Understanding how social media supports healthcare providers' knowledge use in clinical practice: a realist inquiry

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Preface

This thesis is an original and independent work by Junqiang Zhao. The qualitative research, a part of this thesis, received research ethics approval from the University of Ottawa Research Ethics Board, project name: Understanding how healthcare providers use social media to influence knowledge use in clinical practice: a realist qualitative study, No. H-04-21-6774, approval date: May 17th, 2021.

This thesis is comprised of three papers, of which two papers have been published and the other one is ready to be submitted.

Paper one has been published as: Zhao J, Harvey G, Vandyk A, Gifford W. Social Media for ImpLementing Evidence (SMILE): Conceptual Framework. JMIR Form Res 2022;6(3):e29891. doi: 10.2196/29891. In this paper, I was responsible for the conceptualization, composition, writing, and submission of this paper. Dr. Gifford was the supervisory author and was involved in the intellectual development of this paper. Drs. Harvey and Vandyk, as the thesis committee members, contributed to the paper by offering comments and feedback.

Paper two has been published as: Zhao, J., Harvey, G., Vandyk, A., Huang, M., Hu, J., Modanloo, S., & Gifford, W. (2022). Understanding How and Under What Circumstances Social Media Supports Healthcare Providers' Knowledge Use in Clinical Practice: A Realist Review. Telemedicine and e-health. Advance online publication. doi:10.1089/tmj.2022.0213. In this paper, Dr. Gifford and I conceptualized the study. Dr. Harvey provided methodological guidance. Huang and I performed the literature search, screening, appraisal, and data extraction. All the

authors were involved in the data analysis and synthesis. I drafted the manuscript. All the authors have critically reviewed and approved the submission.

Paper three is in preparation for publication as: Zhao, J., Vandyk, A., Harvey, G., Huang, & Gifford, W. Consolidating the program theory on how social media supports healthcare providers' knowledge use in clinical practice: a realist-informed qualitative study. (Target journal: Telemedicine and e-health). In this paper, Dr. Gifford and I conceptualized the study. I was responsible for conducting the interviews and data transcription. Dr. Gifford, Huang, and I were involved in the data analysis. Drs. Harvey and Vandyk provided methodological guidance and offered comments and feedback for the manuscript.

Abstract

Background: Despite the increasing popularity of using social media to disseminate and translate knowledge, there remains a lack of theoretical understanding of how social media can work for healthcare providers' knowledge use. The purpose of this thesis was to understand how and under what circumstances social media supports healthcare providers' use of knowledge in clinical practice.

Methods: Drawing on the tenets of scientific realism and the context (C) + mechanism (M) = outcome (O) (CMO) heuristic, a three-phase multi-method study was conducted to build a progressive theoretical understanding of how social media supports healthcare providers' use of knowledge: 1) theory gleaning by a narrative review of five social media initiatives, five theories, and 58 empirical studies; 2) theory refining by a realist review of 32 articles; and 3) theory consolidation by a realist-informed qualitative study with 11 participants.

Results: The Social Media for ImpLementing Evidence (SMILE) framework was developed in the theory gleaning phase. In the theory refining phase, two causal explanations were identified: 1) the rationality-driven approach that primarily uses open social media platforms (eight CMOs), and 2) the relationality-driven approach that primarily uses closed social media platforms (six CMOs). In the theory consolidation phase, the program theory developed for open social media platforms from the realist review was refined to ten CMOs, of which four confirmed the original CMOs, four refined the original CMOs, and two were new CMO propositions. The key mechanisms included content developers' capabilities and capacities, along with healthcare providers' increased attention; fulfillment of information needs; access to

social influence and support; perception of message value and implementability; behaviour capabilities, self-efficacy, intention, and awareness; and ability to exercise professional autonomy.

Conclusions: Through a three-phase realist theory development process, a theoretical understanding of how social media supports healthcare providers' knowledge use in clinical practice was built. Future research is necessary to further develop this framework and investigate the synergistic effects of the rationality and relationality-driven approaches.

Acknowledgments

As a single, homosexual, and mandarin-speaking student doing my PhD in an English and French-speaking country for four years without getting back to my homeland even once, I suffered but survived. I have been dreaming of this day when I wrap up my PhD journey and say proudly to myself: Junqiang, you made it!

Now this day comes.

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Abbreviations

BUCM	Beijing University of Chinese Medicine
BUCM Cochrane Initiative	Beijing University of Chinese Medicine Cochrane Evidence Dissemination Initiative
CIMO	Context–Intervention–Mechanism–Outcome
CMO	Context-Mechanism-Outcome
COM-B	Capability, opportunity, motivation, and behaviour
ECHO	Translating Evidence in Child Health to Enhance Outcomes
Fudan JBI Initiative	Fudan University JBI Center Nursing Evidence Dissemination Initiative
ICMAO	Intervention–Context–Mechanism–Agency–Outcome
ICAMO	Intervention–Context–Actor–Mechanism–Outcome
i-PARIHS	integrated Promoting Action on Research Implementation in Health Services
JBI	Joanna Briggs Institute
RAMESES	Realist And Meta-narrative Evidence Syntheses: Evolving Standards
S/ICMO	Strategy/Intervention–Context–Mechanism–Outcome
SMILE framework	Social Media for ImpLementing Evidence framework
TREKK	TRanslating Emergency Knowledge for Kids

Chapter 1: Introduction

The purpose of this dissertation was to understand the mechanisms of how social media supports healthcare providers' knowledge use in clinical practice and the contextual factors that activate the mechanisms. This first chapter orients readers to the research problem, research purpose and objectives, my positionality and philosophical stance underpinning the PhD project, and the structure of this manuscript-based dissertation.

1.1 Research Problem

1.1.1 Definition of social media

Social media has become an integral part of people's everyday life. Although it has been ubiquitously used and people can readily list online tools that can be considered social media, a consensus has not been reached on what defines social media, what exactly could be included in this term, and how it differs from other related concepts, such as Web 2.0 (Carr & Hayes, 2015). Social media has been defined in various ways. Carr and Hayes (2015) conducted a review and identified more than 10 different definitions of social media. For example, Russo et al (2008) defined social media as "those that facilitate online communication, networking, and/or collaboration (p. 22)". Lewis (2009) considered social media a "label for digital technologies that allow people to connect, interact, produce and share content (p. 2)". These definitions are often criticized as being too general in that they fail to distinguish social media from other communication technologies, such as email (Carr & Hayes, 2015). In this dissertation, I acknowledge that social media is still a fast-growing field with its definition constantly evolving, and do not debate the different connotations among its multiple definitions. Instead, I use a

widely accepted definition that considers social media as “a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content” (Kaplan & Haenlein, 2010, p. 61). Generally, there are seven functional building blocks for social media: identity, conversations, sharing, presence, relationships, reputation, and groups (Kietzmann et al., 2011). Different social media activities can be classified according to the extent to which they focus on some or all of these building blocks (Kietzmann et al., 2011). Based on the degree of social presence and self-disclosure, social media in my dissertation is classified into six different categories: blogs, social networking sites (eg, Facebook), content communities (eg, YouTube), collaborative projects (eg, Wikipedia), virtual social worlds, and virtual game worlds (Kaplan & Haenlein, 2010).

1.1.2 Social media use in the healthcare domain

Social media has been widely used in healthcare globally. It has changed the ways healthcare providers and patients seek health information. In the United States, nearly 90% of adults search for health information on Facebook, Twitter, YouTube, and other social media sites (Bishop, 2019). In Canada, almost 70% of Canadian Internet users search online for medical or health-related information (Statistics Canada, 2013). In China, 570 million users log on to WeChat every day, nearly one-third of whom frequently receive and read health information through WeChat (Zhang et al., 2017).

Healthcare providers have been using social media for various purposes, such as health communication and promotion, professional networking, medical education, and scientific

research (Farsi, 2021; Ventola, 2014). Currently, there is also a trend among them to correct misinformation spreading on social media (Arora et al., 2022; Bautista et al., 2021). Although social media has been reported as promising to improve healthcare providers' knowledge (Hamm, Chisholm, Shulhan, Milne, Scott, Klassen, et al., 2013), facilitate communication and networking (Moorhead et al., 2013), and improve the quality of patient care (McGowan et al., 2012), it is still underused with commonly cited barriers as information quality concerns, patient privacy concerns, professional image concerns, lack of institutional support, and lack of guidelines (Campbell et al., 2016; Moorhead et al., 2013; Ventola, 2014). The frequency of healthcare providers' social media use was reported to be influenced by the behavioural intention, habit, attitude, and perceived usefulness of the platforms (Hazzam & Lahrech, 2018; McGowan et al., 2012). Grajales et al (2014) conducted a review of social media applications in healthcare and offered four recommendations for healthcare providers wishing to engage with social media: 1) maintain professionalism at all times, 2) be authentic and have fun, 3) ask for help, and 4) focus, grab attention and engage.

Social media has also been extensively used by patients, family members, and the public to find health information, support peers, and share personal stories and experiences (Gupta et al., 2020; Hamm, Chisholm, Shulhan, Milne, Scott, Given, et al., 2013). Smailhodzic et al (2016) conducted a systematic review and classified patients' social media use into six categories, namely: emotional support, information support, esteem support, network support, social comparison, and emotional expression. Patients' social media use has been found to improve their relationships with healthcare professionals (Smailhodzic et al., 2016), and promising in promoting self-care (Alanzi, 2018; Elnaggar et al., 2020), personal well-being (Petkovic et al.,

2021) and behaviour change (Laranjo et al., 2015). Factors that have been reported to influence patients and the public use of social media are demographics (eg, age, gender, geography, socioeconomic status, ethnicity, and lifestyle) (Mislove et al., 2011; Ngai, Tao, et al., 2015), personal traits (Correa et al., 2010; Zhong et al., 2011), motivation (eg, perceived needs, attitude, intention, self-efficacy, and goals)(Rauniar et al., 2014; Zolkepli & Kamarulzaman, 2015), and capability (eg, knowledge and skills) (Rauniar et al., 2014).

