented by the researcher. [129, 130] To ensure confirmability, the analytic steps from codes to themes were thoroughly presented. In addition, the co-authors were familiar with the data by being involved in both data collection and the analytic process. However, according to Braun and Clarke, [109] the analysis is active and generative; the final analysis is a product of deep and prolonged data immersion,

thoughtfulness and reflection, and the themes do not passively emerge. Their view of qualitative research is that it is creative, reflexive, and subjective, with researcher subjectivity understood as a resource rather than a potential threat to knowledge production. Thematic analysis is a rigorous and systematic approach but also fluid and recursive. [109] In Paper III, the coding approach was, as suggested by Braun and Clarke, [109] collaborative and reflexive, designed to develop a richer, more nuanced reading of the data rather than seeking a consensus on meaning. However, through discussions, a form of consensus was achieved during the process. As a researcher during the intervention phase, I was eager to make the intervention as potent and effective as possible. However, in the analysis phase of the FGIs, I was equally interested in both positive and negative experiences to gain knowledge about how the intervention could have been improved. In the research group, we discussed my participation in the FGIs, and the possible influence this could have on the participants' openness. Participation in the FGIs was deemed necessary for the following analytical process, and thus it was decided that HW, as an experienced qualitative researcher, would conduct the interviews with me as an observer. The focus groups were active and conflicting feelings about the topic were uncovered.

Discussion of main results

The present thesis aimed to explore, describe, and evaluate the use of SoMe among ICU nurses and physicians and the impact of using closed Facebook groups as a communication tool for professional purposes. These findings elucidate both positive aspects and challenges associated with utilising SoMe in intensive care.

The main findings were that most ICU nurses and physicians used SoMe, with Facebook reported as the most popular platform (Paper I). Thus, the majority of the clinical ICU personnel were exposed to the quality improvement campaign provided through the four ICUs' closed Facebook groups (Paper II). The provision of professional content, including A&F on QIs through the closed Facebook groups, coupled with educational events and support from opinion leaders, led to an increase in documented PAD assessments during the intervention period (Paper II). This suggests that Facebook may effectively serve as a platform for disseminating professional information and potentially improving the quality of intensive care. Finally, through the FGIs, ICU personnel expressed mixed feelings about using

Facebook, highlighting the ambivalence surrounding its usage (Paper III). They acknowledged being motivated to improve care by the professional content provided through Facebook, particularly the A&F of QIs. However, the appearance of professional content on Facebook was deemed inappropriate, intrusive, disruptive, and even provocative, encompassing the theme "matter out of place". This reluctance towards the use of Facebook for professional purposes and limited value for quality improvement is supported by the high number of seen yet low numbers of 'comments' and 'likes' on the Facebook posts (Paper II), in addition to the low rating of using SoMe for disseminating professional information to improve their clinical practice (Paper I). The FGI participants suggested alternative SoMe platforms but deemed that "one size does not fit all" in implementation or quality improvement and that several strategies were needed (Paper III).

In the following chapters, the main findings are more closely discussed across the three papers, focusing on:

- SoMe use among ICU nurses and physicians
- SoMe usage to improve guideline adherence in the ICU.

SoMe use among ICU nurses and physicians

SoMe, and particularly Facebook, was extensively used among ICU nurses and physicians (Paper I). These findings correspond well with other studies among other HCP and the general population. [87-93, 127, 132-134] This may indicate that strategic use of SoMe, including the provision of professional content, has the potential to enhance the quality of care in ICUs. Closed Facebook groups were already utilised for social purposes and shift swapping in the four study ICUs. The large potential to reach ICU personnel was indeed confirmed during the quality improvement campaign due to the fact that the majority of group members saw and were exposed to the Facebook posts (Paper II).

According to the pre-intervention survey (Paper I), SoMe were mainly used for personal purposes. Only 13% of the ICU personnel reported professional development as an important reason for using SoMe among the eight listed reasons. Some studies confirm that SoMe among HCP are mainly used for personal purposes. [88, 135, 136] However, several other studies have found that the majority of HCP already utilise or are interested in using SoMe for both personal and professional purposes. [92, 93, 137] In this last referred survey, 19% declared to use SoMe exclusively for professional purposes, 18% only for private purposes, and 64% for both. Of those, 72% used the same accounts for both professional and private purposes, while

28% preferred to have separate accounts. [137] Ranschaert et al. [92] found that 76% used SoMe for both private and professional purposes, but private usage was preferred considering that only 34% said they were popular for professional purposes. Several FGI participants deemed that SoMe are intended for private and social use, not for professional or work-related purposes (Paper III). However, some FGI participants considered Facebook to be an applicable platform for professional purposes. This highlights the fact that SoMe use for professional purposes does not fit all ICU personnel, corresponding well to previous findings among other HCP. [93] According to the pre-intervention survey, ICU nurses were more positive than physicians towards receiving professional ICU-related content in the closed Facebook groups (Paper I). This indicates a higher potential benefit of using SoMe for professional purposes among ICU nurses than physicians. Noteworthy, the nurses also reported to read professional literature less frequently than the physicians, indicating an even higher potential benefit. Moreover, the higher membership rate of ICU nurses in the closed Facebook groups indicates their inclination towards utilising such platforms for professional networking compared to physicians.

The choice of SoMe platforms may be affected by several aspects, such as the purpose of use, the targeted population and that it may change with time. It is worth noting that younger participants and ICU nurses were more likely to have a Facebook profile and engaged in daily use (Paper I), indicating a generational and professional difference in SoMe adoption. Previous studies have shown that the frequency of professional SoMe use is associated with age, gender, country of residence and graduate status. [93] For instance, those under 25 years were the most frequent SoMe users for professional purposes. [93] Thus, it is of utmost importance to be aware of the potential future development and integration of SoMe in ICUs, particularly regarding how younger generations will utilise it, adapt to it, and adhere to recommended clinical practice.

SoMe use is like an ongoing dynamic process with new platforms being developed and introduced to the users through applications on our smartphones. Facebook was and still is the most applied SoMe in Norway and worldwide. [83, 138] However, the number of Facebook's daily active users has recently declined. [83] Data from Norway in 2022 indicate that 67% were daily users compared to 83% in 2017. Still, the number of those having a Facebook profile was similar in 2022 and 2017 (82% and 84%, respectively). [82, 138] Especially among the youngest (18-29 years), daily users on Facebook seem to decline, but at the same time, rapidly increasing on the TikTok platform. [138] Obviously, even though

Facebook was the most used SoMe in the survey from 2017 (Paper I), the choice of SoMe platform is an ongoing dynamic process and will probably change in the future or is already altered depending on the targeted population. Further, only one-fourth of the ICU nurses and physicians participating in the survey (Paper I) were younger than 30 years. In contrast, as previously stated, the majority of ICU nurses in other European countries are younger than 30 years. [126] More responders of lower age could indeed have given different results. [93] When selecting a SoMe platform for professional purposes, it is therefore essential to consider the targeted audience and the purpose of using it. Certain platforms may be better suited for specific types of content. For instance, Twitter ("X" from July 2023) and LinkedIn may be more appropriate for professional content than, e.g. Facebook. [92, 137, 139] Live tweeting (with Twitter) is more frequently used in international conferences, [140] and evidence suggest that highly tweeted articles are more likely to be cited. [141, 142] However, according to Paper I, only 25% of the ICU nurses and physicians used Twitter. Thus, with only 6% daily Twitter users among the responders in 2017, a Twitter intervention would have had very limited potential. Facebook was chosen due to its great potential to reach the targeted population because the majority used the platform, and closed Facebook groups were already established within the four ICUs.

SoMe usage to improve guideline adherence in the ICU

The multifaceted quality improvement intervention, including A&F of QIs through closed Facebook groups, improved the documentation of PAD assessments during the campaign (Paper II). Furthermore, the process evaluation indicated that ICU personnel were exposed to the Facebook intervention (Paper II), and the FGI participants expressed being motivated to improve their quality of care according to the recommendations provided through Facebook (Paper III). Especially the A&F of QIs were reported by many to increase their awareness of the current state and motivated improvement, especially if adherence was lower than expected or lower than in the other participating ICUs. This is in line with the theoretical assumptions on the effects of A&F through changing the recipient's awareness and beliefs about current practice, with subsequent motivation to improve care. [59] The level of PAD-QIs improved/ increased significantly in Intervention by 26-34% (Paper II), which was comparable to findings from a Cochrane review on A&F from 2012. [59] Furthermore, the feedback provided in the four ICUs' closed Facebook groups (Intervention in Paper II) included various features that are known to enhance the effectiveness of A&F. [57, 59] Feedback was based on monthly,

audited QIs, including multiple feedback sessions provided by supervisors or colleagues (both dedicated ICU nurses and senior consultants), verbal and written communication, and clear objectives. Noteworthy, despite the fact that the improvement campaign contained more QIs, the main study (Paper II) only evaluated improvements in the three PAD-QIs. Other QIs, such as the mobilisation of patients, could have yielded different results. [119] Additionally, the study's main focus was directed towards the process of care regarding PAD assessment rather than the clinical indicators of less pain and delirium, which could have been regarded as more important quality outcomes for ICU patients. However, previous studies have shown a clear relationship between guideline adherence and clinical patient outcomes. [28, 143] Luetz et al. [28] found a reduction in in-hospital mortality if delirium monitoring was conducted 50% or more of ICU days per patient. Adherence was defined as delirium monitoring a minimum of once per day, with no monitoring defined as adherence when RASS was -3 or lower. [28] In comparison, adherence in Paper II was defined as documented PAD assessment at least once per nursing shift (i.e. every eight hours on average), corresponding to guideline recommendations for delirium assessment. [16] Delirium might fluctuate over time, and to identify these fluctuations in delirium, the patients could benefit from being assessed at least every shift because targeted prevention and treatment could be initiated. Noteworthy, adherence to delirium monitoring based on RASS was not calculated in this study. Even if the documented delirium assessment improved in all four ICUs during the intervention period, it did not reach the aimed goal level of at least 70%. [43] Moreover, other intervention strategies could also have influenced the impact of documented PAD assessments differently. For example, an intervention focusing exclusively on PAD assessments rather than multiple different QIs could have further improved PAD monitoring. On the other hand, using several QIs during the intervention campaign might have strengthened the study, considering ICU personnel were unaware of which QIs would be evaluated in the study. This could potentially have reduced the Hawthorne effect.

Indeed, Facebook was part of a larger multifaceted intervention campaign, challenging the evaluation of the utilisation of Facebook alone on the PAD-QIs in Paper II. However, the fact that the majority of ICU nurses being responsible for documenting PAD assessments had seen the posts indicates a reasonable level of exposure to the provided content. Strategical use of SoMe has, in several previous studies, been shown to reach many recipients, disseminate knowledge and research effectively, improve knowledge and promote practice change. [144-147] In a recent pilot RCT, continuous professional education was provided through either

Facebook or email. [145] The results showed that Facebook was effective in improving HCPs' knowledge, whereas email was not. [145] The fact that the A&F on QIs through Facebook reached the majority of ICU personnel (Paper II) and that the FGIs documented their motivation for improvement (Paper III) underscore the potential benefits of utilising SoMe platforms, like Facebook, for professional communication and quality improvement in ICUs. However, the FGI participants described ambivalent experiences with the use of Facebook for professional purposes, and this was also rated lowest among strategies for optimising adherence to recommended clinical practice in the survey (Paper I). The latter corresponds well with the findings from a previous study among health researchers and clinicians. [93] The ambivalence towards using SoMe for professional purposes encompassing the theme 'Matter out of place' (Paper III), is also supported by similar findings in other comparable studies. [93, 97] Apprehension of mixing professional and personal lives, feeling that SoMe could not replace face-to-face interactions and that using SoMe is unprofessional, have all been mentioned as typical examples. [93, 97] On the other hand, the study by Tunnecliff et al. [93] indicated that SoMe could be used for professional purposes if specific platforms for professional use, run by accredited or respected bodies or peers, existed. [93] Interestingly, this was also highlighted in the FGIs (Paper III), where the participants emphasised the need for appropriate communication platforms tailored to the professional needs of ICU personnel. It was further suggested that the responsibility lies with the employers to provide such platforms. In addition, Facebook groups specifically established for professional communication were further communicated to be less intrusive than the already existing closed Facebook groups (Paper III). In agreement with this, results from the survey (Paper I) indicated more positive attitudes towards being members of a group aimed at exchanging professional content on critical care topics than the already established Facebook groups.

The other main theme from the FGIs, - 'One size does not fit all' in implementation and quality improvement (Paper III), aligns with previous knowledge about the difficulties related to changing practice. [148] It is challenging to find a strategy or choice that suits all personnel and situations, regardless of the efforts made. The context is of general importance when attempting to understand people's experiences. [149, 150] Several additional aspects should be noted regarding the ICU personnel's attitudes to the intervention campaign (Paper II-III), such as the findings being based on data from 2017/2018 and the fact that data were collected in the same period as the Facebook- data privacy scandal, where personal data about users were shared. [83] Also, the COVID-19 pandemic might have changed ICU personnel's view on

the use of SoMe platforms for professional content because the use of digital communication, including SoMe, has become more important. SoMe has since early 2020 played a significant role in the dissemination of timely evidence-based information due to impeded traditional educational sessions, congresses, and meetings. [133, 151-153] During and after the pandemic, major medical organisations have used SoMe pervasively to share professional content such as guidelines, consensus reports, and webinars. [151, 154] As an example, more than 100 000 people tuned in to the ESICM 7-hour webinar marathon on 28 March 2020. [154] Noteworthy, HCP appear more eager to access professional information through SoMe to learn about self-protection from COVID-19. [155-157] Adapting and customising interventions to specific contexts can enhance the acceptance and effectiveness of SoMe platforms in quality improvement initiatives within the ICU setting.

It is important to emphasise that SoMe usage in healthcare has certain risks and challenges. For example, it can be difficult to ensure the accuracy and reliability of information shared online, and there is also a risk of violating patient privacy and confidentiality. [158] The FGI participants were also concerned with Facebook's lack of data privacy (Paper III). A significant general concern with the use of SoMe in ICUs or hospitals has been shown to be the issue of information security consisting of confidentiality of patient-sensitive data, the integrity of the data (data not tampered with) and availability for authorised personnel when needed. [159, 160] There is a growing threat to cyber-security in hospitals. [160, 161] Cyber-attacks such as phishing, hacking and ransomware exploit the vulnerabilities of systems such as IT infrastructures as well as human-attributed weakness and vulnerability to cause service disruption and thus threaten human lives. [160, 162, 163] Thus, HCP need to be educated in cyber-security and cyber-hygiene while accessing SoMe platforms. [160, 162] The enormous potential benefits of using SoMe to communicate evidence-based knowledge among HCP may outweigh the risks if used thoughtfully. [162, 164] In conclusion, the ambivalent experiences expressed by ICU nurses and physicians regarding Facebook use in a quality improvement campaign highlight the importance of recognising contextual appropriateness, individual preferences, and platform limitations.

Clinical implications and future perspectives

This thesis builds on and contributes to the field of quality improvement and implementation science in the intensive care setting. In particular, it is directed towards professional-oriented interventions. Although several studies have examined quality improvement and implementational strategies and the use of SoMe, there has not been a strong focus on using SoMe in intensive care to improve the quality of care process (guideline adherence). As such, this study provides additional insights about SoMe as an alternative to hospital communication platforms to communicate about and improve the quality of intensive care. Strategic use of SoMe has the potential to reach out to the majority of ICU personnel. Furthermore, professional content such as A&F on QIs provided via SoMe has the potential to increase awareness and motivate ICU personnel to improve intensive care quality.