In addition to clinical and public health settings, social media has become increasingly popular in healthcare education, in which Twitter, blogs, podcasts, wikis, and Facebook are commonly used (Cheston et al., 2013; Sterling et al., 2017). It is used to promote learner engagement and interaction, provide feedback to students, and facilitate collaboration and professional development (Cheston et al., 2013; Chugh & Ruhi, 2018). Similar to clinical and public settings, social media can be double-edged when it is used in education. Although it is associated with improved knowledge, attitudes, and skills (Cheston et al., 2013), unsupervised social media use would distract students with extensive time commitments and exert very limited educational value (Sobaih et al., 2016; Sutherland & Jalali, 2017). To promote the wise and mindful use of social media in the education setting, it was suggested that educators design courses together with students regarding when (not) to use what type of social media (Stathopoulou et al., 2019) and tackle the barriers to its use at the virtual, personal and institutional levels (Chan et al., 2021), such as the technical challenges, difficulty in sustaining learner participation, lack of institutional support, and privacy and security concerns (Cheston et al., 2013; Chugh & Ruhi, 2018; Luo et al., 2020; Sobaih et al., 2016).

In healthcare research, social media has become extensively used for recruiting participants (Topolovec-Vranic & Natarajan, 2016), implementing interventions (Shaw et al., 2015), collecting and mining data (Zhang et al., 2018), and sharing research findings (Ahmed et al., 2019; Bhatt et al., 2021). Within the social media platforms, Twitter, Facebook, blogs, YouTube, LinkedIn, and Instagram are the most widely used ones (Dol et al., 2019). Compared with traditional health research approaches, social media can increase participation and reduce recruitment costs (Darmawan et al., 2020). Different social media have different strengths for health research, for example, Facebook was suggested to be advantageous for recruitment and Twitter for data collection (Bour et al., 2021). Researchers should understand the strengths and nuances of various platforms and determine which platform best fits their research objectives (Lu et al., 2021). Currently, there has been limited guidance on how to use social media for health and social research in a systematic way (Arigo et al., 2018; Elliott et al., 2020).

Overall, social media has permeated almost every aspect of healthcare and this seems to be an irreversible trend. While it has some unique advantages, it also is accompanied with risks and pitfalls. Social media users should refer to current good practices and use social media judiciously.

1.1.3 Social media as a means of knowledge translation

Among its wide use in healthcare, social media has become prevalent as a means of knowledge translation (Barton & Merolli, 2019; Korda & Itani, 2013; Moorhead et al., 2013). Knowledge in my dissertation is defined as primarily synthesized research evidence, such as the evidence from clinical practice guidelines or systematic reviews, while other types of knowledge,

such as tacit knowledge from clinical practice or anecdotal evidence from patient narratives would also be included if they are considered credible from healthcare providers' perspective. Knowledge translation in my dissertation is defined as "a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health, provide more effective health services and products and strengthen the healthcare system"(Graham et al., 2006, p. 15). It involves conceptual, instrumental, and persuasive use of knowledge. Conceptual knowledge use refers to utilizing research evidence to change the levels of knowledge, understanding, or attitudes of a recipient. Instrumental knowledge use involves the direct application of research evidence in practice or behaviour. Persuasive knowledge use refers to utilizing research evidence as a political or persuasive tool to justify an action, attain power, or achieve goals (Graham et al., 2006; Straus et al., 2013). Using social media and other digital technology to promote knowledge translation has been advocated as one of the priorities in current knowledge translation research and practice from trainees' perspectives (Newman et al., 2015).

More and more research groups and organizations now use social media to promote knowledge translation to healthcare providers, patients, and the public. In China, Fudan University Joanna Briggs Institute (JBI) center (JBI is a global organization that promotes and supports evidence-based decisions to improve health and health service delivery, https://jbi.global/) uses WeChat to disseminate short, refined healthcare evidence from Cochrane, JBI, and evidence-based guidelines. Within less than two years, the followers of their WeChat account reached 22 369 from 34 provinces in China (Zhu et al., 2018; Zhu et al., 2017). Since 2014, Cochrane China (Cochrane Collaboration is an international and independent non-

profit organization that aims to help people make well-informed decisions about healthcare by preparing, maintaining, and promoting the accessibility of systematic reviews, https://www.cochrane.org/) has been using WeChat to disseminate the translated plain language Cochrane evidence. Up until January 2019, their team had translated more than 616 abstracts and plain language summaries. Their WeChat account subscription had reached 1,829 with the number of readers in a single month reaching 2000 (Cochrane Community, 2019).

In Canada, Alberta Research Centre for Health Evidence used three social media strategies: daily tweets using the Cochrane Child Health Twitter account, weekly WordPress blog posts, and a monthly journal club on Twitter ("tweet chat") to disseminate Cochrane evidence on child health topics. After half a year, their blogs were found to receive 2555 visitors and 3967 pageviews from a geographically diverse audience of healthcare providers, academics, and healthcare organizations, and their Twitter account gained 469 new followers (Dyson et al., 2017). The *TRanslating Emergency Knowledge for Kids (TREKK)* team collaborated with Cochrane child health and undertook a planned social media promotion using Twitter (@TREKKca and @Cochrane_Child) and blogs. After 16 weeks, followers of the two Twitter accounts increased by 24% and 15% respectively. Monthly users of *TREKK*'s website increased by 29% and clicks to the *TREKK* child health recommendations increased by 22% (Gates et al., 2018). The *Be Sweet to Babies* initiative developed a brief consumer-targeted video demonstrating the use of effective pain reduction strategies during infant vaccinations, which has been translated into seven different languages, uploaded to YouTube and Facebook, and disseminated on Twitter. It has shown an extensive reach, high acceptability, and intention to practice by healthcare providers and parents (Bueno et al., 2018; Harrison et al., 2017; Harrison

et al., 2016). The *It Doesn't Have to Hurt* initiative developed a two-minute 18-second video to share evidence-based strategies to reduce procedural pain in children. Five years after its launch, the video had reached 237,132 unique views from 182 countries. Both parents and healthcare providers reported strong acceptance and high intention to use the strategies mentioned in the video, such as distraction or using topical anesthetics (Chambers et al., 2020). The number of parents who have used topical anesthetic cream to reduce procedural pain grew from 18% to 63% after watching this video (Canadian Institutes of Health Research, 2018).

In Europe, the Croatian Cochrane Branch used Facebook as a knowledge translation tool to disseminate the plain language summaries of Cochrane evidence. They found that their Facebook page reached 1441 followers in one year. The followers were mostly women aged 25 to 44 and were mostly laypersons, health professionals, and journalists who further disseminate the page content. The most popular content was related to pregnancy, childbirth, and breastfeeding (Puljak, 2016).

In the United Kingdom, the Manchester Royal Infirmary developed St. Emlyn's blog, an open-access resource that provides free education in the field of emergency medicine in 2012. Up to January 2017, the site had been viewed over 1.25 million times with linear annual growth. Each of the over 500 blog posts attracted a mean of 2466 views (range 382–69 671) with the viewers coming from different countries (Carley et al., 2018).

As these examples demonstrate, people are using different tools and strategies to facilitate knowledge translation through social media. These tools and strategies have their own strengths and limitations, and vary in their impacts on social media engagement. Cochrane UK

develops visual abstracts as a new way to make Cochrane evidence accessible to the public and disseminate them on social media allowing users to download and share (Cochrane UK, 2015). Data showed that compared with text-only tweets, tweets that used visual abstracts were retweeted 8.4 more times and received 7.7 times more impressions (Ibrahim et al., 2017). Videos have the unique advantages to help visualize practice and provide step-by-step guidance on how to perform technical procedures (Topps et al., 2013). For example, the *Be Sweet to Babies* YouTube video visualized the process of using breastfeeding, sugar water, and kangaroo care to reduce procedural pain in babies (Harrison et al., 2016). Tweetorials, a collection of threaded tweets, have become common as a way to teach key concepts, tell stories, appraise new research, and share best practices on Twitter (Breu, 2019, 2020; Breu et al., 2021). Within a tweetorial, polls, hyperlinks, images, GIFs, videos, and graphics can all be employed to attract and engage audiences and provide additional information (Breu et al., 2021). Podcasts have also been increasingly used in recent years as a promising tool for continuing professional development (Cadogan et al., 2014). Podcasts can help build human connection and a sense of community among users because of their conversational nature and the use of a storytelling approach (Kaplan et al., 2020). Barton and Merolli (2019) summarised five opportunities for using social media to facilitate knowledge translation with healthcare professionals and patients: 1) using popular social media platforms (eg, Twitter) to widely disseminate new and existing knowledge; 2) creating visually engaging summaries of research findings (eg, infographics) to improve the efficiency of knowledge translation and retention of audiences; 3) producing video content (eg, YouTube) to provide “how-to” guidance on implementation; 4) developing podcasts to engage with consumers and share insights on evidence implementation;

5) summarizing key research findings into engaging written content and posting them on influential and trusted blogging platforms. In an experimental study, Gough et al.(2017) framed their Twitter messages on skin cancer prevention into five broad categories: humor, shock or disgust, informative, personal stories, and opportunistic. They found that shocking messages got the greatest impressions, humorous messages generated greatest engagement, and informative messages resulted in the greatest number of shares.

A behaviour change technique is an "observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behaviour" (Michie et al., 2013, p. 82), and has been used in social media interventions to promote knowledge translation. Webb et al (2010) found in their systematic review that Internet-based interventions that incorporated more behaviour change techniques had larger effects than interventions that incorporated fewer techniques. In a systematic review of studies that used social media for health promotion, Simeon et al (2020) identified 46 techniques that were employed in the 71 included studies. Among them, instruction on how to perform the behaviour, social support, self-monitoring of behaviour, information about health consequences, and credible source were identified as the top five techniques delivered with the highest intensity (Simeon et al., 2020). In a systematic review of characteristics of Internet-delivered healthy lifestyle promotion interventions, Brouwer et al (2011) reported that feedback, interactive elements, and email/phone contact were the most commonly used techniques. In their scoping review of 118 studies that used digital technology to change behaviour, Taj et al (2019) found that goal setting, self-monitoring, motivation, and feedback were the most frequently employed strategies.

With the different social media strategies and behaviour change techniques used in social media interventions, the effectiveness of social media interventions for knowledge translation, especially for behaviour change, seems promising. A systematic review on the effectiveness of online social network health behaviour interventions found that nine of the ten included studies reported significant improvements in health behaviour change outcomes, although in general, the effect sizes were small in magnitude (Maher et al., 2014). Similarly, a meta-analysis of eight randomized controlled trials on social media interventions showed a positive effect on health behaviour outcomes (Laranjo et al., 2015). Positive findings were also found in using social media for smoking cessation (Luo et al., 2021; Naslund et al., 2017), exercise behaviours in people with non-communicable diseases (McKeon et al., 2022), physical activities and dietary behaviour in young people and adults (Goodyear et al., 2021), and reduction of body weight (An et al., 2017). In a large Cochrane review of 88 studies that used social media interventions for changing health behaviours or improving body functions and psychological health, the reviewers found that social media interventions might increase physical activity and well-being, but have little to no effect on people's mental health, such as depression (Petkovic et al., 2021). Among populations with health disparities, social media interventions were found to have a significant moderate-sized effect on behaviour change (Vereen et al., 2021).

1.1.4 Social media and healthcare providers' knowledge use

Even with its popularity among health researchers and organizations globally to use social media for research evidence dissemination (Barton, 2017) and the promising effect of

using social media for health behaviour change, little attention has been paid to investigating how social media strategies impact healthcare providers' knowledge use. Healthcare providers in my dissertation are defined as those health professionals who are qualified and allowed by regulatory bodies to provide healthcare services to patients.

At the empirical level, very few studies have been done to understand healthcare providers' clinical behaviour change by using social media. Hamm et al (2013) conducted a scoping review of social media use in healthcare professionals and found that most studies primarily focused on healthcare providers' experience of using social media; very limited studies investigated the impact of social media on professional behaviour change. In the 13 included experimental studies, nearly all reported that the use of social media was beneficial, whereas half of them failed to provide statistically significant findings to substantiate this claim (Hamm, Chisholm, Shulhan, Milne, Scott, Klassen, et al., 2013). A recent scoping review of 628 papers on using social media for knowledge translation with physicians and trainees found that there had been a steady increase of literature in this field since 1996 (Chan et al., 2020). Among the included papers, most were descriptive studies (38.5%, n=242) or conceptual pieces (30.6%, n=192) with only 7.2% of the studies (n=45) comparing social media interventions against a standard educational intervention (Chan et al., 2020). Seventy percent of the studies measured social media intervention acceptability; 24.7% measured knowledge improvement. Only six studies measured behaviour change and four studies measured organizational and patient-level outcomes (Chan et al., 2020).

A large cross-sectional study conducted in China in 2019 showed that 84.3% (n=555/658) of registered nurses believed that social media had positively influenced their clinical practice (Z.

Wang et al., 2019). Similarly, a mixed-method study of evidence-based practices delivered via social media found that 70.1% (n=136/194) of respondents from more than five countries indicated that the education they received via social media had changed the way they practice or intended to practice, and 69.9% (n=135/193) of respondents indicated that the education they had received via social media increased their use of research evidence in clinical practice (Maloney et al., 2015). Tunnecliff et al (2017) conducted a randomized trial to compare healthcare providers' knowledge and behaviour change after exposure to evidence-based tendon management recommendations delivered by either Twitter or Facebook. They found that both groups demonstrated improvements in knowledge and reported changes to clinical practice and there were no significant differences between the two groups on the two outcomes. Although these primary studies showed promising findings on using social media to change practice, none of them used validated tools to measure practice change. Instead, they used self-reported questions (yes/no) and did not investigate the mechanisms of how the change happened.

At the theoretical level, understanding the mechanism of how social media can help create change in healthcare providers' clinical practice is necessary to help guide the future development and implementation of social media interventions. Currently, few studies have been conducted to theorize the process. Arguel et al (2018) identified in their systematic review that only 15 experimental studies published between 2005 and 2016 applied theoretical approaches to guide the development of social media interventions. Within the 15 studies, five used social cognitive theory, while the others used the theory of planned behaviour, technology acceptance model, and internet popular opinion leader model. In a scoping review of digital

health behaviour change technologies between 2000 and 2018, Taj et al (2019) found that only 33% (59/118) of articles reported the use of behaviour change theories, in which social cognitive theory, transtheoretical model, self-determination theory, and motivational interviewing were the most frequently reported ones. Although the aforementioned reviews showed that theories have been used in studies aimed at changing behaviour, these studies all centred on patients' and the public's behaviour change. Very few social media studies have reported using theories to guide or explain healthcare providers' behaviour change.

In the social media research field, Ngai et al (2015) conducted a systematic review and classified 31 social media theories into three broad categories: personal behaviour theories, social behaviour theories, and mass communication theories. Personal behaviour theories, such as the theory of planned behaviour, identify the individual-level determinants that influence user behaviour in social media. Social behaviour theories, such as social capital theory, explain individual behavior towards social media from a social level. Mass communication theories, such as the media richness theory, consider social media as a communication and marketing strategy and aim to understand the effect of mass communication on individual activities in social communities (Ngai, Moon, et al., 2015; Ngai, Tao, et al., 2015). Based on in-depth analysis and integration of the constructs in these 31 theories and drawing on the input-moderator–mediator-output model (Mohammed et al., 2010), Ngai et al (2015) developed a general causal-chain framework for social media research. While all these theories provide us a rich picture of the theoretical development of social media research, several limitations exist in using them to understand healthcare providers' evidence uptake and implementation. First, most of these theories only consider one of two latent and indispensable layers of social media use: using the

social media platform and using the messages on the platform. For example, the technology acceptance model can explain the use of social media platforms, but fails to explain the message use. On the contrary, the social cognitive theory and theory of planned behaviour can explain message use, but have limited explanatory power for understanding technology adoption. Theories that do not address both layers fail to fully explain the process of using research evidence through social media. Second, the above theories often neglect the multi-level contextual factors, such as the virtual-technical (relating to the social media platform), organizational, and system contexts, in shaping behaviour. This may lead to the development of implementation strategies solely from the individual perspective without considering the contextual determinants that impact recipients' behaviour. Third, many of these theories, such as the para-social interaction theory, were developed and used predominantly in the business field to understand consumer behaviour and build the organizational brand. However, the behaviour of consumers in business is considerably different from healthcare providers' behaviour (Francis & Presseau, 2019), thus weakening their explanatory power when used in healthcare contexts and suggesting a need for more empirical studies to test their applicability.

Ritterband et al (2009) developed the Behaviour Change Model for Internet Interventions, which proposed that behaviour change from Internet interventions relied on nine nonlinear steps: the user influenced by environmental factors affects website use and adherence, which is influenced by support and website characteristics. Website use leads to behaviour change through various mechanisms of change, such as knowledge and motivation. This model has been widely used to guide internet and social media interventions (Ritterband et al., 2012; Shaw, 2014; Taj et al., 2019). While this model distinguished website use and

message use and considered the multilevel contexts in shaping behaviour, it did not make explicit the mechanisms of change.

Fogg (2009) developed a behaviour model for persuasive design, which posited that for a person to perform a target behaviour, the person should be sufficiently motivated, have the ability, and be triggered to perform the behaviour. These three factors must occur concurrently, otherwise, the behaviour will not happen. In this model, Fogg differentiated three types of triggers: spark as a trigger to improve motivation, facilitator as a trigger to improve ability, and signal as a trigger to remind the behaviour. He also identified three core motivators: pleasure/pain, hope/fear, and acceptance/rejection. In terms of the construct of ability, Fogg argued that products that require people to learn new things often fail. Rather than considering improvements in abilities as teaching or training of new things, the behaviour must be made easy and simple to perform. Fogg defined “easy and simple” from six dimensions: time, money, physical efforts, brain cycles, social deviance, and non-routine. These six elements are linked in a chain and if the chain breaks in any part, simplicity is lost. This behaviour model has been widely cited and used in the uptake of health technologies and is considered useful in the design and analysis of persuasive technologies. Similar to this model is the Capability, Opportunity, Motivation, and Behaviour (COM-B) model developed by Michie et al (2011) which posits that capability, opportunity, and motivation interact to generate behaviour that in turn influences these components. This model has been extensively used in understanding behaviour change in the knowledge translation and implementation science field and has informed health technology design and analysis (Tung et al., 2022).

Drawing on behavioural theories, behaviour change technique taxonomy, and persuasive system design principles, Wang et al (2019) proposed a holistic framework to guide digital health interventions for behaviour change, named TUDER framework. This framework includes four development steps, namely 1) targeting the user group, the health program, and the behaviour; 2) understanding behaviour theories; 3) designing the intervention strategies, characteristics, and workflow; 4) evaluating and refining the intervention design. Alongside the four development steps, the TUDER framework also contains two toolboxes (behavioural theories and the digital health interventions taxonomy) and a workflow to guide the design, evaluation, and reporting of digital interventions.

In the knowledge translation field, drawing on the Knowledge-to-Action framework (Graham et al., 2006), Levac et al (2015) developed an ADDIE model (Analysis; Design; Development; Implementation; Evaluation) and offered recommendations, step-by-step guidance, and relevant examples to support online knowledge translation practice. Nevertheless, it failed to explain the behaviour change process. Other implementation theories informed by sociological perspectives, such as the Normalization Process Theory (May & Finch, 2009), provide insights into key factors that influence the processes and outcomes of implementing research evidence in practice. However, to my knowledge, little research has applied these theories to understand how social media influences the use of research evidence in healthcare.

Overall, social media has been ubiquitously used in almost every domain of healthcare and has large untapped potential in promoting health behaviour change and healthcare. It has also become a popular means of knowledge translation. Nevertheless, two large research gaps

exist in current studies which largely limit its potential to bridge evidence-practice gaps and contribute to improved healthcare practices. First, a large proportion of social media intervention studies in the healthcare field focus on patients' and public behaviour change with limited social media studies aimed at changing or understanding healthcare providers' clinical behaviour, which is considered a specialized form of behaviour different from patients and the public (Francis & Presseau, 2019). Healthcare providers' clinical behaviour is a key determinant of patients' health (Francis & Presseau, 2019; Hardeman et al., 2005). Promoting healthcare providers' evidence-informed practice through the use of social media is likely to improve health service delivery and consequently improve patient outcomes. Second, social media is rarely used in a well-planned way with end-users in mind. Most health researchers tend to post research findings onto social media directly without a deliberate plan on how to facilitate its use by recipients in policies, programs, or practices. Current theoretical understanding of how social media supports healthcare providers' knowledge use is lacking. Therefore, unpacking the mechanisms by which social media works as a knowledge translation strategy for healthcare providers is important to inform intervention development for changing healthcare providers' clinical behaviour, and thus improving healthcare practices and patient outcomes.

1.2 Purpose and objectives

The purpose of this thesis was to understand how and under what circumstances social media supports healthcare providers' knowledge use in clinical practice. It aimed to identify the possible mechanisms by which social media interventions result in healthcare providers' knowledge use, and to identify the contextual factors that activate the mechanisms and result in healthcare providers' knowledge use through social media.