Considering Facebook usage among the youngest population is declining, other SoMe platforms will potentially be more appropriate in the future. Further research and interventions should focus on identifying and incorporating appropriate SoMe platforms that address ICU personnel's specific needs and preferences, thus facilitating effective and efficient communication within the intensive care environment. Several Norwegian Health trusts have updated to the cloud-based service, Microsoft 365, in 2022/ 2023, with applications such as Teams and Yammer available through smartphones. Employees may deem these platforms more appropriate, and this should be further investigated. To what degree ICU personnel would actively visit a web-based site used explicitly for professional content and work in their free time is still unknown. These platforms may lack Facebook's intrusiveness, with professional content appearing without actively searching for it. It could be that the intrusiveness of Facebook, by already being used for social content, is needed to reach the personnel. Experiences with the use of SoMe for quality improvement purposes, such as being inappropriate, with a mix-up of work and personal time, may change with time. Younger generations, such as Generation Z (born from the mid-to-late 1990s- to the early 2010s), are obviously more used to the internet and SoMe with all its solutions and possibilities, [165] and are increasingly employed in ICUs worldwide. In addition, new pandemics, wars or environmental disasters might impact how we share both personal and professional information. Noteworthy, cyber security is a severe concern and must be seriously addressed and solved in all future studies related to SoMe.

CONCLUSIONS

Paper I

The majority of ICU nurses and physicians were active SoMe users, mainly for non-professional use. Facebook was the most popular SoMe platform. More nurses used Facebook daily than physicians and were more positive toward content on critical care topics in closed Facebook groups.

Paper II

A multifaceted intervention, including active use of the ICUs' closed Facebook groups, was associated with improved guideline adherence measured with audited quality indicators of pain, agitation/sedation and delirium assessments. Most Facebook group members had seen the posts, indicating exposure to the quality improvement campaign. However, only few liked or commented on the posts.

Paper III

Although audit and feedback on quality indicators through Facebook motivated improvements, professional content on Facebook was perceived as inappropriate. More applicable hospital platforms with positive SoMe features, such as reach, availability, convenience, and comments, were suggested by the ICU personnel to secure professional communication about recommended practices in ICUs.

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Original papers

I. Use of social media for communicating about critical care topics: A Norwegian cross-sectional survey.

II. Multifaceted intervention including Facebook-groups to improve guideline-adherence in ICU: A quasi-experimental interrupted time series study.

III. Use of Facebook in a quality improvement campaign to increase adherence to guidelines in intensive care: A qualitative study of nurses' and physicians' experiences.

Original papers

Paper I

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ORIGINAL ARTICLE

acta Anaesthesiologica Scandinavica

Use of social media for communicating about critical care topics: A Norwegian cross-sectional survey

Antonija Petosic[1,2] | Kjetil Sunde[3,4] | Dimitri Beeckman[5] | Hans K. Flaatten[6] | Hilde Wøien[1,2]

[1]Department of Postoperative and Intensive Care, Oslo University Hospital, Oslo, Norway

[2]Institute of Health and Society, University of Oslo, Oslo, Norway

[3]Department of Anaesthesiology, Oslo University Hospital, Oslo, Norway

[4]Institute of Clinical Medicine, University of Oslo, Oslo, Norway

[5]Ghent University, Ghent, Belgium

[6]University of Bergen, Bergen, Norway

Correspondence
Antonija Petosic, General Intensive Care Unit–Ullevål, Department of Postoperative and Intensive Care, Division of Emergencies and Critical Care, Oslo University Hospital, Kirkeveien 166, 0450 Oslo, Norway.
Emails: antonija.petosic@studmed.uio.no; antonija.petosic@ous-hf.no

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Background: Social media (SoMe) might be an alternative platform for communicating critical care topics to implement evidence-based practice in the intensive care unit (ICU). This survey aims to describe ICU nurses' and physicians' use of SoMe in general, and their perception of using closed Facebook-groups for receiving content on critical care topics.

Methods: A cross-sectional, web-based, anonymous survey was distributed to ICU physicians and nurses in four ICUs in autumn 2017 via an email-campaign. Descriptive statistics with rates, percentages and median numeric rating scale (NRS) scores, interquartile ranges are presented.

Results: The response-rate was 64% (253/ 394) including 210 nurses and 43 physicians. Overall, 93% had a SoMe-profile, and 77% had a profile on more than one network site. Facebook was the most used social network site, with 87% having a profile. Totally, 68% were daily users, but more nurses used Facebook daily vs physicians (81% vs 60%, respectively, $P = 0.006$). Nurses were also more positive toward being members of closed Facebook-groups aimed to exchange content on critical care topics (median NRS 9 (6-10) vs 6 (3-9), respectively, $P = 0.014$).

Conclusion: The majority of ICU nurses and physicians were active SoMe users, mainly for personal purposes, and Facebook was the most popular SoMe. Nurses used Facebook daily more frequent and were more positive toward content on critical care topics on Facebook than physicians. These findings might be relevant to customize future communication about critical care topics via SoMe.

1 | INTRODUCTION

Optimizing critical care in intensive care units (ICU) based on evidence-based practice (EBP), international consensus, and guidelines outlined from all available scientific knowledge is important to enhance patient outcomes.[1-3] The implementation of EBP remains a challenge and lack of effective communication is one among many other implementation barriers in the ICU.[4,5] Gathering multi-professional teams for teaching and training purposes is particularly demanding due to the busy ICU environment and the context in which critical care is provided.[5] Moreover, traditional electronical professional hospital communication platforms generally require a login procedure onto a hospital server, limiting the accessibility and thus effective real time communication about EBP.

Social media (SoMe) are forms of electronic communications (websites and applications) facilitating the creation and sharing of information, ideas, personal messages, and other content via virtual communities and networks quickly, efficiently, and in real-time.[6-11]

Benefits of SoMe use in health communication include more frequent interactions with others, more available, shared and tailored information (with user generated content), and increased accessibility and widening access to information (to those not accessing information via traditional methods). Limitations are associated with quality concerns and lack of reliability of content, confidentiality and privacy.[12] In the critical care community the majority of critical care medicine conferences, journals, and societies use SoMe for education, research, and advocacy.[13]

SoMe has with its availability and interactivity changed the way people communicate worldwide,[12,14] and might serve as a possible communication platform worthwile to consider to improve implementation of EBP even in the high technological and busy ICU. Nurses and physicians are the main providers of critical care in the ICU, and EBP needs to be communicated within the interdisciplinary team to ensure that provided care is based on current professional knowledge.

Facebook is the most used SoMe,[15] with 1.52 billion daily active users.[16] In Norway, 81% of the adult population had a Facebook profile in 2018.[9] Younger generations, who have grown up with the internet, use SoMe more frequently (96% in the age group 16-24 years), however, increased use is also described in older generations (23% in the age group 75-79 years).[8,9] Education and profession could also influence use of SoMe[17] and usage among ICU nurses and physicians could be different from the general public. ICU nurses' and physicians' use of SoMe and their view on SoMe-usage for professional purposes has yet not been studied.

The primary aim of this study was to describe ICU nurses' and physicians' use of SoMe in general, as well as their perception of using closed Facebook-groups for receiving professional content on critical care topics. The secondary aim was to describe ICU nurses' and physicians' habits of acquiring professional knowledge in general. The results from this study intend to inform the development of SoMe interventions using closed Facebook-groups as a communication tool for providing professional content on critical care topics in the ICU.

2 | METHODS

2.1 | Design and setting

An observational cross-sectional study using a web-based anonymous survey was conducted at four ICUs at Oslo University Hospital (OUH).

2.2 | Questionnaire development

The questionnaire was developed based on a Norwegian survey studying media use in the general public,[18] and was adapted to reflect the specific ICU context. Questions were modified for clarity after pilot testing in a sample of five ICU nurses and fellow researchers. Modifications were related to the adaptation of the five-point-Likert scale to the 11-point numeric rating scale (NRS) with 0 indicating "not at all" and 10 "very much."

Editorial Comments

In this Norwegian survey on use of social media (SoMe) for communicating about critical care, it appears that the vast majority of intensive care unit nurses and physicians in that country are active SoMe users. This has implications for alternatives and choices for dissemination or retrieval of information about critical care topics.

The survey questions comprised 82 closed-ended items, grouped into five sections:

a. demographics
b. SoMe- and smartphone-habits
c. use of Facebook including closed Facebook-groups and traditional hospital communication platforms
d. frequency and preferences of reading professional literature and the perceived importance of eight methods of knowledge-dissemination aiming to optimize critical care
e. perceived importance of seven critical care topics (multi-professional ward rounds, early enteral nutrition, pain-, agitation/sedation-, delirium-assessment and management, early mobilization and pressure ulcers prevention), and perceived quality on these topics in their ICU is not the scope of this study, but the answers are available in Appendix S1.

All questions had to be answered to complete the survey. See Appendix S2 for the full questionnaire.

2.3 | Sample

All ICU nurses and physicians in clinical work in one of the four ICUs were invited to participate in the survey through an e-mail campaign between 25 August 2017 and 21 September 2017. Initially, a list of 456 e-mail-addresses, provided by the head of departments, was entered into the electronically survey programme "Nettskjema" version 140.0 provided by the University of Oslo. After removing duplicates, 450 participants were invited via e-mail.

Three automated reminders were distributed 4, 16, and 21 days after the first invitation. In addition, efforts were made to achieve a high response rate through written and oral reminders in the ICUs, providing response-rate statistics and announcing a reward to the ICU with the best response-rate.

2.4 | Ethics

Permission to conduct the survey was obtained from the Regional Ethics Committee (2016/2281/REK sør-øst A), the data protection officer at OUH, and the respective heads of the different ICU departments. Participation in the study was voluntary and anonymous, and completing the survey implied informed consent.

2.5 | Statistical analysis

Descriptive statistics with percentages and 95% CI are presented for categorical variables unless stated otherwise. The 11-point NRS was interpreted as a continuous interval variable and results are presented with median and interquartile range with first (Q1) and third (Q3) quartiles. Differences between groups for categorical nominal variables were tested with crosstabs tables and Pearson Chi-square tests or Fischer exact test as appropriate, and with McNemar's test within group. Differences between groups for continuous skewed data were tested with the Mann-Whitney *U* test. *P* values ≤ 0.05 were considered significant. Statistical analysis was performed with IBM Statistical Packages for Social Sciences (SPSS version 25.0).

3 | RESULTS

3.1 | Sample demographics

The response-rate was 64% (Figure 1). Among the 253 participants, 210 (83%) were nurses- and 43 (17%) physicians. Overall, 74% were female and 61% were >40 years of age; however, age and gender were differently distributed between nurses and physicians (Table 1).

3.2 | SoMe and traditional communication platforms

Overall, 99% (97%-100%) of the respondents used a smartphone (not shown in table). Among eight listed smartphone-activities, 77% (71%-82%) spent most of their time on traditional communication (call, text and e-mail), whereas 63% (57%-69%) reported SoMe-use as one of three top activities (not shown in table). Spending most time on SoMe (as top three activities) was significantly more frequent by female than male (68% (61%-75%) vs 48% (35%-61%), respectively *P* = 0.003), by younger more than older than 40 years (76% (66%-84%) vs 55% (46%-63%), respectively, *P* = 0.001), and by nurses more than physicians (68% (61%-74%) vs 37% (23%-53%), respectively, *P* = <0.001) (not shown in table).

Overall, 93% (89%-95%) had a SoMe profile, and 77% (71%-82%) had a profile on more than one social network site. Among eight listed reasons for the use of SoMe, the non-professional use, ie contact with family/friends was reported by 70% (64%-75%) as an important reason, whereas only 13% (10%-18%) reported professional development (not shown in table).

Facebook was the most used SoMe network with 87% (83%-91%) having a Facebook-profile, and 68% (62%-74%) were daily Facebook-users (Figure 2). Having a Facebook-profile was evenly distributed among men and women (82% (70%-90%) vs 89% (84%-93%), respectively, *P* = 0.102), and among nurses and physicians (89% (84%-93%) vs 81% (67%-92%), respectively, *P* = 0.197) (not shown in table). A Facebook-profile was less common among those >40 years compared to those ≤40 years (81% (74%-87%) vs 97% (91%-99%), respectively, *P* = <0.001) (not shown in table). Daily Facebook-use varied between female and male (81% (74%-87%) vs 68% (54%-80%), respectively, *P* = 0.047), and between nurses and physicians (81% (75%-87%) vs 60% (42%-76%), respectively, *P* = 0.006), but was similar in those >40 years vs those ≤40 years (76% (68%-83%) vs 80% (71%-88%), respectively, *P* = 0.455) (not shown in table).

Among nurses, Instagram (66% (59%-73%)) was the second most popular SoMe followed by Snapchat (63% (56%-70%)). Among the physicians, Snapchat was the second most popular (49% (33%-65%)), followed by Twitter (47% (31%-62%)) and Instagram (47% (31%-62%)) (not shown in table).

Of all more traditional communication platforms, work-mail was used by all respondents, but daily use was less frequent than the reported use of Facebook (38% (32%-44%) vs 68% (62%-74%), respectively, *P* = <0.001) (Figure 2). Physicians used e-mail significantly more frequent on a daily basis than nurses (77% (63%-90%) vs 30% (24%-36%), respectively, *P* = <0.001), male more than female (60% (47%-72%) vs 30% (24%-37%), respectively, *P* = <0.001), but no difference was found in use of e-mail among the respondents ≤40 years and those >40 years (33% (24%-44%) vs 41% (33%-49%), respectively, *P* = 0.226) (not shown in table).

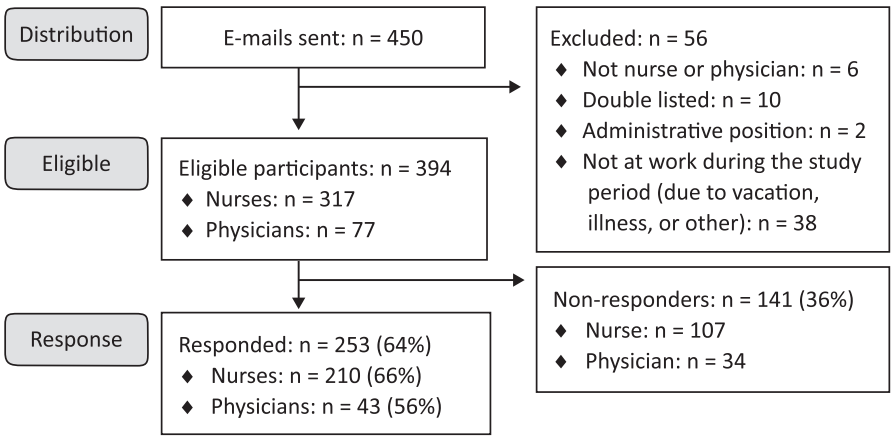

FIGURE 1 Flow diagram, distribution, exclusion and response

TABLE 1 Respondents' characteristics/ demographics

	All (n = 253)	Nurses (n = 210)	Physicians (n = 43)
	% (n)	% (n)	% (n)
Gender*			
Female	74 (188)	83 (174)	33 (14)
Age (years)*			
21-30	9 (24)	11 (24)	–
31-40	30 (75)	31 (64)	26 (11)
41-50	39 (98)	38 (80)	42 (18)
51-60	19 (49)	19 (39)	23 (10)
Older than 60	3 (7)	1 (3)	9 (4)
Highest level of education			
Nursing school	12 (31)	15 (31)	–
Medical school	1 (2)	–	5 (2)
Specialization	70 (176)	70 (147)	67 (29)
Master degree (MSc)	12 (31)	15 (31)	–
PhD	5 (13)	1 (1)	28 (12)
Experience in intensive care unit (y)			
<1	3 (8)	4 (8)	–
1-5	22 (57)	23 (49)	19 (8)
6-10	19 (47)	18 (38)	21 (9)
11-15	21 (53)	20 (41)	28 (12)
16-20	15 (37)	15 (31)	14 (6)
More than 20	20 (51)	20 (43)	19 (8)

Age and gender were significantly different distributed between nurses and physicians, statistical tests; Pearson chi-square test.
*P-value below 0.05 = significant.

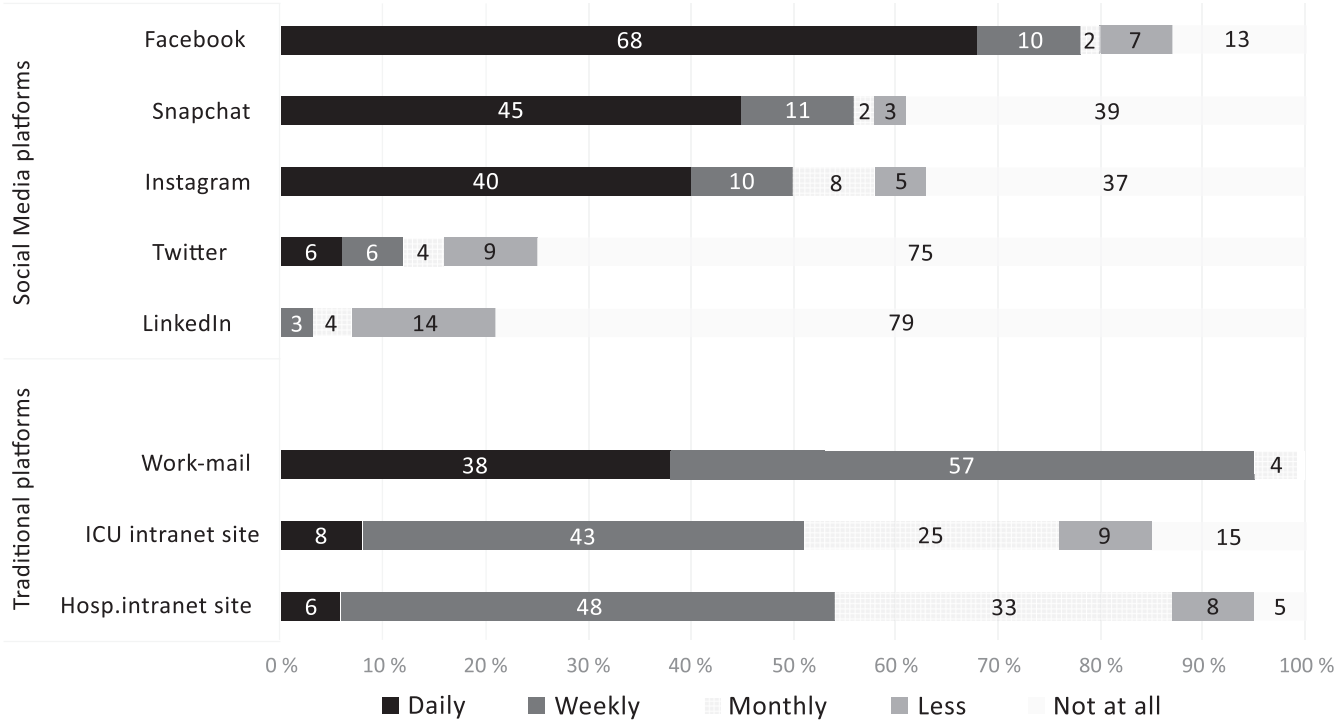

FIGURE 2 Frequency of critical care nurses' and -physicians' use of social media and traditional communication platforms (n = 253)

3.3 | Closed Facebook-groups as a professional communication-platform

Among the 186 nurses having a Facebook profile, 98% (95%-99%) were members of the ICUs' closed Facebook-group at work, whereas only 43% (26%-61%) of the 35 physicians having a Facebook-profile were aware of the ICUs' existing closed Facebook-group and only 31% (17%-49%) were members (not shown in table).

Nurses reported a more positive attitude than physicians toward joining closed Facebook-groups aimed to exchange professional content on critical care topics with median reported NRS-scores of 9 (6-10) vs 6 (3-9), respectively, (P = 0.014) (Table 2).

3.4 | Habits of acquiring professional knowledge in general

Physicians reported a higher frequency of reading professional literature daily than nurses (42% (27%-58%) vs 5% (3%-9%), respectively, P = <0.001) (Table 3). Professional literature was in the survey exemplified as books, papers, web-sites (eg UpToDate), the eHandbook, organizations homepages, etc with professional content on critical care topics.

When reading professional literature electronically (PC, tablet, smartphone) the respondents were asked to choose the three most important sources among nine listed options: "e-guidelines, online version of international journals, online version of Norwegian journals, literature search in databases, papers through links on web-pages, papers through links on SoMe, papers received on mail, other, and don't read professional literature electronically." Nurses reported e-guidelines (62% (56%-69%)), research-papers via links on different web-sites (49% (42%-56%)) and research-papers received via e-mail (34% (28%-41%)) as the three most important sources (not shown in table). Physicians reported literature-search in databases (84% (69%-93%)), online version of international journals (77% (61%-88%)), and e-guidelines (40% (25%-56%)) as the three most important ones (not shown in table).

TABLE 2 ICU nurses' and -physicians' perception of professional use of closed FB-groups

	All (n = 217)	Nurses (n = 186)	Physicians (n = 31)	Difference (nurse/physician)
	Median NRS-score (IQR)	Median NRS-score (IQR)	Median NRS-score (IQR)	*P*-value
Accept to receive *professional content* on *critical care topics* on ICUs' closed FB-groups	6 (2-9)	7 (3-9)	5 (1-8)	0.117
Negative to receive *professional content* on *critical care topics* on ICUs' closed FB-groups	2 (0-6)	1 (0-6)	2 (0-7)	0.829
Accept to receive other *work-related* information on ICUs' closed FB-groups	7 (4-10)	8 (5-10)	5 (2-7)	0.002*
Negative to receive other *work-related* information on ICUs' closed FB-groups	2 (0-6)	1 (1-5)	5 (0-8)	0.075
Would you like to be a **member of a group** *aimed to* exchange *professional* content on *critical care topics*	9 (5-10)	9 (6-10)	6 (3-9)	0.014*

Note: Professional content on critical care topics: eg research papers, guidelines, congress-info and such. *Other work-related information*: eg social gatherings, schedules, staff-meetings and such. Statistical tests: independent-samples Mann-Whitney *U* test.
Abbreviations: NRS, numeric rating scale 0-10; (0 = "not at all" and 10 = "very much"); IQR, interquartile range presented with first (Q1) and third quartiles (Q3); FB, Facebook; ICU, intensive care unit.
*P-value below 0.05 = significant.

TABLE 3 ICU nurses' and -physicians' reported frequency of reading professional literature on critical care topics

	All (n = 253) % (95% CI)	Nurses (n = 210) % (95% CI)	Physicians (n = 43) % (95% CI)	Difference (nurses/physicians) *P*-value
Daily	12 (8-16)	5 (3-9)	42 (27-58)	
Several times/wk	25 (19-30)	23 (18-30)	30 (17-46)	<0.001*
Weekly	39 (33-45)	41 (35-48)	26 (14-41)	
Monthly	22 (17-28)	26 (20-33)	2 (0-12)	
Annually	3 (1-6)	3 (1-7)	0 (0-8)	
Don't read "Professional literature"	<1 (0-2)	<1 (0-3)	0 (0-8)	

Note: Statistical analysis with Fischer exacts test.
*P-value below 0.05 = significant.

Among the eight listed methods of dissemination of knowledge for optimizing adherence to recommended clinical practice, "Use of SoMe" was rated at the bottom by both nurses and physicians, with median NRS-scores of 6 (4-8) and 3 (2-6) respectively (Table 4). Nurses, however, rated the method significantly higher than physicians (*P* = <0.001) (Table 4).

4 | DISCUSSION

In the present cross-sectional study, describing SoMe-use among nurses and physicians in the ICU, the majority of the participants reported active use of SoMe, and especially Facebook, however, mostly for personal purposes. Nurses were more positive than physicians toward receiving professional content on critical care topics in closed Facebook-groups. On the other hand, physicians read professional literature more frequently than nurses and used traditional work e-mail daily more often.

The findings of active SoMe-use are consistent with findings of SoMe-use in the general public in Norway,[18,19] and in other studies including healthcare providers, radiologists, emergency medicine physicians, and continuing medical education (CME) course participants.[17,20-23] Only 13% reported professional development as one of the three most important reasons for using SoMe. This rather disappointing finding of low SoMe-use for professional purposes is in contradiction with 2,[22,24] but in line with 3 previous studies.[17,20,21] There might be a potential for the use of SoMe for educational purposes in professional healthcare, but there are obvious barriers. According to Ranschaert et al[20], the 2 most cited reasons for not using SoMe were fear of mixing personal and professional information as well as lack of time. Tunnecliff et al[22] found that the biggest obstacle for obtaining research information via SoMe was participants (71%) belief of the information being untrustworthy. Surani et al[17] reported that less than 50% of physicians and nurses considered the available online information to be reliable. They still, however, encouraged patients to use it and to search about their illness online.[17] The source of the information obtained is obviously still a large concern surrounding SoMe use.

Facebook was the most popular network site among both professions in the present study. Daily Facebook use was more common among females and nurses. Although having a Facebook profile was more common among those younger than 40 years, daily Facebook-use did not differ between younger and older than 40 years. Other studies have also found that age, gender, profession, and education, in addition to country of residence, all influence the frequency of SoMe use,[17,22,23] as well as choice of SoMe-platforms.[17,20,21,24] Facebook is described as the most gender- and age neutral SoMe-platform,[18,19,25] indicating the potential for using Facebook to share professional content among health care providers. In a mixed method study among 317 health clinicians (mainly physicians and physiotherapists), the participants reported an overall improvement in attitudes toward SoMe (Twitter and Facebook) for professional

TABLE 4 ICU nurses' and physicians' perception of the importance of different methods for disseminating knowledge to optimize critical care -How important are the named methods on a scale from 0 to 10

	All (n = 253)	Nurses (n = 210)	Physicians (n = 43)	Difference (nurse/physician)
	Median NRS-score (IQR)	Median NRS-score (IQR)	Median NRS-score (IQR)	*P*-value
Lectures (international congresses/ courses/training days)	8 (7-10)	8 (7-10)	8 (7-9)	0.188
Interdisciplinary (physicians and nurses) **collaboration** (development of guidelines and other quality improvement projects)	9 (8-10)	8 (8-10)	8 (7-9)	0.001*
Traditional dissemination of articles and other educational material via **e-mail**	7 (5-8)	7 (5-8)	7 (5-8)	0.301
Use of **Social Media** for dissemination of articles and other educational material	6 (3-8)	6 (4-8)	3 (2-6)	<0.001*
Research in the ICU	8 (6-9)	8 (6-9)	8 (6-9)	0.933
Feedback of own practice using quality measurements	8 (6-9)	8 (6-9)	8 (5-9)	0.171
Simulation training (skills training, practical exercise)	9 (7-10)	9 (8-10)	8 (7-9)	0.002*
Supervision and counseling; clinically and in groups	8 (8-10)	9 (8-10)	8 (6-9)	0.001*

Note: Statistical tests with independent-samples Mann-Whitney *U* test.
Abbreviations: NRS, numeric rating scale 0-10; (0 = "not at all" and 10 = "very much"); IQR, interquartile range presented with first (Q1) and third quartiles (Q3); ICU; intensive care unit.
**P*-value below 0.05 = significant.

development and an increase in knowledge.[26] Furthermore, 70% of the respondents indicated that the education they received through SoMe had changed the way they practice, or intended to practice.[26] If Facebook is useful to improve standards of critical care in the ICU remains unsettled and should be explored in future studies.

The most important challenge with using Facebook to provide professional content on critical care topics, is probably the critical care providers' perception of using Facebook for this purpose. In comparison between lectures, interdisciplinary collaboration, simulation training, supervision and counselling, and dissemination via e-mail, both professions in the present study rated the use of SoMe lowest for optimizing critical care practice. This is consistent with previous findings,[22] and indicates that currently traditional methods are perceived as more important to optimize critical care than use of SoMe. We found, however, that nurses were more positive than physicians toward being members of closed Facebook-groups aimed to exchange professional content on critical care topics, and toward receiving professional content in already existing Facebook-groups. Of concern, only 43% of the physicians were even aware of the existence of these groups. Attitudes and habits of learning, and educational behavior obviously seem to differ between nurses and physicians. Nurses reported a lower frequency of reading traditional hospital e-mail and professional literature than physicians in the present study, and in addition, they preferred research-papers via links on different web-sites when reading professional literature electronically. Consequently, we might assume that there is a higher benefit potential among nurses than physicians by using closed Facebook-groups for disseminating professional content on critical care. However, the nurses were younger, used Facebook more frequently, and have a lower professional degree than the physicians. In agreement with this, it has previously been shown that favorable attitudes toward SoMe among CME course participants were associated with younger age, using SoMe frequently, and professional degree.[23] We might speculate if attitudes may change in the future, when younger physicians more familiar with SoMe take over as consultants and chairs in the ICUs.

Finally, SoMe-use can obviously be a distraction at the workplace,[17] and SoMe-applications are automatically stopped on the hospital computers by the hospital network at OUH. The participants in the present study were considered to be aware of this aspect, and we have to emphasize that their answers regarding professional content on Facebook is interpreted related to their free time. It is therefore reasonable to assume that perhaps the biggest challenge with SoMe-use for professional development, is that the health care providers are not interested in using their free time on professional content. This aspect and concern, must be acknowledged and addressed in future studies.

4.1 | Strengths and limitations

This study achieved a response-rate of 64%. A higher response-rate would be desirable to get a study sample accepted as representative of the overall target population. A lower response-rate is however common in electronical surveys.[27] The electronical survey programme "Nettskjema" had limitations partly because of keeping the survey anonymous, making an attrition analysis impossible. We distributed the survey on e-mails and those rarely reading their e-mail on a regular basis might be under-represented in the study, in spite of reminders in the ICUs to increase survey participation.

A strength in the present survey is that there were no missing data due to mandatory questions. However, statistical challenges occurred anyway because of skewed samples. Few responders were without Facebook or SoMe-profiles, and just a few physicians were younger females and few nurses were older males. The sample is representative for the two professions in the study ICUs, but the skewed groups provided statistical challenges in addition to the lower number of physicians. Another limitation is that an analysis about concomitant use of different SoMe platforms was not performed, even if this could be interesting.

The relatively small sample size, encompassing a single hospital, limits the generalizability of the results to a larger population. Other limitations include weakness of collecting self-reported information (eg response bias) via a non-validated survey questionnaire and the lower participation from physicians.

5 | CONCLUSION

The majority of ICU nurses and physicians were active SoMe users, mainly for personal purposes, and Facebook was the most popular SoMe. Nurses used Facebook daily more frequent and were more positive toward content on critical care topics on Facebook than physicians. These findings might be relevant to customize future communication about critical care topics via SoMe.

CONFLICT OF INTEREST

The authors have no conflicts of interest.

ORCID

Antonija Petosic https://orcid.org/0000-0003-0801-9892
Kjetil Sunde https://orcid.org/0000-0001-9518-5199
Dimitri Beeckman https://orcid.org/0000-0003-3080-8716
Hans K. Flaatten https://orcid.org/0000-0001-9186-3482
Hilde Wøien https://orcid.org/0000-0002-0723-4112

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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RESEARCH ARTICLE

Multifaceted intervention including Facebook-groups to improve guideline-adherence in ICU: A quasi-experimental interrupted time series study

Antonija Petosic[1,2] | Milada C. Småstuen[3,4] | Dimitri Beeckman[5,6,7] | Hans Flaatten[8] | Kjetil Sunde[9,10] | Hilde Wøien[1,2]

[1]Division of Emergencies and Critical Care, Department of Postoperative and Intensive Care, Oslo University Hospital, Oslo, Norway

[2]Institute of Health and Society, University of Oslo, Oslo, Norway

[3]Department of Public Health, Oslo Metropolitan University, Oslo, Norway

[4]Division of Emergencies and critical care, Department of Research and Development, Oslo University Hospital, Oslo, Norway

[5]Skin Integrity Research Group (SKINT), Department of Public Health and Primary Care, University Centre for Nursing and Midwifery, Ghent University, Ghent, Belgium

[6]Swedish Centre for Skin and Wound Research (SCENTR), School of Health Sciences, Örebro University, Örebro, Sweden

[7]Research Unit of Plastic Surgery, Department of Clinical Research, Faculty of Health Sciences, Odense University, Odense, Denmark

[8]University of Bergen, Bergen, Norway

[9]Division of Emergencies and Critical Care, Department of Anaesthesiology, Oslo University Hospital, Oslo, Norway

[10]Institute of Clinical Medicine, University of Oslo, Oslo, Norway

Correspondence
Antonija Petosic, Department of Postoperative and Intensive Care, Division of Emergencies and Critical Care, Oslo University Hospital, Kirkeveien 166 0450 Oslo, Norway.
Email: antonija.petosic@studmed.uio.no

Abstract

Background: The impact of social media, with its speed, reach and accessibility, in interventions aimed to improve adherence to guidelines such as assessment of Pain, Agitation/Sedation and Delirium (PAD) in intensive care is not described. Therefore, the primary objective of this quality improvement study was to evaluate the impact of a multifaceted intervention including audit and feedback of quality indicators (QI) via Facebook-groups, educational events and engagement of opinion leaders on adherence to PAD-guidelines in four ICUs.