Specifically, the thesis had three objectives: 1) to develop an initial program theory to understand how social media works as a knowledge translation strategy to inform healthcare practice through a narrative review (phase one); 2) to refine the program theory to understand how, for whom, and under what circumstances social media works to support healthcare providers' knowledge use though a realist review (phase two); 3) to consolidate the program theory through a realist-informed qualitative study with knowledge users (phase three).

1.3 Positionality statement and philosophical underpinnings

1.3.1 positionality statement

I present my positionality statement from three aspects: 1) my personal experience as a social media user and content developer, 2) my life experience in both China and Canada, and 3) my training experience in the field of knowledge translation. All these experiences shaped my research focus and to some extent, my worldview which will be illustrated in the following.

I am both an active social media user and a content developer. Social media has influenced my practice as a nurse, a nursing researcher, and a citizen. As a nurse, the evidence-based resources on social media enhanced my nursing knowledge and impacted my clinical practice. As a nursing researcher, social media allowed me to connect with leading nursing scientists on a global scale and track the latest research findings in my field. It also inspired my research directions. As a citizen, the health advises from authoritative public health organizations, especially during the COVID-19 pandemic, influenced my health behavior. As a content developer, I participated in the development of social media content on postoperative pain management for clinical nurses. This experience improved my perception of when social

media works (or does not work) for knowledge translation. Overall, as an active social media user and content developer, I see the power of social media in influencing my professional and personal life, and the challenging process of using social media to impact professional practice. All these experiences drive me to investigate how social media supports healthcare providers' knowledge use in clinical practice.

I was born and have been living in China for 26 years. I am familiar with and have been using many different types of social media in China, either those used by the general public (eg, WeChat, Weibo) or those specialized for health professionals (eg, Dingxiaoyuan, Yimaitong). However, I did not have access to some social media that are popular in western countries, such as Twitter, Facebook, and Instagram, due to national law restrictions. I came to Canada in 2018 and have been living in Canada for four years. I begin to use social media that are not accessible previously, especially Twitter, to network, track publications, and find evidence-based resources. My life experience in both China and Canada enriched my understanding of the culture of social media usage in different political and ideological systems.

I have been working in the field of knowledge translation for seven years now since my graduate study. My Alma Mater for my graduate study is both a Cochrane and a JBI center, which created opportunities for me to connect and collaborate with knowledge translation teams in China and familiarize myself with organizations that use social media as a long-term knowledge translation strategy. During my PhD study, I had the chance to attend knowledge translation conferences and connect with scientists who develop, disseminate, and facilitate

the uptake of social media products. Those experiences allowed me to gain a sense of how social media initiatives operate to generate impacts.

Overall, all these experiences shaped my research focus and the whole research process. Specifically, they influenced: 1) the scope of my PhD research; 2) my choices of social media initiatives to be reviewed in phase one of the project (see Chapter 3); 3) my choices of expert consultation for relevant papers in phase two of the project (see Chapter 4); 4) my recruitment of content developers for interviews in phase three of the project (see Chapter 5); 5) my preconceptions of how social media might (not) work for knowledge translation.

1.3.2 Philosophical underpinnings

At the philosophical level, I position myself as a scientific realist. While there are different schools of scientific realism, I primarily draw on the tenets of Pawson and Tilley (Jagosh, 2020; Pawson, 2013; Pawson & Tilley, 1997), whose understanding of scientific realism is built on the philosophical wisdom of seven scholars (Pawson, 2013): Bhaskar (2008), Archer (1995), Elster (2015), Merton (1967), Popper (1959), Campbell (1988), and Rossi (1987).

One of the key tenets of scientific realism is the concept of “generative mechanism”, which was well-described by Bhaskar (2008). The generative mechanism is the idea that the laws of the natural and social world are not discovered through observations or measurement instruments. Mechanisms are latent until activated. In the latent form, mechanisms exist as possibilities or potentialities. Under a specific context, mechanisms can be activated and hold actual forms, but may or may not be empirically captured (Jagosh, 2020). Scientific realism is also inspired by the work of Archer (1995) on morphogenesis, which is the understanding of

causality in the social world. To put it simply, morphogenesis considers social change as happening across three temporal phases: structural and cultural conditions lead to social interactions that further lead to structural and/or cultural elaboration. At any given time, people's choices are conditioned by pre-existing structural and cultural conditions. Social interactions take place between agents under these conditions and then create social transformation (ie, morphogenetic cycle) or reproduction (ie, morphostatic cycle) (Archer, 1995, 2013). Elster's contribution to scientific realism lies in the argument that the explanation of social phenomena should be rooted in but not identical to the everyday reasoning of its stakeholders. Researchers need to build on and build beyond practitioner wisdom to understand the social mechanism (Elster, 2015).

Scientific realism draws on the notion of middle-range theory described by Merton (1967), which suggests that our theoretical explanations should be sufficiently abstract to apply to other social programs so that they transcend the sheer description. Scientific realism argues that evaluation studies should start with a program theory and iteratively refine the program theory by seeking patterns across seemingly diverse programs (Pawson, 2013). Next, the Popperian philosophy of science argues that scientific inquiry is a continuous evolutionary process—it is our theories that make sense of observable events and patterns, but empirical evidence still plays a vital role in scientific research for its capability to falsify or limit the scope of theories. Theories that survive the empirical study test are then subject to further testing and development as new data emerges (Popper, 1959). Scientific realism aligns with a Popperian stance that evidence does not offer certainty to decision making and the task of evaluation research is to articulate and refine theories (Pawson, 2013).

In addition, Campbell's contribution to scientific realism is its criticism of the objectivity and hierarchy of evidence (Campbell, 1988). Scientific realism embraces multiple forms of evidence and argues that we need to attend more closely to the quality of reasoning rather than look only at the quality of data (Pawson, 2013). Lastly, Rossi contributes to scientific realism by making the early claim for the utility of a theory-driven approach to evaluation (Chen & Rossi, 1983). In his influential evaluation study on providing released prisoners with small incentives to facilitate their adjustment to life beyond the prison wires, he found that the same intervention activated opposing mechanisms and it was the choices made by the study population that determined the program outcome (Rossi et al., 1980). Therefore, programs work only when implemented in a particular way, for the right subjects, and in appropriate circumstances (Rossi, 1987).

Overall, scientific realism is considered a school of philosophy that sits between positivism and constructivism. It holds the position of *realist and depth ontology*, *relativist epistemology*, and *methodological pluralism* (Jagosh, 2020; Pawson & Tilley, 1997). I describe each of these stances briefly below.

Realist and depth ontology assumes that there is a real world that exists independent of our beliefs and social constructions (Jagosh, 2019, 2020). The world has properties and structures that can be known. While (post)positivists perceive the world as ontologically flat, scientific realists hold the stance of depth ontology. Flat ontology prioritizes the observable reality with an assumption that reality is only what we can see at the empirical level and science must work with objects that can be observed and possibly manipulated (Jagosh, 2020). Depth

ontology, in contrast, is the idea that the world is stratified into multiple layers including the empirical, actual, and real layers (Bhaskar, 2008). The empirical layer consists of the observable and measurable events that can be experienced either directly or indirectly; the actual layer includes events and actions that occur but may not be experienced or measured; the real layer is the underlying structures and mechanisms which have powers and liabilities to generate phenomena. When these causal mechanisms are activated, events happen, unless countervailing mechanisms inhibit them (Mukumbang, 2021). Causal mechanisms cannot be grasped directly through empirical investigation as they are not open to observation, but can be inferred through a combination of empirical studies and theory construction (McEvoy & Richards, 2006). For scientific realists, the ultimate goal of research is not to identify the universal law in the physical or social world (ie, positivism), or understand the lived experience of social actors (ie, interpretivism). It is to uncover the underlying structure and mechanisms in the "real" layer through developing causal explanations (McEvoy & Richards, 2006)(see Figure 1.1).

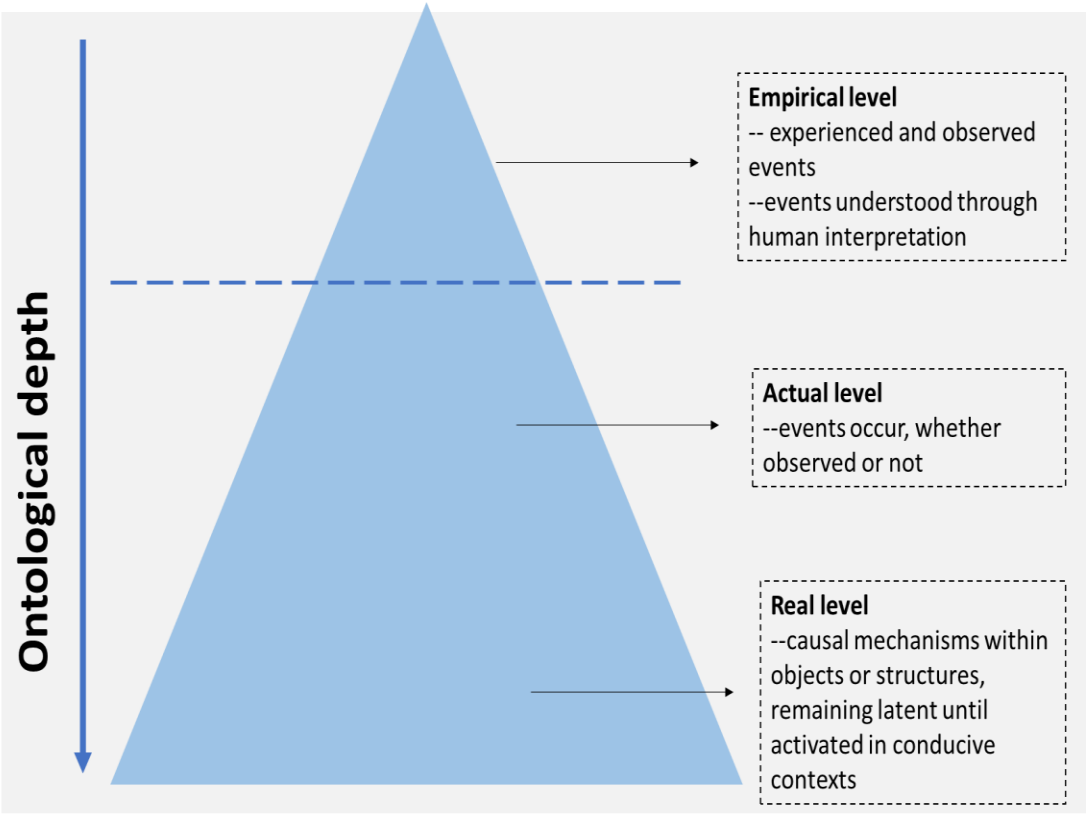

Figure 1.1 The realist concept of ontological depth (Jagosh, 2019)

Relativist epistemology refers to the understanding that our knowledge of the world is inevitably our own construction, created from a specific vantage point, despite the existence of a mind-independent physical world. All knowledge is thus theory-laden, but this does not contradict the existence of a physical world to which this knowledge refers. Researchers build conceptual models and theories as a way of explaining the social phenomena that we experience in the observable empirical domain. Such understanding is always formed from the combination of one's own experiences, perceptions, and standpoints (Maxwell & Mittapalli, 2010).