Methods: A quasi-experimental interrupted time series study with eight monthly data points in the two phases Before and Intervention was designed. Proportion of nursing shifts with documented PAD-assessment (PAD-QIs) were retrieved from the electronical medical chart from included adult ICU patient-stays in four participating ICUs. Difference between the two time periods was assessed using generalised mixed model for repeated measures with unstructured covariance matrix, and presented as Beta (B) with 95% confidence interval (CI).

Results: Finally, 1049 ICU patient-stays were analysed; 534 in Before and 515 in Intervention. All three PAD-QIs significantly increased in Intervention by 31% (B = 30.7, 95%CI [25.7 to 35.8]), 26% (B = 25.8, 95%CI [19.4 to 32.2]) and 34% (B = 33.9, 95%CI [28.4 to 39.4]) in pain, agitation/sedation and delirium, respectively.

Conclusion: A multifaceted intervention including use of Facebook-groups was associated with improved guideline-adherence in four ICUs, as measured with process PAD-QIs of PAD assessment. Further research on use of social media to improve guideline adherence is warranted, particularly as social distancing impacts clinical education and training and new approaches are needed.

KEYWORDS
agitation/sedation, delirium, facebook, guideline adherence, intensive care unit, interrupted time series, multifacetted intervention, pain, quality improvement, quasi experimental, social media, social networking sites

1 | INTRODUCTION

Health status of critically ill patients depends significantly on quality of care in the intensive care unit (ICU).[1,2] Optimisation of provided critical care according to evidence-based guidelines is of utmost importance.[1,2] Quality should be monitored and measured, and action must be taken if quality is found to be suboptimal.[2,3] Current practice for providing information and feedback about quality of care is mainly based on traditional communication methods such as international, national and local meetings, e-mails, web-pages and posters in the ICU. The effects of single components or multifaceted interventions targeting common barriers such as lack of knowledge, awareness or motivation on improved adherence vary.[4-10] An overview of systematic reviews from 2011 showed that multifaceted interventions are more likely to improve practice than single interventions.[9]

We use social media (SoMe) as a daily way of communication. SoMe can improve communication and information sharing,[11] and provide an educational medium for improving health care personnel (HCP) knowledge, research evidence adherence and clinical behaviour.[12] However, use of SoMe in an integrated approach aimed to communicate with HCPs to improve ICU guideline-adherence has not been studied.[13-15] SoMe can be an alternative communication method with its speed, reach and accessibility via their smartphones.[12,16,17] In a recent Norwegian survey, 93% of ICU nurses and physicians reported having a SoMe profile, with Facebook being the most popular.[18] In particular, ICU nurses reported a positive attitude towards receiving content on critical care topics in work-related closed Facebook-groups.[18] To our knowledge, no study has tested use of Facebook-groups to improve HCP's adherence to ICU guidelines.

Assessment of guideline-adherence can be measured through quality indicators (QIs).[19] QIs are defined as 'measures to assess a particular health care structure, process or outcome',[1,20,21] and may be used as screening tools to flag potential health care quality problems needing further investigation.[22] Process indicators describe the process of care itself; whether what is known as good clinical practice has been applied.[1,20] ICU staff deal with several care processes, and pain, agitation/sedation and delirium (PAD) are typical examples.[23,24] Routines of systematic assessment of PAD with validated tools are strongly recommended in evidence-based international guidelines.[23,24] In a large study, adherence to a bundle including PAD assessment and management was associated with a clear dose-response relationship between higher bundle-adherence and improved patient outcomes.[25] In addition, significant pain was more frequently reported as bundle performance proportionally increased.[25] HCPs need both knowledge and clinical competency in understanding the complexity of PAD elements and overcome barriers to improve treatment based on PAD assessment. Therefore, a multifaceted approach would be more likely to facilitate adherence to PAD assessment, also considering that people respond differently to varying types of interventions.[9,26]

The primary objective of the present quality improvement study was to evaluate the impact of a multifaceted intervention including audit and feedback of QIs via Facebook-groups and email, educational events and engagement of opinion leaders to ensure adherence to the recommended PAD-guidelines.[23] We hypothesised that process PAD-QIs would increase in the intervention period compared to the period before. In addition, we aimed to perform an exploratory process evaluation of the Facebook-intervention.

Editorial Comment

Use of social media may play a role in the dissemination and implementation of clinical practice guidelines in the ICU.

2 | METHODS

This study is part of a larger quality improvement initiative through a multifaceted intervention. In addition to PAD, four other QIs were included: multi-professional ward rounds, early mobilisation, early enteral nutrition and pressure ulcers (Figure 1, Appendix 1). Only the impact on PAD are included within the scope of this study, because PAD-QIs are applicable to all patients, less influenced by specific diagnoses and circumstances, thereby clearly reflecting the impact of the intervention on adherence.

2.1 | Design

A quasi-experimental interrupted time series study with two phases was designed, including eight monthly data points before (January'17–August'17, Before) and after initiation of the multifaceted intervention (October'17–May'18, Intervention) (Figure 1). Intervention onset was in September 2017 (Figure 1). Data on PAD-QIs were collected from the electronic medical chart of ICU patients admitted in these time periods. Adult (>18 years) patients' ICU-stays with a minimum ICU-length of stay (LOS) of 48 h were included retrospectively (before 11 June 2017) and thereafter prospectively.

Prior to Intervention, the ICUs had regular focus on PAD with traditional educational events and various types of reminders by opinion leaders (OL). Existing closed Facebook-groups were mainly used for social content and shift-swapping and not for quality improvement purposes.

2.2 | Setting and participation

The study was conducted in four ICUs at Oslo University Hospital (OUH). In 2017, OUH had 3390 ICU patient-stays from 11 ICUs registered in the national Norwegian ICU Registry (NIR), of which 1378 (41%) represented the four study ICUs.[27] These ICUs are organised within the same department, with two physically located at OUH

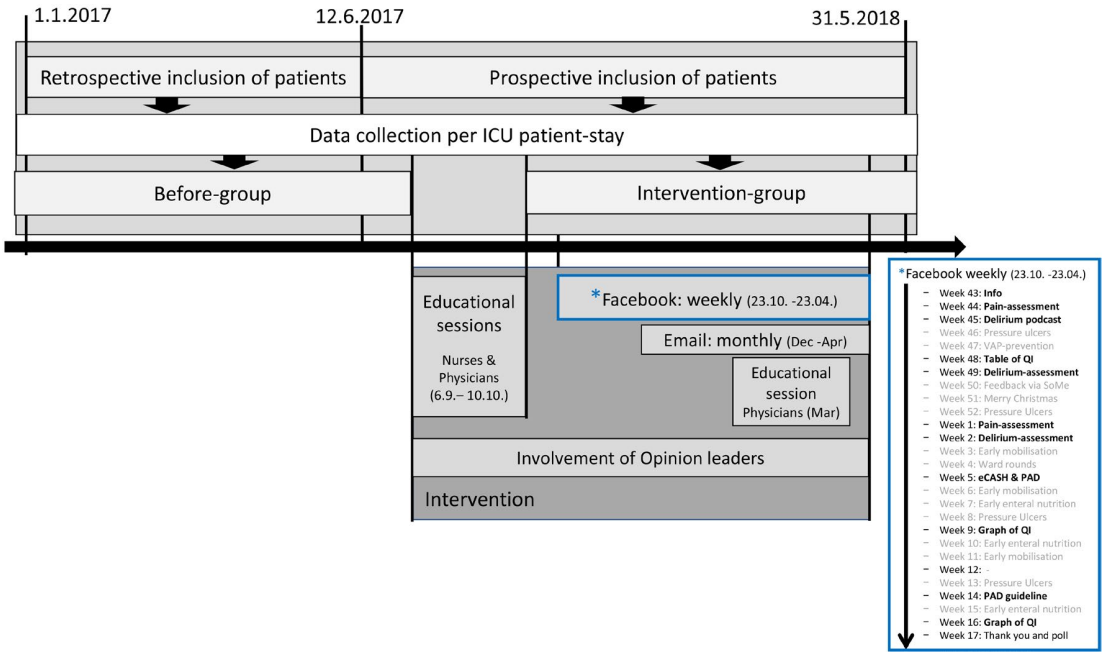

FIGURE 1 Study design [Colour figure can be viewed at wileyonlinelibrary.com]

Rikshospitalet and two at OUH Ullevål. Each ICU has 8–12 beds (see structures in Table 1).

2.3 | Multifaceted intervention

The multifaceted intervention included educational events, audit and feedback of QIs via Facebook and email, and engagement with OL (Figure 1).

Educational events were provided to all ICU nurses in September–October'17. The nine sessions included a three-hour interactive classroom lecture with group discussion. All lectures included definition of quality in health care, quality measurements, overview of the selected critical care topics, discussions around adherence to guideline recommendations and feedback on baseline performance in each ICU. ICU-physicians were offered two one-hour meetings, with presentations, feedback and discussion about the different critical care topics.

Audit and feedback of QIs were provided via weekly Facebook-posts in the closed Facebook-groups between 23.10.17.–23.04.18., and monthly emails to relevant department heads and local OLs. The audited QIs were compared to previous QI-levels within each participating ICUs and to the other ICUs. Twenty-six different Facebook-posts (including 11 images, 11 videos, 3 weblinks and one podcast) were posted simultaneously in all four Facebook-groups (altogether 104 posts), of which 10 consisted of PAD-QI content (Appendix 2). The posts were posted at all weekdays except Sundays, and all times except between midnight and 6.00 am. To increase distribution, visibility and interest, they included emojis, questions and a call to action to gain comments and/or 'likes', including offering gifts to one of those who liked/ commented. The last Facebook-post was a poll asking Facebook-members to vote for their future preferred place to receive information on critical care topics. All options known to members were available, and multiple options could be voted for.

Involvement of local OL[7] included staff leadership and especially professional development nurses who were involved in planning, patient-inclusion and bedside follow-up. QIs were presented to OLs at two meetings during the intervention period in addition to an ongoing dialog. The importance of their involvement to optimise care was emphasised.

2.4 | Data collection

Data from each ICU patient-stay related to PAD-QI calculations, were retrieved retrospectively from the electronical patient chart system (MetaVision, iMDsoft, Israel). To describe included stays, data were retrieved from NIR, including demographic data, primary reason for ICU admission, treatment-interventions, Nursing Activities Scores (NAS), LOS, time on invasive mechanical ventilation and ICU mortality.

We intended to collect data on engagement from the closed Facebook-groups on each Facebook-post 24 h after posting. Data from the poll was summarised when there was no more activity.

2.5 | Variables and outcomes

Primary outcome was adherence to PAD guidelines, measured by the level of the three PAD-QIs in Before and Intervention. The PAD-QIs were calculated per ICU patient-stay and defined as number of

TABLE 1 The study ICUs structure

	Hospital 1		Hospital 2	
	ICU 1 No. (%)	ICU 2 No. (%)	ICU 3 No. (%)	ICU 4 No. (%)
Actual ICU beds	12	8	11	9
Staffed ICU beds	10	6	10	6
No. of regular ICU physicians (persons)	10		6	
Total nursing FTEs with planned use of temporary staff[a]	98.8	62.4	100.8	61.9
Regular nursing FTEs[a]	90 (91)	55 (88)	92 (91)	53 (86)
ICU specialised nurses (FTEs)[a] (% of regular FTEs)	76 (84)	31 (56)	84 (83)	45 (84)
No. of regular nurses (persons)[b]	107	68	113	70
Gender of nursing staff (female)[b]	90 (84)	55 (81)	99 (88)	56 (80)
Age of nursing staff[b] (mean (SD))	47.1 (9.3)	40.6 (10.3)	46.7 (11.4)	41.9 (10.2)

Abbreviations: FTEs, Full time equivalents; ICU, Intensive Care Unit; No, number; SD, Standard deviation.

[a]Budget numbers for 2017.

[b]Data extracted from the database for Personnel rotation planning (MinGat, Visma).

nursing shifts with a minimum of one documented assessment of pain, agitation/sedation and delirium per number of nursing shifts (minimum duration 2 h) during the complete ICU patient-stay.

Process evaluation of the Facebook-intervention was counted by actual number of closed Facebook-group members and numbers of 'seen', 'likes' and 'comments'.

2.6 | Ethics

Study approval was obtained from the Regional Ethics Committee (2016/2281/REK sør-øst A), and the data protection officer at OUH. Permission was obtained to connect NIR data with data from MetaVision. Data were safely stored on the hospital research server.

All patients included received standard care. Written informed consent was obtained prospectively by the patient or a relative. Consent from retrospectively included patients was achieved by a letter with a request to use a defined set of their ICU data with the possibility to withdraw their study participation.

Permission was obtained from department heads. ICU nurses and physicians were informed during educational sessions and through Facebook in the four closed Facebook-groups.

2.7 | Statistical analysis

Categorical data are presented as counts and percentages. Continuous variables are described with mean and standard deviation (SD) or median and interquartile range (IQR) depending on the distribution. Crude differences between Before and Intervention for continuous variables were assessed by independent samples t-test or non-parametric independent samples Mann-Whitney U test, when appropriate. Pairs of categorical data were compared using Pearson's chi-square test or Fisher's exact test, as appropriate.

For the ITS analysis, time was measured in months. Data from each ICU patient-stay was allocated to the appropriate month based on date of discharge. Data are depicted graphically using estimates of aggregated monthly averages with 95% confidence intervals (CI). Differences between Before and Intervention were assessed using generalised mixed model for repeated measures with unstructured covariance matrix, and results are presented as estimated means at given time points (separately for each ICU) and overall estimated change (Intervention–Before) quantified as regression coefficient Beta (B) with 95% CI. p values ≤ 0.05 were considered significant. The study is considered exploratory so no correction for multiple testing was performed.

Statistical analyses were performed with IBM Statistical Packages for Social Sciences (SPSS version 26.0). Figures are created using the software MATLAB by MathWorks, Inc.

3 | RESULTS

Of 1413 eligible ICU patient-stays, 1108 (78%) in 978 patients were included. Finally, 1049 ICU patient-stays were analysed; 534 in Before and 515 in Intervention, after excluding 59 ICU stays overlapping with the two time periods (Figure 2). Details from the two cohorts are shown in Table 2.

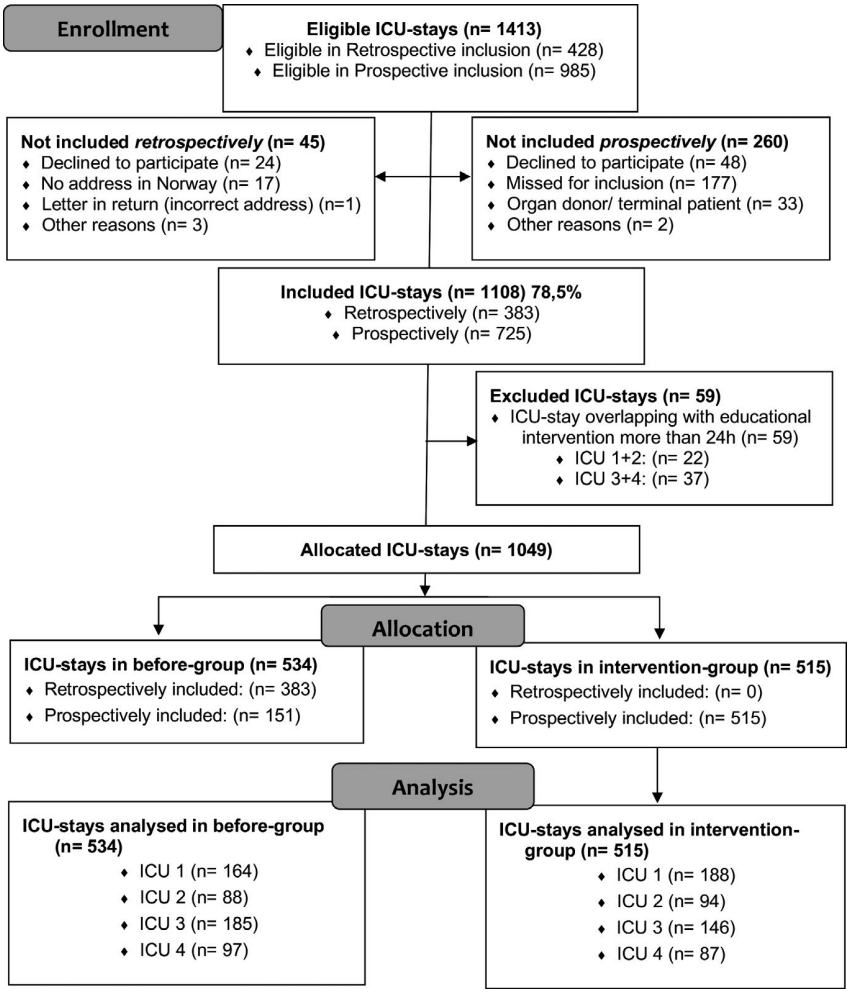

FIGURE 2 ICU patient- stays; Flow chart of enrollment, allocation and analysis

3.1 | Levels of PAD-QIs

The 16 individual monthly data points included PAD-QIs from 53 to 80 ICU patient-stays. ITS-analyses showed a significant increase in all three PAD-QIs in Intervention versus Before (Figure 3). All three PAD-QIs increased significantly in Intervention by 31% (B = 30.7, 95%CI [25.7 to 35.8], 26% (B = 25.8, 95%CI [19.4 to 32.2]) and 34% (B = 33.9, 95%CI [28.4 to 39.4]) in pain, agitation/sedation and delirium, respectively (Table 3). The size of the change differed between the four ICUs (Table 3). Documentation of pain and agitation/sedation remained unchanged in ICU3 with high pre-existing activity in Before, whereas the other three ICUs improved in Intervention (Table 3). Documentation of delirium improved in all four ICUs (Table 3).

3.2 | ICU personnel's engagement in Facebook-posts

The four closed Facebook-groups had 78–160 members. After 24 h from posting, we had relevant data on 79 of the 104 (76%) posts, which had been 'seen' by mean 69.6% (SD: 7.4) members, 'liked' by mean 7.1% (SD: 4.0) and commented on by median 2.9% (IQR: 0.0, 4.6).

The top five most 'seen' posts had a contest activity including a gift, were posted in evenings (5:48 PM and 8:55 PM) between Monday and Wednesday, and included a video or an image.

In the poll with 189 votes, closed Facebook-groups (62 votes, 33%) and e-mails (70 votes, 37%) were the two most popular choices on preferred location for critical care topic information (Table 4).

4 | DISCUSSION

The main finding of this study evaluating the impact of a multifaceted intervention including closed Facebook-groups on adherence to current PAD recommendations, was a significant improvement in PAD-QI over time. Delirium was documented significantly more frequently in all four ICUs in Intervention versus Before, while pain and agitation/sedation were documented more frequently in three of the four ICUs. The ICU with no difference in pain and agitation/sedation, had already a high documentation rate in Before. Most

TABLE 2 ICU patient-stays characteristics

Variables	Before (n = 534)	Intervention (n = 515)	*p*-value
Demographics			
Age (mean (SD))	55.6 (16.1)	55.1 (16.6)	0.650
Gender (male) (no (%))	345 (64.6)	341 (66.2)	0.584
Bodyweight[a] (kg) (mean (SD))	82.8 (19.5)	79.7 (18.9)	**0.014**
SAPS II (mean (SD))	38.4 (16.6)	37.4 (17.2)	0.359
Primary reason for ICU admission			0.535
Respiratory failure (no (%))	57 (10.7)	52 (10.1)	
Circulatory/ cardiovascular failure (no (%))	45 (8.4)	37 (7.2)	
Gastroenterological failure (no (%))	99 (18.5)	115 (22.3)	
Neurological failure (no (%))	88 (16.5)	75 (14.6)	
Sepsis (no (%))	24 (4.5)	15 (2.9)	
Injury/trauma (no (%))	146 (27.3)	143 (27.8)	
Other (no (%))	75 (14.0)	78 (15.1)	
Admitted from another ICU (no (%))	203 (38.0)	170 (33.0)	0.090
ICU Treatment			
Mechanical ventilation (no (%))	479 (89.7)	412 (80.0)	**<0.001**
Tracheostomy (no (%))	154 (28.8)	117 (22.7)	**0.024**
Intracranial Pressure monitoring (no (%))	74 (13.9)	72 (14.0)	0.954
Vasoactive infusion >6 h (no (%))	467 (87.5)	413 (80.2)	**0.001**
Extended haemodynamic monitoring[b] (no (%))	58 (10.9)	60 (11.7)	0.686
Targeted temperature management (no (%))	21 (3.9)	19 (3.7)	0.837
Haemodynamic support[c] (no (%))	10 (1.9)	13 (2.5)	0.471
Renal replacement therapy (no (%))	113 (21.2)	94 (18.3)	0.237
NAS per ICU day (mean (SD))	146.2 (92.0)	148.3 (79.4)	0.702
Time on invasive mechanical ventilation (days) (median (IQR))	4.7 (1.9, 10.3)	4.0 (1.0, 9.7)	**0.026**
LOS ICU (days) (median (IQR))	6.8 (3.7, 12.9)	6.1 (3.7, 10.7)	0.279
ICU Mortality (No (%))	53 (9.9)	33 (6.4)	**0.038**

Abbreviations: ICU, Intensive Care Unit; IQR, Interquartile Range with 25, 75 percentiles; kg, kilograms; LOS, Length of stay; NAS, Nursing Activities Score; no, number; SAPS, Simplified Acute Physiology Score; SD, Standard Deviation.

[a]Due to missing data for Bodyweight; n = 499 in before, n = 438 in after.

[b]Extended hemodynamic monitoring includes SwanGanz or PiCCO.

[c]Haemodynamic support includes ECMO, IABP or Impella.

Facebook-group members had seen the Facebook-posts 24 h from posting, but numbers of 'likes' and comments were low. Still, closed Facebook-groups received 33% of Facebook-poll votes of preferred location for critical care topic information.

To our knowledge, this is the first study to use closed Facebook-groups as part of an intervention strategy to improve adherence to ICU recommendations. The QIs in Before were relatively low for pain (40%) and especially low for delirium (10%), and these increased by 31% and 34%, respectively. To improve an activity that prior to intervention is low is less challenging and not surprising.[4,28] For agitation/sedation, the documentation activity was higher (60%) in Before, but still improved by 26%. A scoring frequency of above 70% is considered standard in the German QI-set, with recommended PAD scoring at least every 8 h.[19] In our study, this standard was only achieved for agitation/sedation overall and in three of the four ICUs. For pain, the standard of 70% was only reached in one of the four ICUs.

Indeed, this was a multifaceted intervention, and we certainly do not know which part of the intervention had an effect on the measured level of PAD QIs. Audit and feedback have the potential to change recipients' awareness and beliefs about current practice, and inherently motivate improvement in care, particularly when compliance is low.[4,28] The overall improvements in the three PAD-QIs were relatively high and similar to the highest IQR presented in a Cochrane review of audit and feedback.[4] In addition to low compliance, audit and feedback appears to be most effective when provided several times by a supervisor or colleague, given

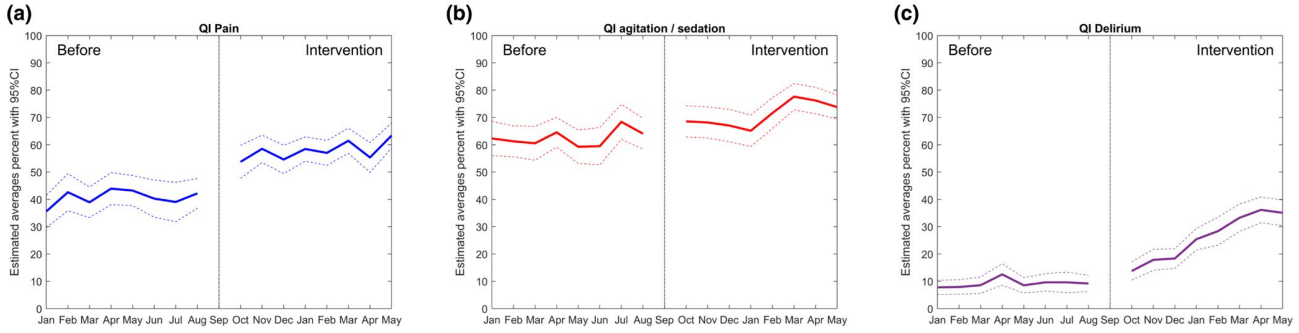

FIGURE 3 Interrupted Time Series charts for the development of quality indicators (QI); pain (a), agitation/sedation (b), delirium (c), in percentage of nursing shifts with documented assessments, in the two time periods: Before (Jan–Aug) and Intervention (Oct–May) [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Quality indicators of pain, agitation/ sedation and delirium before and Intervention. Estimated means for the ICUs and results of the generalised mixed model for repeated measures with unstructured covariance matrix for total difference

	Before	Intervention		
	Mean (95% CI)	Mean (95% CI)	Coefficient Beta (95% CI)	
QI Pain (Total)			30.7	(25.7, 35.8)
ICU 1 (n = 164; n = 188)	26.1 (23.4, 28.7)	55.1 (52.5, 57.6)		
ICU 2 (n = 88; n = 94)	23.8 (20.1, 27.4)	42.1 (38.6, 45.6)		
ICU 3 (n = 185; n = 146)	63.5 (61.0, 66.1)	64.2 (61.4, 67.1)		
ICU 4 (n = 97; n = 87)	39.3 (35.8, 42.8)	70.0 (66.3, 73.7)		
QI Agitation/ Sedation (Total)			25.8	(19.4, 32.2)
ICU 1 (n = 164; n = 188)	69.6 (66.2, 73.0)	76.4 (73.2, 79.6)		
ICU 2 (n = 88; n = 94)	35.5 (30.9, 40.1)	51.5 (46.9, 56.0)		
ICU 3 (n = 185; n = 146)	76.4 (73.2, 79.6)	77.4 (73.8, 81.1)		
ICU 4 (n = 97; n = 87)	45.8 (41.4, 50.2)	71.7 (67.0, 76.3)		
QI Delirium (Total)			33.9	(28.4, 39.4)
ICU 1 (n = 164; n = 188)	3.0 (0.1, 5.9)	21.3 (18.5, 24.1)		
ICU 2 (n = 88; n = 94)	1.0 (−2.9, 4.8)	15.3 (11.4, 19.2)		
ICU 3 (n = 185; n = 146)	22.3 (19.6, 25.1)	34.0 (30.8, 37.2)		
ICU 4 (n = 97; n = 87)	3.1 (−0.7, 6.9)	37.0 (33.0, 41.1)		

Abbreviations: CI, Confidence interval; ICU, intensive care unit; n, number.

both verbally and in writing, including clear objectives and an action plan. [4,28] Inclusion of most of these aspects were achieved with the present Facebook-posts, with feedback of monthly, audited QIs from the main investigator (AP) to ICU colleagues. In addition, educational events and OLs were also included. In two Cochrane reviews, median-adjusted risk difference in adherence to desired practice was 6% with educational events[5] and 10.8% improvements in adherence to evidence-based practice with *OL* interventions.[7]

The impact of Facebook on the observed changes in PAD-QIs in this study is unclear, and studies of Facebook-use to improve adherence to patient care are lacking. In a study, communicating evidence-based practice points via Facebook and Twitter, 70% of respondents reported that SoMe had changed their practice.[12] We found that a large proportion of Facebook-group members saw the posts indicating that the intervention was adopted. However, we do not know whether 'seen' actually means that they read the content or just scrolled over it. Further, we do not know whether this affected their PAD documentation practice, since we collected data on included patients rather than on individual HCP. Positive predictors of SoMe use for professional purposes are younger age and fewer years of professional experience,[11] indicating that SoMe could become more effective in the future. Furthermore, SoMe is an important platform for disseminating information and remote learning during the COVID-19 pandemic, as social distancing affects clinical training and didactic education and new approaches to enhance education of HCP are needed.[29-31]

The magnitude of improvements and the settings prior to Intervention varied across the four ICUs. ICU 3 had the lowest improvement in PAD-QIs, with no significant improvement in pain- and agitation/sedation-assessment, which were relatively high in Before. ICU 4 had the largest improvements in all three PAD-QIs, but in addition the lowest proportion of 'seen' and

TABLE 4 Engagement in Facebook-post by members in the closed Facebook-groups and votes from the last post of where they in the future wanted to receive critical care content

	Total	ICU 1	ICU 2	ICU 3	ICU 4
No of Facebook-group members (Median (min-max))	122 (78–160)	155 (150–157)	82 (78–85)	130 (127–160)	112 (109–117)
Engagement in posts after 24 h					
No of posts[a]	n = 79	n = 20	n = 19	n = 20	n = 20
Seen in % of no of group-members (mean (SD))	69.6 (7.4)	68.6 (5.5)	73.5 (8.4)	72.0 (7.0)	64.4 (5.5)
Likes in % of no of group-members (median (IQR))	6.2 (4.3, 9.4)	8.5 (5.3, 12.3)	6.0 (3.5, 8.3)	5.2 (3.3, 10.8)	6.1 (5.3, 7.3)
Comments in % of no of group-members (median (IQR))	2.3 (0.0, 4.6)	2.0 (0.8, 4.0)	4.7 (2.5, 6.3)	2.3 (0.8, 3.8)	0.4 (0.0, 2.4)
Facebook Poll: Votes of preferred source for receiving information on critical care topics					
No of votes	n = 189	n = 67	n = 39	n = 48	n = 36
	n (%)	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Closed-Facebook group	62 (33)	21 (31)	17 (44)	17 (35)	7 (19)
E-mail	70 (37)	22 (33)	4 (10)	21 (44)	23 (64)
Hospital Intranet	41 (22)	18 (27)	11 (28)	6 (13)	6 (17)
Posters in ICU	14 (7)	6 (9)	6 (15)	2 (4)	0 (0)
Paper in mail-shelf	2 (1)	0 (0)	1 (3)	2 (4)	0 (0)

Abbreviations: ICU, intensive care unit; IQR. Interquartile Range with 25, 75 percentiles; SD, Standard Deviation, no, number.

[a]26 Facebook posts were posted in each of the four ICU closed Facebook-groups, giving altogether 104 posts; N is lower in the table due to missing data.

comments on Facebook. Local circumstances can always contribute to improvements in quality of care, and we know that the OL in ICU 4 was particularly active with additional bedside reminders in Intervention. Different approaches by local OLs in different ICUs may have affected overall engagement in the study, and the extent of forwarding emails, posting audit and feedback from Facebook-posts or bedside support varied across ICUs.

4.1 | Strengths and limitations

Randomisation was not possible due to logistical issues. The ability to attribute the change to the intervention is strengthened with ITS including multiple measurements by reduced uncertainty of unstable measurements at only two time-points.[32-34] However, we cannot completely exclude that the difference in PAD-QIs could be caused by something else and not the intervention due to the history threat. We are, however, not aware of any structural changes made in Intervention versus Before. Characteristics of included ICU patient-stays were similar in both cohorts. However, mechanical ventilation including tracheostomies and use of vasoactive infusions were more common, in addition to longer time on mechanical ventilation and higher ICU mortality in Before. Whether this is relevant to PAD-documentation is unclear.

Effects of the multifaceted intervention were evaluated during an ongoing intervention period, and we do not know if the effect was sustainable or if it just represented a Hawthorne effect.[33,35] At what point the effect on improved adherence should be measured is controversial, due to several confounding aspects developing over time.[34] Implementation and quality improvement initiatives are ongoing processes for several years, and more follow-up is needed after this study's intervention period both to maintain and further improve practice. Moreover, since we only evaluated PAD, we do not know if the other QIs could have provided different results. This study focused on PAD assessment, not the clinical sign of less pain and less delirium, which could be more important quality outcomes for patients. However, a clear dose-response relationship has previously been shown between guideline adherence and clinical patient outcomes.[25]

Typical ITS limitations are autocorrelation and seasonality. Autocorrelation was adjusted for using appropriate statistical methodology, and seasonal changes are not expected in the PAD-QIs except for weekends and holidays with more use of temporary staff. Before included summer holidays, with expected lower guideline adherence, but this was not reflected in the ITS figure. Finally, blinding of ICU personnel and study-investigators was impossible.