Recognizing the inherent complexity of social phenomena, scientific realists embrace *methodological pluralism* or *multimethodological approaches*. A wide range of quantitative, qualitative, and mixed methods data can and should be used to support theory development (Bhaskar & Danermark, 2006; Schiller, 2016; Van Belle et al., 2016). There have been calls among realist social scientists to abandon the qualitative and quantitative method division and replace them with intensive and extensive research methods to understand complex social phenomena. On the one hand, the distinction between qualitative and quantitative research seems no longer relevant as the practical research process inevitably contains elements from both approaches. On the other hand, the intensive and extensive approaches are meaningful in different ways to search for generative mechanisms. The intensive approach characterized by focusing on a few cases can gain an in-depth understanding of causal processes; the extensive approach characterized by population-level studies can help describe the demi-regularities (ie, "particular contexts influence our choices such that reoccurring patterns emerge"(Rycroft-Malone et al., 2012, p. 2)) of social phenomena (Danermark et al., 2019).

In addition to the above three philosophical stances, scientific realism has its own understanding of causation. Different from the empirical view of causation which is explained by the constant conjunction of observable events, scientific realism posits that "causal outcomes follow from mechanisms acting in contexts" (Pawson & Tilley, 1997, p. 58), and that "Outcome patterns do not occur directly because of the intervention strategies that are used. Instead, outcomes are caused by invisible mechanisms that are sensitive to context." (Van Belle et al., 2016, p. 2). To understand causation, the induction and deduction reasoning approaches

are insufficient and risk creating scientific outputs that are ontologically flat (Jagosh, 2020). Abduction and retroduction are the commonly used modes of inference to uncover the causal mechanisms of social phenomena from a scientific realism position (Greenhalgh et al., 2017; Jagosh, 2020; Meyer & Lunnay, 2013) and are further described below.

Abduction is “to interpret and recontextualize individual phenomena within a conceptual framework or a set of ideas; to understand something in a new way by observing and interpreting in a new conceptual framework (p.103)” (Danermark et al., 2019). An example of abduction is Karl Marx's reinterpretation of the history of humankind from a historical materialist view. Abduction is considered a “hunch-driven” and pragmatic theorizing approach that focusses on creativity as the logic of inference (Mingers, 2014; Tavory & Timmermans, 2014). Thus, reconceptualization or redescription and creativity are the central elements of abduction (Jagosh, 2020).

Retroduction is to identify the hidden causal mechanisms that lie behind the observed patterns or regularities of phenomena (Greenhalgh et al., 2017). The core of retroduction is transcendental or transfactual argumentation. Researchers move from empirical observation of events to arrive at a conceptualization of structural and transfactual conditions. They seek to clarify the basic prerequisites that are fundamental to the existence of phenomena by resembling deductive, inductive, and abductive reasoning (Danermark et al., 2019; Greenhalgh et al., 2017). Five complementary strategies can be employed to facilitate retroductive inference: counterfactual thinking, social experiments, studies of pathological cases, studies of extreme cases, and comparative case studies (Danermark et al., 2019; Meyer & Lunnay, 2013).

Abduction and retroduction can be considered as “two sides of a coin” where abduction is situated at the epistemological side in that it directs researchers’ attention to novel theoretical understanding and retroduction is situated at the ontological side in the sense of uncovering generative mechanisms in the real domain of reality (Jagosh, 2020).

I acknowledge that there is still ongoing debate surrounding the overlaps and differences between scientific realism and critical realism within the philosophy of science. Critical realism is a branch of philosophy developed by Roy Bhaskar and progressed by several British social theorists, such as Margaret Archer and Andrew Sayer, to name a few (Gorski, 2013). While critical realism and scientific realism share some commonalities in their ontological and epistemological stances, and Pawson built his understanding of scientific realism from critical realism, debates between the two centre on the relationship between social structure and human agency, study methods (eg, randomized controlled trials for social science under realist philosophy), and other issues. Further information on the debates can be seen in several scholarly papers (Bonell et al., 2016; Marchal et al., 2013; Pawson, 2016; Porter, 2015a, 2015b, 2017; Van Belle et al., 2016). It is not the goal of this thesis to comment on those debates and position myself between the two. In this thesis, I turn to scientific realism as the philosophical stance, rather than critical realism, because the realist methodology that I used was built under the tenets of scientific realism. To make it coherent and consistent, I take scientific realism as the philosophical foundation for this thesis.

1.4 Structure of this dissertation

This is a manuscript-based dissertation, the structure of which is outlined in Table 1.1. This dissertation follows a three-phase theory-building process: theory gleaning, theory refining, and theory consolidation. The three manuscripts correspond to the three phases of theory building in realist inquiry (Chapters 3, 4, 5), alongside an introduction chapter (Chapter 1), a methodology chapter (Chapter 2), and an integrated discussion chapter (Chapter 6).

Table 1.1 Structure and contents of the manuscript-based dissertation

Chapter	Chapter objectives	Study design	Theory-building phase	Manuscript
Chapter 1: Introduction	To describe the research problem, research purpose and objectives, and the philosophical stance underpinning the thesis	-	-	-
Chapter 2: Methodology	To explain the methodological process for the dissertation	-	-	-
Chapter 3: Social Media for ImpLementing Evidence (SMILE): Conceptual Framework	To propose a conceptual framework to understand how social media works as a knowledge translation strategy to inform healthcare practice.	Narrative review	Theory gleaning	Published: Zhao J, Harvey G, Vandyk A, Gifford W. Social Media for ImpLementing Evidence (SMILE): Conceptual Framework. JMIR Form Res 2022;6(3):e29891. doi: 10.2196/29891.
Chapter 4: Understanding how and under what circumstances social media supports healthcare providers'	To understand how and under what circumstances social media support healthcare providers' knowledge use in clinical practice	Realist review	Theory refining	Zhao, J., Harvey, G., Vandyk, A., Huang, M., Hu, J., Modanloo, S., & Gifford, W. (2022). Understanding How and Under What Circumstances Social Media Supports Healthcare Providers' Knowledge Use in Clinical Practice: A Realist

knowledge use in clinical practice: a realist review				Review. Telemedicine and e-health. 10.1089/tmj.2022.0213.
Chapter 5: Consolidating the program theory on how social media supports healthcare providers' knowledge use in clinical practice: a realist-informed qualitative study	To consolidate the program theory on how open social media supports healthcare providers' knowledge use in clinical practice	Realist-informed qualitative study	Theory consolidation	The manuscript is ready to be submitted
Chapter 6: Integrated discussion	To integrate the dissertation findings and discuss implications for nursing practice and future research.	-	-	-

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Chapter 2: Methodology

In the previous chapter, I oriented readers to the rationale for conducting this research and the philosophical position that shapes my ontological and epistemological understanding of the world. In this chapter, I orient readers to the methodology I used in the thesis (see Figure 2.1), specifically, I describe in detail the realist inquiry and the rationale for using a realist methodology for my research, and give a brief introduction of the methods I used for each phase of my study. For detailed descriptions of the methods I used in each of the three phases see Chapters 3, 4, and 5.

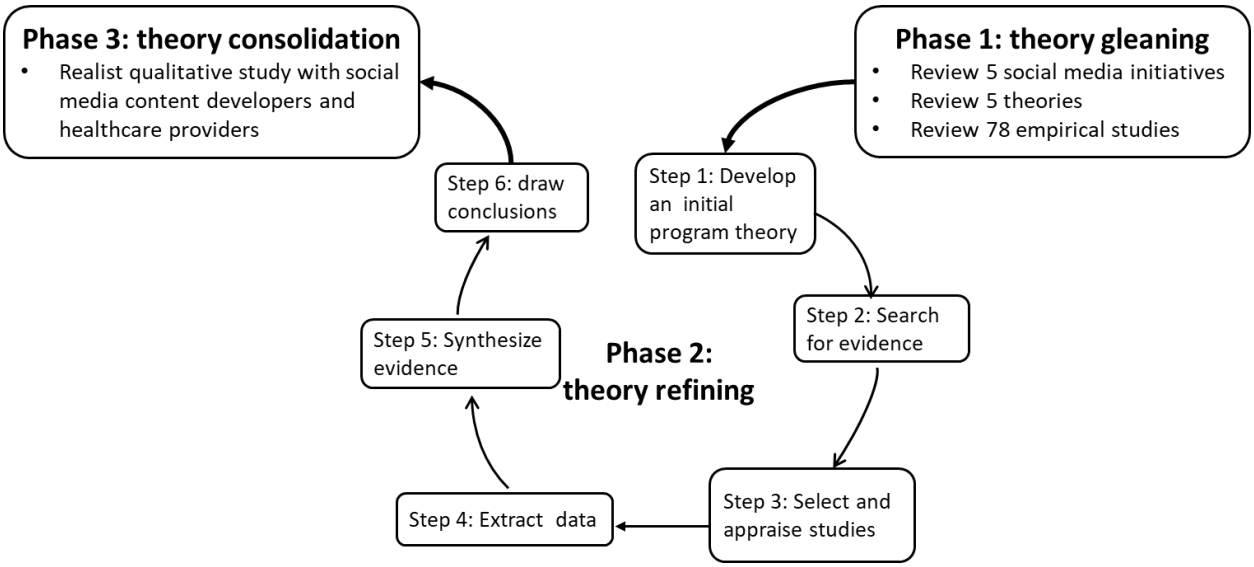

Figure 2.1 Research flow diagram for the thesis

2.1 Realist inquiry

Realist inquiry is a theory-driven approach underpinned by the scientific realism philosophy to assess programs, interventions, services, and policies. It includes realist evaluation and realist review (or realist synthesis). Realist inquiry does not answer questions of

whether an intervention works or the average effect of an intervention, rather, it aims to explain some or all the elements of what works, for whom, under what circumstances, and how, operationalized as context-mechanism-outcome (CMO) configurations (Pawson & Tilley, 1997).