5 | CONCLUSION

A multifaceted intervention including use of closed Facebook-groups was associated with an improved guideline-adherence measured with process PAD-QIs of PAD assessment. Further research on the impact of using SoMe to improve guideline adherence is warranted, particularly as social distancing impacts clinical education and training and new approaches to training HCPs are needed.

ORCID

Antonija Petosic https://orcid.org/0000-0003-0801-9892
Milada C. Småstuen https://orcid.org/0000-0001-8947-8649
Dimitri Beeckman https://orcid.org/0000-0003-3080-8716
Hans Flaatten https://orcid.org/0000-0001-9186-3482
Kjetil Sunde https://orcid.org/0000-0001-9518-5199
Hilde Wøien https://orcid.org/0000-0002-0723-4112

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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Research Article

Use of Facebook in a quality improvement campaign to increase adherence to guidelines in intensive care: A qualitative study of nurses' and physicians' experiences

Antonija Petosic [a,b,c,*], Helene Berntzen [a], Dimitri Beeckman [d,e], Hans Flaatten [f], Kjetil Sunde [g,h], Hilde Wøien [a,b]

[a] Department of Postoperative and Intensive Care Nursing, Division of Emergencies and Critical Care, Oslo University Hospital, Oslo, Norway
[b] Institute of Health and Society, University of Oslo, Oslo, Norway
[c] The Norwegian Intensive Care Registry, Haukeland University Hospital, Helse Bergen, Bergen, Norway
[d] Skin Integrity Research Group (SKINT), University Centre for Nursing and Midwifery, Department of Public Health and Primary Care, Ghent University, Ghent, Belgium
[e] Swedish Centre for Skin and Wound Research (SCENTR), Nursing Science Unit, School of Health Sciences, Örebro University, Sweden
[f] Haukeland University Hospital, Bergen Norway
[g] Department of Anesthesia and Intensive Care Medicine, Division of Emergencies and Critical Care, Oslo University Hospital, Oslo, Norway
[h] Institute of Clinical Medicine, University of Oslo, Oslo, Norway

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ABSTRACT

Objectives: This study aimed to explore intensive care unit nurses' and physicians' experiences with professional content provided through closed Facebook groups, as part of a quality improvement campaign to improve guideline adherence.
Research methodology: This study used an exploratory qualitative design. In June 2018, data were collected through focus groups of intensive care nurses and physicians who also were members of closed Facebook groups. Data were analysed using reflexive thematic analysis, and the study was reported according to the consolidated criteria for reporting qualitative research.
Setting: The study's setting was four intensive care units at Oslo University Hospital, Norway. Professional content on Facebook comprised audit and feedback on quality indicators on intensive care topics with related pictures, videos, and weblinks.
Findings: Two focus groups of 12 participants were included in this study. Two main themes were identified: '*One size does not fit all* ' described that quality improvement and implementation are influenced by several factors related to current recommendations and personal preferences. Various strategies are required to serve different purposes and meet individual needs. '*Matter out of place*' described conflicting experiences of being offered or exposed to professional content on Facebook.
Conclusion: Although the audit and feedback on quality indicators presented on Facebook motivated improvements, professional content on Facebook was perceived as inappropriate. Hospital platforms with applicable features of social media, such as reach, availability, convenience, ease, and possibility for commenting, were suggested to secure professional communication about recommended practices in intensive care units.
Implications for clinical practice: Social media platforms may be useful for professional communication among ICU personnel, but appropriate hospital applications with available and applicable social media features are recommended and needed. The use of several platforms may still be needed to reach all.

* Corresponding author at: Department of Postoperative and Intensive Care, Division of Emergencies and Critical Care, Oslo University Hospital, Kirkeveien 166, 0450 Oslo, Norway.
E-mail addresses: antonija.petosic@studmed.uio.no (A. Petosic), uxhebe@ous-hf.no (H. Berntzen), Dimitri.Beeckman@UGent.be (D. Beeckman), Hans.Flaatten@uib.no (H. Flaatten), kjetil.sunde@medisin.uio.no (K. Sunde), hilde.woien@medisin.uio.no (H. Wøien).

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Introduction

Social media has changed the way people communicate worldwide. Healthcare professionals report a high frequency of social media use, even during work and for professional purposes, but the usage may vary with age, sex, graduate status and country of residence (Khan et al., 2021; Piscotty et al., 2016; Surani et al., 2017; Tunnecliff et al., 2015; Wang et al., 2019). With its speed, reach and accessibility through smartphones, social media may improve communication, information sharing and collaboration among healthcare professionals, and provide an educational medium for improving knowledge, adherence to research evidence and clinical behaviour (Chan and Leung, 2018; Maloney et al., 2015). However, reported limitations related to social media are concerns about data protection, privacy, liability and issues in professionalism (Chan and Leung, 2018). Cyber security in hospitals is a growing concern with the increased use of technology and the internet (Wasserman and Wasserman, 2022).

In intensive care, few studies have explored the use of different modern social media for education and dissemination of knowledge (Bourgault et al., 2022; Kleinpell et al., 2017; May et al., 2021; Witherspoon et al., 2016). Frequent use of social media was reported among both nurses and physicians in intensive care units (ICU), with Facebook being the most popular (Petosic et al., 2019). A Facebook profile was more common among those younger than 40, and daily use was more frequent among females and nurses. ICU nurses reported a more positive attitude towards receiving professional content in closed Facebook groups than physicians. In a subsequent clinical study, we used previously established, nurse-administered, closed Facebook groups for a multifaceted quality improvement campaign (Hauff et al., 2023; Petosic et al., 2021). Group membership was voluntary for the employees at four ICUs in Oslo University Hospital. Most ICU nurses, some physicians, and other healthcare personnel were members of the groups, mainly used for social content and for shift-swapping. Audit and feedback on quality indicators were provided first during educational events, followed by a six-month period via weekly Facebook posts with related pictures, videos, and weblinks, defined as professional content (Table 1). The quality indicators were related to pain, agitation/sedation, delirium, early mobilisation, early enteral nutrition, multi-professional ward rounds, and pressure injuries in ICU patients. Facebook posts were seen by many of the group members but commented on and liked only by a few (Petosic et al., 2021), indicating exposure to the content, but the experiences of those exposed were not described. We made the assumption that using a qualitative approach may provide a nuanced and deeper knowledge about this novel way of using Facebook as an implementation strategy for quality improvement in ICUs. Therefore, the present study aimed to explore ICU nurses' and physicians' experiences with professional content provided through closed Facebook groups as part of a quality improvement campaign, to improve guideline adherence in ICUs.

Table 1
Main components of the 26 weekly Facebook posts (Nov.'17-May'18).

Audit and feedback of the following quality indicators (20 posts, one post included feedback of both PAD and mobilisation):
- Pain, agitation/sedation and/or delirium (7 posts)
- Early Mobilisation (4 posts)
- Early enteral nutrition (3 posts)
- Multi-professional ward rounds (1 post)
- Pressure injuries (3 posts included feedback on quality indicator, 1 post on the topic, but without feedback)
- All five quality indicators (3 posts)
- None of the five topics mentioned specifically (4 posts)
Feedback on quality indicators via social media in general
Ventilator-associated pneumonia
Silly Happy Holidays video
Facebook poll of preferred place of information
Posted content related to the ICU quality indicator (two posts had both pictures and weblinks):
- Image (11 posts)
Graph: development of QIs within the ICU (2 posts)
Table: QIs levels for all four ICUs (1 post)
An algorithm from the guidelines (3 posts)
Picture (5 posts)
- Video (11 posts)
Interviews (8 posts)
Educational (2 posts)
Silly Happy Holidays video (1 post)
- Weblink (3 posts)
- Podcast (1 post)
Call for action; likes and comments including prizes to one of them

Abbreviations: ICU; intensive care unit, QIs; quality indicators.

Methods

Design

A qualitative exploratory design was used to develop an understanding of the experiences with Facebook usage in a quality improvement campaign. Focus groups were chosen to facilitate dialogue, discussion, and interactivity and provide a range of participants' ideas and feelings (Green and Thorogood, 2018; Krueger and Casey, 2015). For this study, we followed the consolidated criteria for reporting qualitative research (COREQ) (Tong et al., 2007).

Setting

Nurses and physicians from four mixed ICUs at Oslo University Hospital participated in the focus groups. The four ICUs were located across two separated locations, with two ICUs at each location. Each ICU had 6–10 beds, 60–100 nurses per unit, and 8–10 physicians per site. While nurses only worked in one ICU, physicians covered two ICUs at the same location. Contact between the two professional groups existed primarily during direct patient care and daily rounds. Hospital information was available to employees via an intranet site and e-mail, which requires physical presence at the hospital for the vast majority. Internet access through hospital computers was subject to strict limitations, and Facebook posts were accessible only through personal smartphones or computers.

Participant recruitment

Purposive sampling was used (Patton, 2002), and ICU nurses and physicians working full-time during the intervention period and being members of one of the four ICU Facebook groups were considered eligible to participate. We aimed to maximise variation to ensure diverse perspectives and were able to recruit two heterogeneous groups of participants in terms of profession, sex, age, experience, and workplace. Contact persons in each ICU recruited participants to two focus groups: seven in each focus group, two physicians, and five nurses representing both ICUs at each site. We believe that sufficient information power for this study should be achieved with two focus groups of 5–7 participants, considering the narrow study aim, the specific sample, and the exploratory analysis strategy aimed to uncover relevant patterns of meaning (Malterud et al., 2016).

Data collection

Two semi-structured focus group interviews (one at each location) were conducted in hospital meeting rooms in June 2018, a month after completing the Facebook campaign. An interview guide was developed and discussed within the research group to capture all experiences of using existing closed Facebook groups to provide professional ICU-related content. To facilitate entry into a specific topic, we initiated discussions on the general experiences of implementing evidence-based recommendations. HW conducted the interviews with AP as an observer. All participants knew one or both researchers as colleagues.

AP was responsible for the Facebook campaign, and her presence during the focus groups may have hindered openness about possible negative experiences. To encourage openness, we emphasised that both positive and negative experiences were considered important and useful for informing future interventions. To invite participants to confirm or add to the main topics of the discussion, a summary of the interviewer's understanding was presented at the end of each focus group. Focus group interviews were recorded and transcribed verbatim by AP.

Data analysis

Data analysis was performed using the six phases of reflexive thematic analysis described by Braun and Clarke, aiming to identify themes that are patterns of meaning in qualitative data (Braun and Clarke, 2006, 2019). The six phases comprised familiarisation with the data, generating initial codes (coding), generating themes, reviewing themes, defining and naming themes, and producing the report. The analysis was an active, reflexive, recursive and iterative process across the six phases and, as recommended, was not linear or stepwise (Braun and Clarke, 2006, 2019).

Data familiarisation was accomplished by interview participation and manual transcription, by actively listening to the recorded focus groups and repeatedly reading the transcripts, making notes, and listing initial ideas for coding. This process was performed independently and was followed by discussions in the research group (AP, HB, HW). NVivo software (version 12.7.0) was used to organise the data in the following process. *Initial codes were generated* inductively with semantic codes of explicit or surface meanings of the data, coding for as many potential patterns as possible and preserving surrounding data in the coded data extracts. We coded the two focus groups using NVivo; AP coded and discussed the codes and coding process with HB and HW in several meetings throughout the coding of both focus groups and in the subsequent process. Data were extracted from NVivo to tables to check for coherence and discussions among the three researchers. Following the discussion, the codes were renamed and adjusted to capture sufficient meaning. *Generating themes* included the process of collecting codes into groups and then gathering them into larger groups before generating subthemes and themes (Table 2). *Reviewing themes* was done in relation to the codes and the entire dataset, whereupon the codes, subthemes, and themes were again adjusted, regrouped, or renamed. The two phases of *defining and naming themes* and *producing the report* included the process of moving back and forth between the data and writing the results section. All authors provided substantial input during these phases.

Table 2
Example of data extract, code, subtheme, and theme.

Data extract	Codes	Subthemes	Theme
But the advantage was exactly as you say.. that as you sit and scroll through Facebook in the evening and then and suddenly something good appears (laughs) from work, then you have to look at it anyway. (other participant confirming) So.. it's both.	Conflicting experience	Applicable yet inappropriate	Matter out of place -Professional content on Facebook.
I think, I do not think it (professional content) is suitable together with everything else.	Inappropriate mix-up of content		
I have to say that I felt that … ehm.. sitting at home on the couch, finally my legs up, relaxing, checking out the friends' latest updates. And then a lot off professional content appears.. Oh no!.. it was.. it really disgusted me..	Invading private time		

Methodological considerations

Trustworthiness was sought by applying the Lincoln and Guba framework (Lincoln and Guba, 1985; Shenton, 2004). *Credibility* was sought through descriptions and quotations. A summary of the interviewer's understanding was presented to the participants at the end of each focus group to ensure the comprehension of the descriptions. Co-authors were involved in the analytic process to ensure *confirmability* and by presenting the analytic steps from codes to themes. *Dependability* was sought by transparency through detailed descriptions of the research process, allowing the reader to assess research practice. *Transferability* was sought by providing relevant contextual information about the participants and the study ICUs to enable the reader to relate the findings to their practice.

Ethical considerations

Ethical approval for the study was obtained from the Regional Ethics Committee of Southeast Norway (2016/2281/REK sør-øst A), the Data Protection Officer of Oslo University Hospital, and the department heads. Written informed consent was obtained from each participant before their participation. Confidentiality was maintained by storing the original data on a secure hospital research server and by anonymisation. In the transcribed text, all names of participants, other people mentioned, hospitals or units were exchanged with numbers or an X. A participant code list was kept safely in a locked cabinet at the hospital.

Findings

We recruited seven participants for each focus group. However, two initially recruited participants at one site were unable to attend on the day of the focus group and did not participate in the study. The final sample comprised 12 participants. Among the 12, three were physicians and nine were nurses, three were male and nine were female, aged 32–53 years, with an average ICU experience of >10 years, and representing all four ICUs (Table 3). The two focus groups lasted 96 and 75 min, respectively.

The thematic analysis resulted in two main themes and five subthemes (Table 4).

Table 3
Characteristics of the participants (n = 12).

Focus group	Age group	Profession	ICU-experience (years)
1	50–59	physician	20 +
1	40–49	nurse	10–19
1	40–49	nurse	5–9
1	40–49	nurse	10–19
1	40–49	nurse	20 +
2	50–59	nurse	10–19
2	30–39	nurse	5–9
2	40–49	nurse	10–19
2	40–49	physician	5–9
2	30–39	nurse	0–4
2	50–59	nurse	20 +
2	40–49	physician	5–9

Abbreviations: ICU; Intensive care unit.

Table 4
Overview of Main themes and Sub-themes.

Main themes	Sub-themes
One size does not fit all	Simplifying practice or justifying change Targeting individual barriers
Matter out of place	Content is key Applicable, yet inappropriate Ensuring information

One size does not fit all

The first main finding was the participants' experience that quality improvement and implementation was influenced by several different factors and personal preferences. This is described in two sub-themes illustrating that one size does not fit all purposes or individual needs, hence requiring different strategies.

Simplifying practice and justifying change

In terms of quality improvement and implementation in general, the participants favoured improvements in daily work, leading to less complicated or time-consuming procedures that were also considered equally beneficial to patients. Several examples were provided, such as:

> *'When things simplify everyday life for us, it becomes easier to implement. Less frequent routine care of the injection site, for example, or closed suctioning, or when our workload decreases, it is easier to get it implemented.'* (focus-group-1)

Simplification was also described as facilitating the new practices, for example, by placing the delirium assessment tool at the bedside.

To convince and motivate staff to adhere to recommendations, participants agreed that the implementation of new knowledge had to be justified through evidence proving safer or improved practices for patients. The quality improvement Facebook campaign contained professionally justified recommendations but did not necessarily simplify practice. Demanding new practices were more likely supported when they were considered to improve patient outcomes.