2.1.1 Connotations of context, mechanism, outcome, and CMO configuration

The context in realist inquiry is generally considered as the backdrop elements of a program that has an impact on outcomes (Jagosh, 2019). Examples of contexts include the pre-existing social-political and organizational structure, cultural norms, interrelationships, and so on. While some contexts enable particular mechanisms (ie, recipients' responses to resources) to be activated, some contexts prevent mechanisms from being activated (De Weger et al., 2020). The understanding of context in realist studies is still evolving and under debate. Greenhalgh and Manzano (2021) identified two key narratives of how context is conceptualized in realist evaluation and review: 1) context as observable features that activate or block the mechanisms; and 2) context as relational dynamic features that shape mechanisms through which an intervention works. Context as observable features suggests that "context operates at one moment in time and sets in motion a chain reaction of events (p. 4)" and therefore one can identify and reproduce them to optimize the implementation of interventions as intended. Context as relational dynamic features implies that contexts operate in a dynamic and emergent way over time and thus are infinite and uncontrollable, but the understanding of context-mechanism interaction can inform the adaption of interventions to fit with different contexts. Sheaff et al (2021) developed a realist taxonomy of contexts, which included structural, resource-based, motivational, and temporal contexts.

The mechanism in realist inquiry is defined as the resources offered through a program and the way people respond to the resources (Dalkin et al., 2015; Jagosh, 2019; Pawson & Tilley, 1997). A mechanism is hidden but real, sensitive to variations in context, and generates outcomes (De Weger et al., 2020). It is "an element of reasoning and reactions of (an) individual or collective agent(s) in regard of the resources available in a given context to bring about changes through the implementation of an intervention" (Lacouture et al., 2015, p. 8). Yet, the concept of mechanism has also been under debate. Westhorp (2018) argued that the "resources and reasoning" operationalization of mechanisms work well in some contexts where the target of a program is individual and individual level decision making. However, other alternative constructs of mechanisms are necessary to understand how a program works in what circumstances, including powers and liabilities, forces, interactions, and processes. Porter (2015) also criticized the "resources and reasoning" understanding of mechanisms as it conflates structure and agency, and fails to recognize the capacity of humans to choose, thus is insufficient to capture the causal chains of social programs.

The outcomes in realist inquiry are the intended or unintended, and short-term or long-term effects based on context–mechanism interactions (Jagosh, 2019). Context, mechanism, and outcome are not static or fixed, rather the same thing can be a context in one circumstance, an outcome in another, and a mechanism in yet another (Westhorp, 2018). Jagosh et al (2015) used the "ripple effect" to describe complex social phenomena where an outcome from the previous causal configuration became the context for the next causal configuration.

A CMO configuration (see Figure 2.2) is a heuristic analytic tool that helps to illustrate the relationships between a context, mechanism, and outcome of interest in a particular program, and is used to build causal explanations in realist studies (De Weger et al., 2020). A CMO configuration means that "intervention resources are introduced in a context, in a way that enhances a change in reasoning. This alters the behaviour of participants, which leads to outcomes (p. 4)", and can be operationalized as a C + M = O equation (Dalkin et al., 2015). After the CMO analytic tool was introduced to understand causation in realist studies, variations of realist configurations have emerged (De Weger et al., 2020), such as Context–Intervention–Mechanism–Outcome (CIMO) Configuration (Davies et al., 2018; Garg et al., 2019), Intervention–Context–Mechanism–Agency–Outcome (ICMAO) Configuration (Higgins et al., 2012), Strategy/Intervention–Context–Mechanism–Outcome (S/ICMO) Configuration (Willis et al., 2014), and Intervention–Context–Actor–Mechanism–Outcome (ICAMO) Configuration (Abejirinde et al., 2018). De Weger et al (2020) conducted two realist studies using CMO and SCMO configurations respectively to test their applicability and concluded that adding explanatory factors to the original CMO configuration could be useful depending on the research aim and scope, but there should be a clear rationale for choosing a configuration type. In this thesis, I use the original CMO configuration to build causal mechanisms, the reason for which is illustrated in section 2.2—rationale for using the realist methodology.

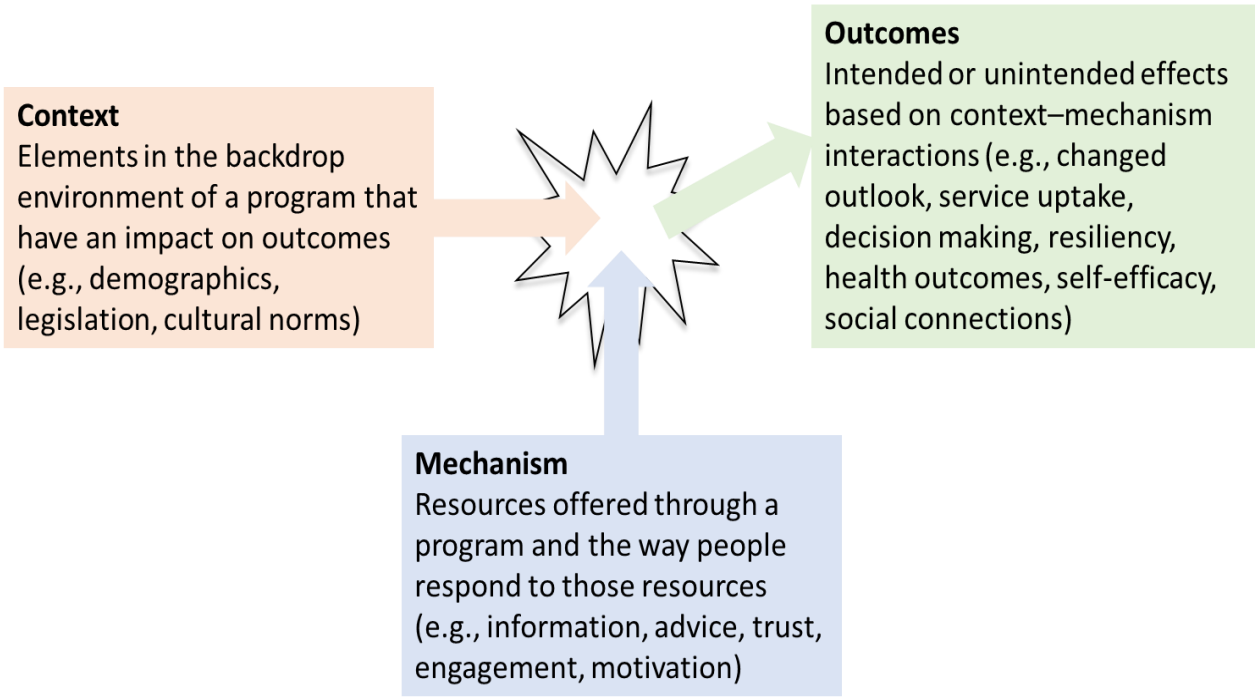

Figure 2.2 The context-mechanism-outcome (CMO) configuration (Jagosh, 2019)

2.1.2 Theory-building in realist inquiry

Theory building in the realist inquiry can be divided into three interconnected phases: theory gleaning, theory refining, and theory consolidation (Manzano, 2016; Mukumbang et al., 2020). The theory gleaning phase aims to elicit an initial program theory that explains how interventions are expected to work to achieve intended outcomes. An initial program theory can be elicited from many resources, such as literature review, program documentation review, interviews, and/or focus groups with key informants (Wong et al., 2016; Wong et al., 2013). Shearn et al (2017) suggested a three-phase process for developing a realist initial program theory: 1) concept defining—articulating the concepts and shared or contested understanding of the program under review. Key questions for this phase include what the program is, who or

what are the target groups, and what are the intended outcomes; 2) proposition development—developing realist statements that articulate the key mechanisms for a program to result in intended outcomes; and 3) theory development—drawing connections between theory propositions. Shearn et al (2017) also highlighted the importance of using the grand- and middle-range theories to guide the initial program theory development. Based on their experience in developing an initial program theory to explain how patient-reported outcomes were used in healthcare, Flynn et al (2020) offered two recommendations for developing initial program theories: 1) narrow the scope of the research question and/or develop a conceptual framework using middle-range theories, and 2) consider practical issues including available labor, funds, expertise and time.

Once an initial program theory is elicited, the next step is to test, develop and refine the program theory using primary data sources (ie, realist evaluation) or secondary data sources (ie, realist review). Researchers collect various quantitative and qualitative data and identify evidence on program elements, program implementation, outcomes, mechanisms of action, and how context affects mechanisms and outcomes. Multiple CMO configurations are then built based on the patterns identified within the data and researchers develop a refined program theory based on the CMO configurations. The Realist And Meta-narrative Evidence Syntheses: Evolving Standards (RAMESES) as described by Wong et al (2014; 2017) outlines the specific steps for performing a realist evaluation and review, and their publication standards.

From a scientific realist perspective, theory development is a continuous evolutionary process. The program theory should be iteratively refined based on empirical evidence to

understand the causal configurations. Therefore, the theory consolidation phase is not one study, but a process that aims to strengthen and fine-tune the program theory. Researchers can turn to multiple sources of data to consolidate the theory. One of its possible ways is to present the program theory to stakeholders and conduct realist interviews. Here the notion of "knowledgeability of the interviewees (p.492)", or "who knows what with regard to the program (p. 492)" is important to identify key informants (Mukumbang et al., 2020). Pawson and Tilley (1997) suggested that two groups of informants are important for the realist evaluation: the practitioners who implement programs or interventions and subjects who receive the programs or interventions. Researchers can use two different techniques when conducting realist interviews: the teacher-learner function and the conceptual refinement process (Manzano, 2016; Mukumbang et al., 2020; Pawson & Tilley, 1997). The teacher-leaner function implies that rather than taking a deliberate naive position for an interview, the interviewer adopts an active role in teaching (part of) the program theory developed in a previous exploratory study to the interviewees for examination. The interviewees, having learned the program theory under test, are able to 'teach back' to the interviewer regarding components of the program theory based on their own experience. So, the teacher and learner roles during the interviews are not static, but interchangeable as the interviewees become more engaged in the meaning-making process. The conceptual refinement process occurs when the interviewees are offered opportunities to explain and clarify their ideas to the interviewer (Manzano, 2016; Mukumbang et al., 2020; Nanninga & Glebbeek, 2011; Pawson & Tilley, 1997).

2.2 Rationale for using the realist methodology

This thesis follows the realist tradition of theory building and includes three interconnected phases: theory gleaning, theory refining, and theory consolidation (see Figure 2.1) (Manzano, 2016; Mukumbang et al., 2020). The reason why I elect to use realist methodology for this thesis is described below.

From the philosophical level, realist methodology aligns with my philosophical position on scientific realism which has been described in Chapter 1. The realist methods are developed under the tenets of scientific realism (Pawson, 2013; Pawson & Tilley, 1997). Scientific realism argues that our knowledge of the world is inevitably our own construction, created from a specific vantage point (ie, epistemological relativism), despite the existence of a mind-independent world (ie, ontological realism). This philosophical position, inherited from critical realism, criticizes the longstanding epistemic fallacy in the philosophy of science, especially in empirical realism. The epistemic fallacy is a reduction of being to our knowledge of being, or the idea that "ontological questions can always be transposed into epistemological terms" (Bhaskar, 2008, p. 26). Under scientific realism, a causal law cannot be reduced to or analyzed in terms of one's knowledge of it, in other words, a casual law would operate despite it being known or unknown. It is not science that gives the world structures, but that the world has such structures that make science possible (Bhaskar, 2008). Therefore, scientific realism (consistent with critical realism) is an argument for ontology and aims to answer the ultimate question: What must the world be like for science to be possible? Accordingly, realist methodologies under the scientific realism paradigm investigate the underlying structures that shape social events. Applied to my research, the aim of my research project is consistent with the goal of

scientific realism, which is to investigate the underlying mechanisms that drive healthcare providers to use knowledge from social media.

In addition to the critiques of the epistemic fallacy and the argument for ontology, scientific realism embraces depth ontology, which also resonates with me (Bhaskar, 2008). As is described in my philosophical position in Chapter 1, I understand reality as stratified into three layers—the empirical, actual, and real layers. In contrast to empirical realism which prioritizes the empirical layer, namely the observable events, and uses constant conjunction to understand causation, scientific realism goes beyond observables and investigates the underlying structures and mechanisms that activate social events. Scientific realism further proposes that mechanisms have latency—non-manifested existence until activated. Even when they are activated, they may or may not be captured by empirical methods (Jagosh, 2020). Such understandings of causal mechanisms indicate that we should go beyond the induction and deduction logic through the collection of empirical data, but use abduction and retroduction inferences to uncover underlying structures.

From the methodological level, the realist methodology under scientific realism is useful to address my research question because it helps to open the "black box" of complex social problems and build theoretical understandings of "what works for whom, in what circumstances, in what respects and how" (Pawson et al., 2005, p. S1:21). Different from the regression analysis and structural equation modeling approaches that aim to generate universal causal understanding, the realist methodology argues that things do not happen in a vacuum, but are context-bounded. The mechanisms that lead to social events can only be activated by

conducive contexts (Jagosh, 2020). Rather than building universal laws, the realist methodology aims to understand causal mechanisms by establishing context-mechanism interactions. Applied to my study, the starting position is that improving healthcare providers' use of knowledge from social media is challenging, but under certain circumstances, it is still possible. Compared with the establishment of a decontextualized causal understanding, it is more meaningful to build context-bounded statements to understand how, when, for whom, and under what circumstances social media is likely to lead to healthcare providers' knowledge use. Such context-dependent understanding of causal mechanisms would be much more informative for developing social media interventions and explaining their successes and failures, compared with decontextualized causal statements. Therefore, the realist methodology is appropriate in my study to understand the mechanisms of how social media supports healthcare providers' knowledge use and the contextual factors that activate these mechanisms.

In this research, I use CMO configurations to build causal explanations because they not only help to identify the underlying mechanisms that shape healthcare providers' knowledge use through social media, but also illustrate the corresponding relations between specific mechanisms and specific contexts that lead to an intended outcome. The reason why I use the CMO configurations rather than the aforementioned other configuration variations is twofold. First, the realist methodology I used in this research is fully based on RAMESES methodological guidance (http://www.ramesesproject.org/). They use CMO configurations to build causal explanations. To be consistent with this methodology, I choose the CMO configurations. Second, adding other explanatory factors to the original CMO configuration risks confusing the exact

nature of the causal explanation (De Weger et al., 2020). Regardless of additional explanatory factors, mechanisms and their activating contexts are always the core explanatory elements (De Weger et al., 2020).

In the following part, I briefly describe the methods I used for each phase of my research. For detailed descriptions of each phase see Chapters 3, 4, and 5.

2.3 Phase one: theory gleaning

The purpose of phase one was to propose a conceptual framework to understand how social media works as a knowledge translation strategy for healthcare providers, policymakers, and patients to inform healthcare practice. This conceptual framework served as an initial program theory that was iteratively refined by literature in phase two.

In the first phase, I used an integrative approach to develop the conceptual framework that involved three steps (Meleis, 2011). First, I reviewed five long-standing social media initiatives in China and Canada to get a sense of how they operate. For each social media initiative, I reviewed the topics and interface of their social media channels, the number of readers, followers, and comments; intervals between posts; and the length of videos and papers published relating to each initiative.

Drawing on five theories on social media studies and knowledge translation, I, together with the thesis committee, used a deductive approach to draft the initial framework. These theories are integrated Promoting Action on Research Implementation in Health Services (i-PARIHS) framework (Harvey & Kitson, 2015); COM-B model (Michie et al., 2011); Fogg's

Behaviour Model (Fogg, 2009); Theory of Innovation Diffusion (Rogers, 2010); and the Behaviour Change Model for Internet Interventions (Ritterband et al., 2009).

I then reviewed 58 empirical papers that were collected from papers relevant to the five social media initiatives, citation tracking, and a snowballing search to substantiate and fine-tune the initial framework. The studies were concerned with factors that influenced people's use of social media and its messages, and strategies for promoting message use. A detailed description of the methods for phase one is outlined in Chapter 3-3.3 methods.

2.4 Phase two: theory refining

The purpose of phase two was to synthesize literature to understand how, for whom, and under what circumstances social media supports healthcare providers' knowledge use in clinical practice. I followed the realist review methodology in this phase (Pawson et al., 2005; Wong, Greenhalgh, Westhrop, et al., 2014). It included six iterative steps: 1) develop an initial program theory; 2) search for evidence; 3) select and appraise studies; 4) extract data; 5) synthesize data; and 6) draw conclusions.

Step 1: develop an initial program theory. The goal of this step was to identify an initial program theory that could explain how social media is thought to work for knowledge use. The conceptual framework developed in phase one served as the initial program theory.

Step 2: search for evidence. This step aimed to find a relevant body of literature that might contain information to help test and refine the program theory (Pawson et al., 2005; Wong, Greenhalgh, Westhorp, et al., 2014). The evidence came from four sources: 1) Electronic searches: CENTRAL, MEDLINE, EMBASE, CINAHL, PsycINFO, ERIC, Communication and Mass

Media, CNKI, and SINOMED. 2) One scoping review of 96 papers on social media use among healthcare providers (Hamm et al., 2013). 3) Expert consultation: I contacted social media content developers (hereafter referred to as "content developers") for suggestions on papers that might be useful for understanding healthcare providers' knowledge use through social media. 4) Reference checking: I also checked the references of highly relevant papers to locate more relevant papers.

Step 3: select and appraise studies. Two reviewers pilot screened 15 papers based on the eligibility criteria and reached a consensus, and then independently screened titles, abstracts and full-text to identify relevant studies. Disagreements were discussed and resolved by consensus or with a third member. We appraised the quality of included documents from two dimensions: relevance and rigor (Pawson et al., 2005; Wong, Greenhalgh, Westhrop, et al., 2014). Two reviewers independently assessed the quality of included studies; discrepancies were resolved through discussion.

Step 4: extract data. A data extraction form was created based on the initial program theory and was fine-tuned during the data extraction process. The form was used to obtain basic characteristics of included studies and to capture information from each paper on the context, proposed/described mechanisms of action, and outcomes. We conducted document appraisal, extraction, and synthesis in parallel (Wong et al., 2013) and prioritized documents rated as highly relevant for synthesis.

Step 5: synthesize evidence. I referred to the categorizing (ie, coding and theming) and connecting strategy (ie, building relationships) proposed by Maxwell (2012; Maxwell & Miller,

2008) to synthesize evidence and develop CMO configurations. A retroductive reasoning approach was used to help identify the hidden mechanisms (Greenhalgh et al., 2017; Meyer & Lunnay, 2013). Three analytic strategies were used to assist the synthesis: juxtaposition, reconciliation, and adjudication (Pawson, 2006).

Step 6: draw conclusions. After the synthesis, I further invited six knowledge users, who were either healthcare providers who use social media for clinical practice or content developers from Canada or China, to help fine-tune the CMOs. After integrating their feedback, I finalized the CMOs and updated the refined program theory. The findings of the realist review were used to inform the theory consolidation in phase three. For a detailed description of the methods of the realist review see Chapter 4-4.2 methods.

2.5 Phase three: theory consolidation

In phase two, I identified two causal explanations of how social media supports healthcare providers' knowledge use, which corresponds to two types of social media platforms: open and closed social media platforms. Focusing on open social media platforms, the purpose of phase three was to consolidate the program theory on how open social media platforms support healthcare providers' knowledge use in clinical practice.

I used a realist-informed qualitative study design for this phase. A purposive sampling approach was used to recruit participants from two groups: 1) healthcare providers who reported that they have used evidence from social media to change their practice; 2) content developers who disseminate research evidence using social media. The content developers were recruited from three teams who were using social media to disseminate synthesized

evidence related to healthcare. Healthcare providers were recruited by disseminating recruitment posters on the social media accounts of the three content developer teams and online knowledge translation interest groups.

Semi-structured individual interviews were conducted to collect data with the use of a teacher-learner technique (Manzano, 2016; Mukumbang et al., 2020; Pawson & Tilley, 1997). The interview guide was developed based on the realist review findings (phase 2) to further investigate the contexts, mechanisms, and outcomes of using social media for knowledge translation. Interviews were conducted on an individual basis virtually in mandarin or English, digitally audio-recorded, and transcribed verbatim.

The categorizing (ie, coding) and connecting strategies (ie, identifying key relationships) proposed by Maxwell informed the analysis (2012; Maxwell & Miller, 2008). To improve the transparency of the data analytic process, I referred to the data analysis and synthesis process for realist evaluation suggested by Gilmore et al (2019). The six criteria for judging qualitative research within the realism paradigm proposed by Healy and Perry (2000) were used to assure the rigor of this study. For detailed descriptions of the methods of the qualitative study see Chapter 5-5.2 methods.