> *'The knowledge must be convincing. Having more and more awake patients in the ICU is more challenging and demanding, but you see and understand that this is beneficial for the patients, - that it is documented* [to be] *beneficial, …'* (focus-group-1)

Despite showing confidence in new practices holding evidence for improved patient outcomes, the participants expressed the need for help and support during the implementation process, suggesting several implementation strategies.

Targeting individual barriers

Implementation barriers related to staff were raised in general terms during the focus groups. Barriers, such as lack of information, knowledge, or motivation to change, were associated with difficulty in reaching all personnel with information and convincing them:

> *'…working shifts, with always someone not being present* [when information is provided]*, it's kind of random what information comes your way.'* (focus group-1)

> *'Those who do it,* [the requested task] *… do it quite regularly every day. Likewise, others notoriously don't, and it is hard to convince them.'* (focus group-2)

The participants suggested several strategies, such as educational events, audits and feedback, reminders, and the use of local opinion leaders, to overcome these barriers. Some participants indicated a need for constant reminders because of the many work-related demands and priorities, although some nurses found them annoying. The suggested strategies and barriers discussed in general terms during the focus groups corresponded to the quality improvement campaign provided, except for Facebook. Use of Facebook was not proposed as a strategy by the participants; however, when asked directly, some confirmed that the posts might work subconsciously as a reminder.

Preferences varied regarding the appropriate time and place for receiving information. It was argued that various interventions and communication strategies are needed, including the presentation of information on several platforms. However, pleasing everyone appeared impossible.

> *'Some will say that I don't have time to* log *on to the intranet, so if I am on leave, I want to catch up … I don't want everything on mail, then Facebook is better. (…) While others will say: No, I don't want Facebook because so and so, and it's my private phone and all the other arguments, so anyway … you cannot please everyone.'* (focus group-1)

In addition to one size not fitting all, there was also ambiguity regarding Facebook use, which was presented as the second main finding.

Matter out of place

The other main finding of this study was the ambivalence expressed regarding Facebook use. Professional content provided via Facebook, especially feedback on quality indicators, was regarded as valuable. However, when the content appeared on Facebook, many regarded it as inappropriate, disruptive, or even provocative, constituting the theme "matter out of place". Instead of Facebook, employers were expected to provide appropriate communication platforms to ensure information. This theme includes three subthemes.

Content is key

Participants from both focus groups agreed that the professional content provided in the multifaceted quality improvement campaign was important and had the potential to raise awareness and improve practice. This particularly applied to the audit and feedback on quality indicators posted on Facebook. However, Facebook as a platform alone was considered insufficient, but the content was crucial.

> *'There must be something … a little more … substantial. So, if you are to introduce something new, and you are supposed to trigger the audience, I believe you have to use meetings, information, e-mail…., so, you can use several platforms, but I think it's the content that … ehm … if it's an interview or a fancy movie on Facebook, … and that's it, it won't catch* [my attention]. *It's not quite enough.'* (focus group-2)

According to the participants, feedback on audited quality indicators focusing on adherence provided a quick overview of the current status of each ICU compared to each other. This motivated improvements through competition, especially if ICU performance fell short of expectations.

One of the participants, who did not prefer or actively read the posted content on Facebook, described how simply noticing the posts may have subconsciously influenced her and affected her practice, for example, how she documented in the patient chart.

Applicable, yet inappropriate

Facebook was perceived to be *applicable* by the participants due to its ability to reach many people, its accessibility outside the hospital, and its ease. Facebook posts frequently led to professional discussions both in Facebook groups and otherwise, for instance, during handovers.

'I really think it has been a good platform because… well, it reaches many. I notice among the staff that we discuss a lot more what was posted on Facebook than what was written in the group e-mail from the manager.' (focus group-2)

Although there were few comments on Facebook posts, they were highlighted as positive and were told to increase reflection and awareness. Facebook usage was considered double-edged, meaning that even if some participants did not prefer to read professional content on Facebook, they read the posts when they appeared in their Facebook feed while scrolling.

The reluctance to adopt Facebook as a platform for professional communication was associated with concerns related to Facebook's sharing of data and lack of privacy protection, exemplified by the recent Facebook data misuse scandal. Some participants disliked Facebook as a platform in general because it was associated with exclusively positive and self-praising posts. Another concern was the lack of access to Facebook through the hospital computer, forcing the staff to use their personal smartphones. Furthermore, social media, in general, as the name implies, was perceived as social and personal and should be used for these purposes. Work-related content on Facebook led to an inappropriate mix-up of content, time, and roles, as it appeared during off-hours, along with other social content or shift changes. When professional content appeared either when scrolling through posts in the pre-existing Facebook group or their Facebook feed, participants indicated that it might lose its importance.

'I must say I felt … ehm … sitting at home on the couch, finally my legs up, relaxing, checking out the friends' latest updates, and then loads of professional content appears … Oh no! … it was … it really disgusted me …' (focus group-1)

For some of the participants, it resembled unwanted advertising, invading their privacy and autonomy. However, some participants suggested that a Facebook group set up specifically for professional purposes (separate from the ICU social content) might work. This would allow them to decide whether to join the group and when to access the information, thereby avoiding becoming involuntary recipients.

Ensuring information

The study participants expected their employer to provide applicable platforms for information and communication and encouraged the use of social media to improve communication among personnel, as email was not perceived as a good tool due to its unavailability at home and as it contained long mail threads.

It was also argued that employers should be cautious about bombarding healthcare personnel with information 24/7, yet the availability of professional information outside the hospital was perceived as highly positive. The choice of Facebook as a platform was criticised, and more suitable platforms were suggested.

'"Slack" [a communication platform for work]*, for instance, or something like it… "Facebook workplace". Then the customer, the employer, registers you with the job e-mail address as username. Then it is connected to work, and not your private… and it is completely separate from the personal, so you cannot cross over'* (focus group-2)

'It is a paradox, though, when you are not allowed to log *in to Facebook when at work and still you provide information through Facebook.'* (focus group-1)

Discussion

The ICU nurses and physicians expressed ambivalence towards the use of Facebook to improve guideline adherence. Although feedback on audited quality indicators was emphasised as important in increasing awareness and motivation to improve practice, the participants suggested alternative hospital communication platforms to separate professional from social and private matters. Disfavouring Facebook, they further claimed that implementation depended on several factors and preferences, indicating that one platform does not fit all purposes or all healthcare personnel, abstracted in our findings as 'one size does not fit all'.

The participants in this study expressed motivation to improve practice through feedback on audited quality indicators, in line with the theoretical assumptions of audit and feedback (Ivers et al., 2012). Implementation strategies such as educational events and reminders were discussed as preferable in general terms in the focus groups, corresponding well to the recommended implementation strategies (Borgert et al., 2015). The participants' conflicting experiences with the use of Facebook for professional purposes might be viewed as akin to 'matter out of place', which is the way that anthropologist Mary Douglas defines 'dirt' (Douglas, 2003). One exemplification is 'shoes', which are not dirty in themselves, but they *turn* dirty when being placed on the dinner table (Douglas, 2003). According to her conceptualisation, dirt offends order as it disorders pure and unclean. Hence, something may be considered pure in one context and unclean in another, and dirt depends on the eyes of the beholder (Douglas, 2003). The way some participants talked about being offended or provoked by content appearing where they felt it did not belong seemed to be triggered by their perception of disorder, as described by Douglas. This may indicate that choosing the right place and time for intervention requires careful consideration, also of "social rules" (McCormack et al., 2002; Skivington et al., 2021). However, such "social rules" may change over time, and the experience of inappropriateness may differ between contexts (Douglas, 2003).

Similar conflicting experiences and opinions regarding the use of social media for professional purposes have been reported among pharmacists, medical students, and health practitioners (Benetoli et al., 2016; Maloney et al., 2014; Tunnecliff et al., 2015). Healthcare workers expressed a need to separate their professional and personal lives, despite several positive features of social media, such as accessibility, convenience, and the ability to disseminate information quickly to a large audience (Maloney et al., 2014; Tunnecliff et al., 2015). It is noteworthy that these studies were all performed before the COVID-19 pandemic. During the pandemic, the use of digital communication, including social media, became more important because of impeded traditional educational sessions, congresses, and meetings, and healthcare workers might have more positive attitudes (Bourgault et al., 2022; Chan et al., 2020; Merchant and Lurie, 2020). The context is of general importance when attempting to understand people's experiences (McCormack et al., 2002; Skivington et al., 2021). In the pandemic context, healthcare personnel appeared more eager to access professional information through social media to learn about self-protection from COVID-19 (Dai et al., 2020; Newby et al., 2020; Vizheh et al., 2020) hence making social media more acceptable even for professional content. This is supported by Douglas' (2003) theoretical aspect of 'dirt' as highly context-dependent; the pandemic may have altered the view on the appropriateness of Facebook. During the pandemic, new Facebook groups were established to spread and exchange professional information and experiences with staff allocated from their original ICUs to work in temporary cohort ICUs.

Even though the focus groups revealed conflicting experiences concerning Facebook, the quality improvement intervention showed a positive impact on the documentation of pain, agitation/sedation, and delirium assessments, as well as mobilisation of patients (Hauff et al., 2023; Petosic et al., 2021). According to the focus groups, the audit and feedback of quality indicators were the active ingredients and not the platform used. However, the content of an intervention may only have an impact if it reaches the targeted population (Brownson et al., 2018; Johannsson and Selak, 2020; Ng et al., 2020; Skivington et al., 2021). The participants highlighted *reach* as a positive feature of Facebook, and the posts were already viewed by many within 24 h of posting (Petosic et al., 2021). This may indicate that social media may be useful, even if

some of the participants found it annoying. According to Perelman (2013), 'content is king', and people are usually interested in both news and gossip or both professional and social content. However, 'distribution is queen' (Perelman, 2013). According to the participants, professional content may be interesting, even when unintentionally accessed on social media. They also expressed the need for multiple interventions and communication strategies, which require information on several platforms.

Participants expressed concerns about the existing hospital platforms being inadequate and suggested the use of more appropriate social media platforms provided by the hospital. Today, hospital computers are frequently inaccessible with slow log-in processes (Chan et al., 2020; Johannsson and Selak, 2020) and organisation-imposed restrictions, which further limit access to social media platforms (Johannsson and Selak, 2020). The combination of strict regulations and limited resources in healthcare may hamper the effective dissemination and communication of guideline recommendations (Brownson et al., 2018; Johannsson and Selak, 2020). The participants' reluctance to use Facebook was partly related to concerns about sharing of data and lack of privacy protection, similar to findings from a systematic review (Chan and Leung, 2018). Information security, including the main three components of *confidentiality*, *integrity* and *availability* (Nifakos et al., 2021; Wasserman and Wasserman, 2022), is required to counteract the growing threat of cyber security in hospitals (Jalali and Kaiser, 2018; Nifakos et al., 2021). A balance between security and availability is, thus, needed, as digitalisation may have significant potential benefits for care quality (Byrnes et al., 2021; Jalali et al., 2021; Rose et al., 2021; Wani et al., 2020). Again, this became particularly evident during the COVID-19 pandemic when numerous restrictions on communication apps were lifted in the US, allowing the use of video conferencing applications (Jalali et al., 2021). Several video platforms facilitated communication and virtual visits (Rose et al., 2021; Tabah et al., 2022), and the COVID-19 pandemic may have resulted in the long-lasting adoption of modern communication tools (Byrnes et al., 2021). The main reason for using Facebook as a central part of the quality improvement campaign was that most of our targeted population was already active on the platform. According to Johannsson and Selak (2020), mainstream media has adapted to customers' needs to access information through social media platforms, and medical publishers and healthcare employers are encouraged to comply with this.

In the focus groups, the availability of social media was emphasised as an important positive feature, in contrast to traditional hospital communication platforms that are unavailable outside the hospital. Our participants called for a platform that supported a balance between work and leisure. Regulations of work and leisure time appear to be needed in the digital age, and some European Union countries provide legal regulations regarding the use of digital tools and working hours. The "right to disconnect" movement in France emphasises the employees' right not to take work-related calls or read e-mails during their time off, ensuring respect for personal and family life (Boring, 2017; Whelan, 2019). Long working hours may contribute to stress, burnout, and poor health (Whelan, 2019). When and where to access and read information should therefore be left for the individual to decide and not to be forced upon, as stated by the participants in this study.

Strengths and limitations

The novelty of this study lies in the investigation of ICU nurses' and physicians' experiences with Facebook use in an intervention. We believe that sufficient information power was achieved, the study aim was relatively narrow, the sample was specific, and the exploratory analysis strategy aimed to uncover selected patterns relevant to the goal of the study rather than the full range of phenomena (Malterud et al., 2016).

We included experienced health personnel representing users throughout the intervention period in each ICU. We did not explore differences between the two professions, sex and age. The physicians and nurses were mixed in the focus groups, which may have influenced the results because of the hierarchy between the two professional groups. In addition, acquaintance with the researchers and the presence of AP, who was responsible for the intervention, may also have influenced openness. Participants expressed both negative and positive experiences, suggesting that they were not inhibited by their acquaintance with the researchers or AP participating in the focus groups. Neutral interviewers may have revealed different results. However, the results correspond well with those of previous qualitative studies on the use of social media in other contexts.

Our findings are based on data from 2018. Considering the development and usage of social media is constantly changing, this is regarded as an additional limitation.

Conclusion

Although audit and feedback on quality indicators on Facebook motivated improvements, professional content on Facebook was perceived as inappropriate. Hospital platforms with applicable features of social media, such as reach, availability, convenience, and comments, have been suggested to secure professional communication about recommended practices in ICUs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices from papers

I. Appendix S1 from Paper I

II. Appendix S2 from Paper I

III. Appendix 1 from Paper II

IV. Appendix 2 From Paper II

Appendices from papers

Appendix S1 (Supplementary online material)

Appendix S1 ICU nurses' and physicians' perceived importance of 7 critical care topics, and reported quality on these

	All (n=253) **Median NRS (IQR) Range**	**Nurses** (n=210) **Median NRS (IQR) Range**	**Physicians** (n=43) **Median NRS (IQR) Range**	**Difference** (Nurse/ Physician) **P -value**
Importance of ICU topic				
How important is the **multi-professional ward round (MWR)** (nurse and physician) for the patients' treatment?	10 (9-10) 2-10	10 (9, 10) 2-10	9 (8, 10) 7-10	<0.001*
How important is it to start **enteral nutrition (EN)** within 48 hours, unless it is contraindicated?	9 (8, 10) 1-10	9 (8, 10) 2-10	8 (8, 9) 1-10	0.005*
How important is it to document level of **pain**?	9 (8, 10) 3-10	10 (9, 10) 3-10	8 (7, 10) 5-10	<0.001*
How important is it to document level of **alertness** (RASS)?	10 (9, 10) 5-10	10 (9, 10) 5-10	9 (8, 10) 6-10	<0.001*
How important is it to document if the patient has **delirium**?	9 (8, 10) 3-10	9 (8, 10) 4-10	9 (8, 10) 3-10	0.019*
How important is it to **mobilize** patients early (within 72 hours) unless it is contraindicated?	10 (8, 10) 2-10	10 (8, 10) 2-10	9 (9, 10) 5-10	0.888
How important is it to prevent **pressure ulcers**?	10 (9, 10) 5-10	10 (9, 10) 5-10	9 (9, 10) 7-10	0.005*
Quality in the ICU				
Last time you participated on the **MWR**, how good was the quality of it?	7 (6, 8) 1-10	7 (6, 8) 1-10	8 (7, 10) 5-10	0.003*
How good are you at providing **EN** early (within 48 hours) in your ICU?	8 (6, 9) 0-10	8 (6, 9) 0-10	7 (7, 8) 3-10	0.791
How good are you at providing **pain-relief** in your ICU?	8 (6, 8) 0-10	8 (6, 8) 0-10	8 (7, 8) 2-10	0.284
How good are you at keeping the patients as **awake** as possible in your ICU?	8 (6, 8) 0-10	8 (6, 8.25) 0-10	7 (5, 8) 1-10	0.011*

How good are you at assessing and documenting **delirium** in your ICU?	7 (5, 8) 1-10	7 (5, 8) 1-10	7 (5, 8) 1-10	0.978
How good are you at **mobilizing** patients early (within 72 hours) in your ICU?	8 (7, 9) 1-10	8 (7, 9) 2-10	8 (6, 8) 1-10	0.376
How good are you at preventing **pressure ulcers** in your ICU?	8 (7, 9) 2-10	8 (7, 9) 2-10	8 (7, 9) 2-10	0.130

NRS; Numeric Rating Scale 0-10; (0= “not at all” and 10= “very much”),
IQR; Interquartile range presented with first (Q1) and third quartiles (Q3),
ICU; intensive care unit, MWR; Multi-professional ward rounds, EN; Enteral nutrition, RASS; Richmond agitation and sedation scale,
Statistical tests with Independent-Samples Mann-Whitney U Test; *p-value below 0.05 = significant

Quality improvement in intensive care units with social media as a communication platform

The survey was performed using Nettskjema, UiO, Norway

Part A. Demography

A1. Gender

- Female
- Male

A2. Age

- 21-30
- 31-40
- 41-50
- 51-60
- 60+

A3. Profession

- Physician
- Nurse

If A3= Physician

A4a. Education (physicians) -choose highest education

- Medical school
- Specialization
- PhD

If A3= Nurse

A4b. Education (nurses) -choose highest education

- Bachelor
- Specialization
- Master's degree
- PhD

A5. How long experience totally do you have from intensive care units? (in total from all ICUs)?

- Less than 1 year
- 1-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- More than 20 years

A6. Does most of your ICU experience come from the ICU you are currently working in?

- Yes
- No
- Do not want to answer

Part B. Use of Social Media

B1. When using your smartphone, which of the three activities do you spend the most time on?

Choose the top three alternatives

- Traditional communication (phone, sms, e-mail)
- Social media (all use of social media; chat, search, etc.)
- Searching information/ knowledge on the internet
- Reading news (newspapers)
- Medical apps
- Watch movies, videos, listen to music
- Taking photos/ videoes
- Games
- I don't have a smart phone

B2. On which social media do you have a profile?

Choose the alternatives where you have a profile

- Facebook
- Twitter
- Instagram
- LinkedIn
- Snapchat
- YouTube
- Pinterest
- Other
- None

B3. How often do you check/ update social media?

Choose one alternative

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- I am not on social media

If B2 = Facebook

B3a. How often do you check/ update Facebook?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- Less

If B2 = Twitter

B3b. How often do you check/ update Twitter?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- Less

If B2 = Instagram

B3c. How often do you check/ update Instagram?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- Less

If B2 = LinkedIn

B3d. How often do you check/ update LinkedIn?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- Less

If B2 = Snapchat

B3e. How often do you check/ update Snapchat?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- Less

If B2 = YouTube

B3f. How often do you check/ update YouTube?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day

- Weekly
- Monthly
- Less

If B2 = Pinterest

B3g. How often do you check/ update Pinterest?

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- Less

If B3 = More than 20 times a day, 11-20 times a day, 4-10 times a day, 1-3 times a day, Weekly, Monthly

B4. What are the most important reasons for using social media?
You can choose several alternatives

- Communicate/ chat
- Keeping updated with friends and family
- Entertainment / To have something to do when I'm bored
- Keeping updated on important news
- Keeping updated on professional development / EBP
- Sharing photo and/ or videos
- Keeping in touch with colleagues / Building my professional network
- Informing people about what I am doing

B5. In how large degree does social media inform you about news?
Choose a number on the scale between 0 (not at all) and 10 (very much)

• 0 (not at all) • 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • 10 (very much)

If B2 = Facebook

Part C. Facebook

If B2 = Facebook

C1. How often do you click in on a news-story or article through Facebook?
Choose one alternative

- More than 20 times a day
- 11-20 times a day
- 4-10 times a day
- 1-3 times a day
- Weekly
- Monthly
- I do not read news on Facebook

If B2 = Facebook

C2. Does your ICU have a closed Facebook group?

- Yes
- No
- Don't know

If C2= Yes

C3. Are you a member of the ICUs' closed Facebook group?

- Yes
- No

If C2 = Yes, Don't know

	0 (not at all)	1	2	3	4	5	6	7	8	9	10 (very much)
C4. Would you **like to receive** professional **content on critical care topics** on the ICUs existing closed Facebook-group? (educational material could be papers, guidelines, courses/ congresses etc.)											
C5. Would you be **annoyed** if the ICU Facebook-group was used to disseminate professional **content on critical care topics?**											
C6. Would you **like to** receive **work-related information** on the closed Facebook- group? (work related information could be social, schedules, staff-meetings)											
C7. Would you be **annoyed i**f the ICU Facebook-group was used for **work-related information?**											
C8. Would you **be a member** of a closed Facebook-group **aimed to exchange** professional **content on critical care topics?**											

Part D. Professional development

D1. How often do you read professional literature (books, papers, web-sites (e.g. UpToDate), eHandbook, organizations home-page, etc. with professional content on critical care topics)?

- Daily
- Several times a week
- Weekly
- Monthly
- Annually
- I don't read journal articles

D2. How do you prefer to read professional literature?
Choose three alternatives

- Traditional book
- Paper version of papers
- Tablet
- eReader
- Laptop or stationary PC
- Smartphone
- Other

If D1 = Daily, Several times a week, Weekly, Monthly, Annual

D3. When reading professional literature electronically (PC, tablet, smartphone), which of the three methods do you consider as most important and prefer to use?
Choose the three most important alternatives

- E-guidelines
- Online version of international journals
- Online version of Norwegian journals
- Literature search in databases
- Articles through links on web-pages
- Articles through links on social media
- Articles received on mail
- Other
- Don't read professional literature electronically

	Several times a day	Once a day	Weekly	Monthly	Yearly	Never
D4. How often do you check your work-mail?						
D5. How often do you click in on news posted on the hospital intranet site?						
D6. How often do you check the ICU ward intranet site?						
D7. How often do you use the eHandbook						

Del E. Quality in critical care

The questions below consist of critical care topics of relevance to monitor quality of critical care. In your opinion, how important are these topics and do you take responsibility for the quality of care within each specific critical care topic?

	0 (not at all)	1	2	3	4	5	6	7	8	9	10 (very much)
E1. How important is the **multi-professional ward round (MWR)** (nurse and physician) for the patients' treatment?											
E2. Do you take responsibility for good quality of the **MWR**?											
E3. How important is it to start **enteral nutrition (EN)** within 48 hours unless it is contraindicated?											
E4. Do you take responsibility for providing **EN** within 48 hours unless it is contraindicated?											
E5. How important is it to document level of **pain**?											
E6. Do you take responsibility for good **pain-relief** in the ICU?											
E7. How important is it to document level of **alertness** (RASS)?											
E8. Do you take responsibility for the patient being as **awake** as possible in the ICU?											
E9. How important is it to document if the patient has **delirium**?											
E10. Do you take responsibility for reducing the scope of **delirium**?											
E11. How important is it to **mobilize** patients early (within 72 hours) unless it is contraindicated?											
E12. Do you take responsibility for **mobilizing** patients early (within 72 hours) unless it is contraindicated?											
E13. How important is it to prevent **ventilator associated pneumonia (VAP)**?											
E14. Do you take responsibility for preventing **VAP**?											
E15. How important is it to prevent **pressure ulcers**?											
E16. Do you take responsibility for preventing **pressure ulcers**?											
E17. How important is it to reduce **time on mechanical ventilation**?											
E18. Do you take responsibility for reducing **time on mechanical ventilation**?											
E19. How important is it to reduce share of **readmissions**?											
E20. Do you take responsibility for reducing the share of **readmissions**?											

Perception of quality in the ICU

	0 (not at all)	1	2	3	4	5	6	7	8	9	10 (very much)
E21. Last time you were part of a **multi-professional ward round**, how good was the quality of it?											
E22. How good are you at providing e**nteral nutrition** early (within 48 hours) in your ICU?											
E23. How good are you at providing **pain-relief** in your ICU?											
E24. How good are you at keeping the patients as **awake** as possible in your ICU?											
E25. How good are you at assessing and documenting **delirium** in your ICU?											
E26. How good are you at **mobilizing** patients early (within 72 hours) in your ICU?											
E27. How good are you at preventing **pressure ulcers** in your ICU?											
E28. How good are you at preventing **VAP** in your ICU? *											
E29. How good are you at preventing **time on mechanical ventilation** in your ICU?											
E30. How good are you at reducing **length of stay** in your ICU?											
E31. How good are you at reducing **readmissions** in your ICU? *											

Perception of own level of knowledge

	0 (not at all)	1	2	3	4	5	6	7	8	9	10 (very much)
E32. Do you perceive to have adequate knowledge about early **enteral nutrition**?											
E33. Do you perceive to have adequate knowledge assessment of **alertness in** ICU patients?											
E34. Do you perceive to have adequate knowledge about good **pain-relief** strategies?											
E35. Do you perceive to have adequate knowledge about how to reduce the scope of **delirium**?											
E36. Do you perceive to have adequate knowledge about early **mobilization** in ICU patients?											

	0 (not at all)	1	2	3	4	5	6	7	8	9	10 (very much)
E37. Do you perceive to have adequate knowledge about **pressure ulcer prevention**?											
E38. Do you perceive to have adequate knowledge about how to prevent **pneumonia** in in the ICU?											
E39. Do you perceive to have adequate knowledge about how to reduce **time on mechanical ventilation**?											
E40. Do you perceive to have adequate knowledge about how to prevent **readmissions**?											

Range the following questions on a scale from 0 (not at all important) to 10 (very important) about how to optimize learning and implementation about critical care topics in the ICU

	0 (not at all)	1	2	3	4	5	6	7	8	9	10 (very much)
D7. Lectures (international congresses/ courses/ training days)											
D8. Interdisciplinary (physicians and nurses) **collaboration** (development of guidelines and other quality improvement projects)											
D9. Traditional dissemination of articles and other educational material via **e-mail**											
D10. Use of **Social Media** for dissemination of articles and other educational material											
D11. Research in the ICU											
D12. Feedback of own practice using quality measurements											
D13. Simulation training (skills training, practical exercise)											
D14. Supervision and counseling; clinically and in groups											

If A3= Physician

- **A7A**. Which hospital do you work at? *
  - Hospital X
  - Hospital Y
  - Do not want to answer

If A3= Nurse

- **A7B.** Which ICU do you work at? *
  Choose ICU from the dropdown

    - ICU1
    - ICU2
    - ICU3
    - ICU4
    - Do not want to answer

APPENDIX 1: INITIAL PROTOCOL SUMMARY OF STUDY INTERVENTION AND MONITORING

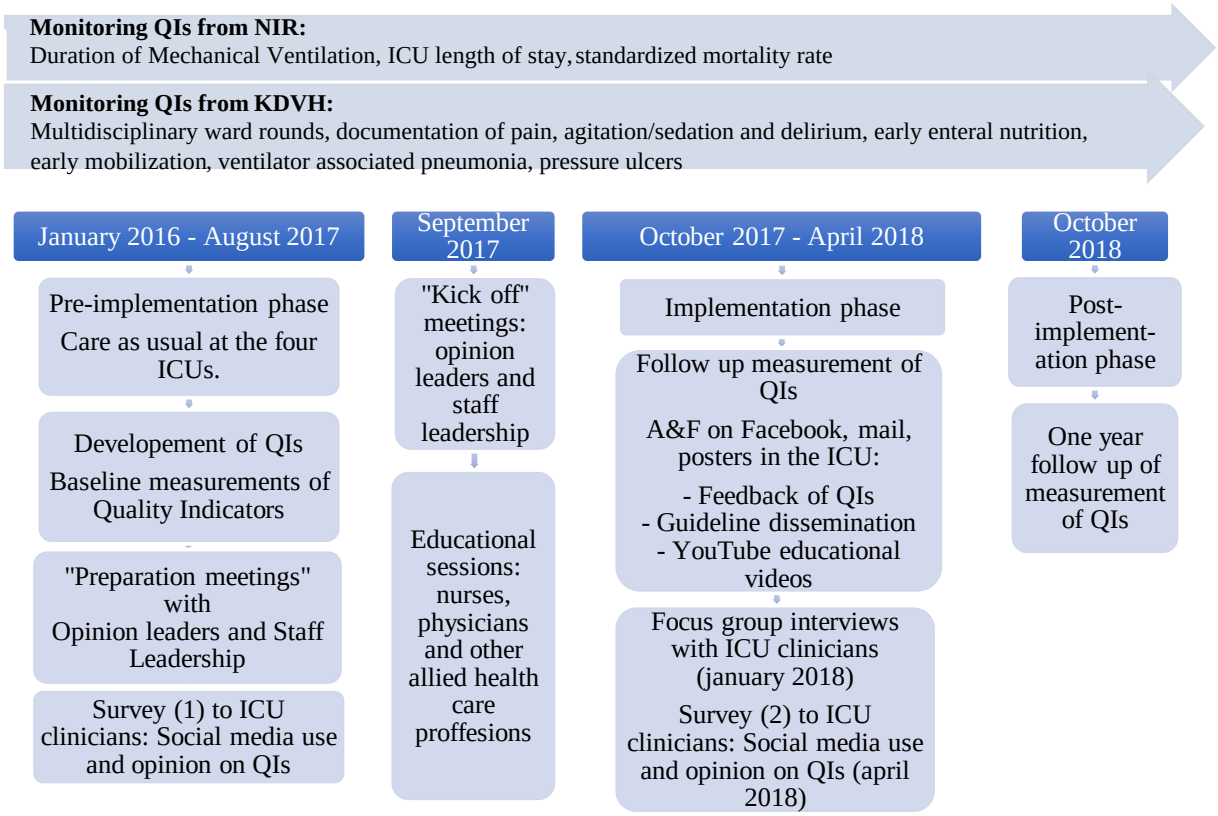

Figure: Study, Intervention and monitoring model
Quality Indicator (QI); Norwegian Intensive Registry (NIR); Intensive Care Unit (ICU); "Klinisk datavarehus" (KDVH); Audit and feedback (A&F);

Table: Initial intervention plan

	June -17	**Sept. -17**	**Okt. -17 – March. -18**
Involvement of Opinion leaders; professional development nurses (PDN) and staff leadership	Presentation of the project and the chosen QIs,	Discussions at -PDN meeting, -Staff leadership meeting,	Follow up: -PDN meetings -Staff leadership meetings -Multi-professional meetings
Educational sessions Classroom lectures covering: - Quality, QI, - Presentation of chosen ICU-QIs - International recommendations for the chosen QIs - Explanation of feedback methods - Oral feedback of chosen QIs		One-three hour meetings: – -nurses, -physicians -physiotherapists -pharmacists	
Written *feedback of QIs on closed FB groups* and on posters in the four ICUs			Repeated feedback of: PIs: EEN, PAD, EM OIs: VAP, PU
Reminders and *educational material* on closed Facebook groups -Links to guidelines and international recommendations -Links to YouTube videos			- Guidelines PAD Nutrition VAP prevention bundle PU prevention - YouTube videos Assessment videos (PAD) Patient Delirium video
Educational outreach visits			The PDN nurses and the researcher will perform outreach visits at the wards on demand and depending on the performance

PDN, Professional Development Nurse; QI, Quality Indicator; FB, Facebook; PI, Process Indicator; OI, Outcome Indicator; EEN, Early Enteral Nutrition; PAD, Pain Agitation/Sedation Delirium; EM, Early Mobilization; VAP, Ventilator Associated Pneumonia; PU, Pressure Ulcers

APPENDIX 2: EXAMPLE OF FACEBOOK POST

Antonija Petosic is watching CPOT -the movie at Oslo University Hospital, Ullevål.
November 1 · Oslo

Målet er:
Smerte vurderes og dokumenteres minst en gang per vakt! 👌

I september ble smerte dokumentert minst en gang per vakt på 55 % av vaktene (n=18 pas).
Dette er en forbedring på 27 % sammenlignet med første måling. BRA! 👏
👍⭐

Sjekk skuespillertalentet til fagutviklingssykepleieren vår; "pasienten" i CPOT -the Movie.
En premie deles ut til en av de som legger igjen en kommentar med CPOT eller BPS skår på scenario 4. Premie blir trukket om en uke.

PS! Et hefte med de ulike skåringsverktøyene er lagt i hylla på avdelingen.
#smerte #ICUpain