Overall, this thesis follows a three-phase realist theory development process (ie, theory gleaning, theory refining, and theory consolidation) to build a theoretical understanding of how social media supports healthcare providers' knowledge use. In the following Chapters 3, 4, and 5, I present the findings of each phase.

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Chapter 3: Social Media for ImpLementing Evidence (SMILE): Conceptual Framework

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In the previous chapter, I described the methodology I used in the whole dissertation and had a brief introduction of the methods I used in each phase of my thesis. In this chapter, I focus on the first phase of my thesis—theory gleaning and the aim to build a conceptual framework to understand how social media works as a knowledge translation strategy for healthcare providers, policymakers, and/or patients to inform their healthcare practice. I draw on an integrated approach to build the conceptual framework as a preliminary theoretical explanation to inform the theory refining phase in the next chapter.

Abstract

Background: Social media has become widely used by individual researchers and professional organizations to translate research evidence into health care practice. Despite its increasing popularity, few social media initiatives consider the theoretical perspectives of how social media works as a knowledge translation strategy to affect research use. Objective: The purpose of this paper is to propose a conceptual framework to understand how social media works as a knowledge translation strategy for health care providers, policy makers, and patients to inform their health care decision-making. Methods: We developed this framework using an integrative approach that first involved reviewing 5 long-standing social media initiatives. We then drafted the initial framework using a deductive approach by referring to 5 theories on

social media studies and knowledge translation. A total of 58 empirical studies on factors that influenced the use of social media and its messages and strategies for promoting the use of research evidence via social media were further integrated to substantiate and fine-tune our initial framework. Through an iterative process, we developed the Social Media for ImpLementing Evidence (SMILE) framework. Results: The SMILE framework has six key constructs: developers, messages and delivery strategies, recipients, context, triggers,and outcomes. For social media to effectively enable recipients to use research evidence in their decision-making, the framework proposes that social media content developers respond to target recipients' needs and context and develop relevant messages and appropriate delivery strategies. The recipients' use of social media messages is influenced by the virtual–technical, individual, organizational, and system contexts and can be activated by three types of triggers: sparks, facilitators, and signals. Conclusions: The SMILE framework maps the factors that are hypothesized to influence the use of social media messages by recipients and offers a heuristic device for social media content developers to create interventions for promoting the use of evidence in health care decision-making. Empirical studies are now needed to test the propositions of this framework.

Keywords: Social media; research use; knowledge translation; implementation science; conceptual framework

3.1 Introduction

3.1.1 Social Media Use in Health Care

Social media has been extensively used worldwide to communicate health-related information. For example, in China, one-third of the users of the social media platform WeChat—which is widely used for instant messaging and social networking [1]—receive and read health information through the platform [2]. In the United States, 32% of social media users post messages about friends and family members' health experiences on social media [3]. Health care professionals use social media to provide health information and answer medical questions [4], and patients and caregivers use social media for self-care and health literacy [5]. In health care research, social media platforms such as Twitter, Facebook, and YouTube are increasingly used for participant recruitment, intervention implementation, data mining and collection, and the sharing of research findings [6]. Social media, with its free access, interactive features, and widespread reach, has become increasingly used by individual researchers and professional organizations who wish to translate research evidence into health care practice. For example, the Joanna Briggs Institute (JBI) at Fudan University in China has been using WeChat to disseminate nursing evidence since 2014. In the first 2 years, their WeChat account reached 22,369 followers from 34 provinces in China [7,8]. The Cochrane Child Health groups in Canada and Portugal used social media strategies to disseminate child health evidence to health care providers, and within 6 months of initiating the strategy, their blog received 2555 visitors and 3967 page views, and their Twitter account gained 469 new followers from a geographically diverse population [9]. A social media initiative called It Doesn't Have to Hurt, led by health care researchers in Canada, developed a short YouTube video on evidence-based strategies, such as distraction and using topical anesthetics for reducing procedural pain in children. Their video received 237,132 unique views from 182 countries 5 years after its launch,

with patients and health care providers reporting strong acceptance and high intention to use the strategies [10]. The number of parents reporting the use of topical anesthetic creams to reduce pain increased from 18% to 63% after watching the video [11].

There has also been a surge in social media initiatives during the COVID-19 pandemic, which are aimed at helping health care professionals, patients, and the public better understand the coronavirus and cope with its impacts. Global evidence synthesis networks such as Cochrane, JBI, and Campbell Collaboration use social media to disseminate rapid review findings related to COVID-19. In China, the Beijing University of Chinese Medicine (BUCM) Cochrane Center, together with 20 evidence-based health care research teams and organizations, launched the Fighting COVID-19 with Evidence initiative. They collect urgent clinical questions about COVID-19 diagnosis, treatment, and nursing care through WeChat and share recommendations after a rapid search and synthesis of research evidence [12]. In England, the Center for Evidence-Based Medicine at Oxford University uses Twitter (@CebmOxford) to share COVID-19 relevant recommendations to a global audience. In Canada, the COVID-19 Evidence Network to support Decision-making initiative (@COVID_E_N_D) collects the best available evidence related to COVID-19 and shares this information on Twitter to support decision-making.

3.1.2 Theoretical Understandings of Social Media as a Knowledge Translation Strategy

Despite its popularity, many researchers and organizational decision-makers upload research findings onto social media platforms without deliberately planning how to facilitate its use by recipients in policies, programs, or practices. In their systematic review, Webb et al [13]

concluded that theory-based internet interventions had greater impacts on health behaviors than non–theory-based interventions, with interventions based on the theory of planned behavior having larger effects than those based on the transtheoretical model or social cognitive theory. However, despite these benefits, theoretical frameworks are rarely used to guide the development of social media interventions aimed at facilitating research use. In their systematic review, Arguel et al [14] only identified 15 experimental studies published between 2005 and 2016 that applied theoretical approaches to guide the development of social media interventions.

Ngai et al [15,16] classified 31 theories used in social media studies into three categories: personal behavior theories, social behavior theories, and mass communication theories. Personal behavior theories (eg, the theory of planned behavior and technology acceptance model) focus on personal factors that affect user behavior on social media. Social behavior theories (eg, social capital theory and social cognitive theory) identify key social factors that stimulate individuals to participate in collective actions on social media. Mass communication theories (eg, parasocial interaction theory) reveal the distinct characteristics of social communications that can assist in the use of social media for communication and marketing [15,16]. These theories provide valuable insights into social media's role in behavior change; however, the following two limitations exist in fully understanding the research use process:

1. They only consider 1 of the 2 latent and indispensable layers of social media use: social media and messages. Recipients must first use social media before they can engage with messages (eg, the technology acceptance model emphasizes the platform, and the

social cognitive theory and theory of planned behavior focus on the message). Theories that do not address both layers fail to fully explain the process of research use through social media.

2. They neglect multilevel contextual factors, such as the virtual–technical, organizational, and system contexts, particularly in relation to the features of the social media platform in shaping behavior. This may lead to the development of knowledge translation strategies solely from an individual perspective, without taking into account the contextual determinants that affect recipients' behaviors.

These 2 limitations were partially addressed by Ritterband et al [17], who developed a behavior change model for internet interventions, which posited that website use was influenced by support, characteristics of the websites and users, and environmental factors. Behavior change from information on websites is then influenced by various mechanisms (eg, knowledge and motivation). This model has been used to guide the development and evaluation of internet interventions in health care [18,19]. Although not exactly the same, websites that allow for multiway interaction are normally considered to be social media [20,21], and the Ritterband et al [17] model has been used in the social media context [22]. It addresses the limitations of the aforementioned social media theories, as it considers the platform—which in this case is the website—and accounts for the multilayered contexts in shaping behavior, such as personal, professional, and community contexts, as well as the health care system [17]. However, the Ritterband et al model [17] does not make mechanisms of change

explicit and presents a linear process for using the internet to change behavior when real-world practice is often complex [17].

Despite its extensive use for disseminating health care research evidence, social media is rarely used in a well-planned way with end users in mind, which largely limits its potential to bridge evidence–practice gaps and contribute to health care practices. Studies on the use of research evidence through social media are sparse [14]. Large theoretical gaps exist in understanding how social media interventions affect health care practices and decision-making. Unpacking the process by which social media works as a knowledge translation strategy is important to not only advance science but also inform interventions for improving health care practices and patient outcomes.

3.2 Objective

The purpose of this paper is to propose a conceptual framework to understand how social media works as a knowledge translation strategy for health care providers, policy makers, and patients to inform their health care decision-making.

3.3 Methods

We used a 3-step process based on the approach described by Meleis [23] to develop our conceptual framework. Meleis suggested that practice, theory, and research are important sources for patterning real-world phenomena and informing theory development [23]. Our approach was iterative and flexible and built a preliminary understanding of the process through which social media works for knowledge translation.

To get a sense of how they operate, we first reviewed five long-standing social media initiatives that have a large number of followers: the Fudan University JBI Center Nursing Evidence Dissemination Initiative (ie, Fudan JBI Initiative) [7,8,24], BUCM Cochrane Evidence Dissemination Initiative (ie, BUCM Cochrane Initiative) [25], *It Doesn't Have to Hurt* initiative[10,26], *Be Sweet to Babies* initiative [27], and Translating Evidence in Child Health to Enhance Outcomes (ECHO) program [28]. For each social media initiative, we specifically reviewed the topics and interface of their social media channels (including format and structure of content); the number of readers, followers, and comments; intervals between posts; and the length of videos and papers published relating to each initiative.

Second, we drafted the initial framework using a deductive approach based on existing theories and our team members' expertise in knowledge translation and social media. We primarily drew on five well-known and widely cited theories, frameworks, and models: integrated Promoting Action on Research Implementation in Health Services (i-PARIHS) [29]; capability, opportunity, motivation, and behavior (COM-B) [30]; Fogg behavior model [31]; theory of innovation diffusion [32]; and behavior change model for Internet interventions [17]. We built the basic structure of our framework based on the i-PARIHS framework, which argues that successful knowledge translation relies on the interactions among four constructs: innovation, recipients, context, and facilitation. In addition to the i-PARIHS constructs, we added one construct for social media content developers (hereafter referred to as developers) in recognition of the crucial role they play in ensuring that recipients get relevant and appropriate messages. We added the virtual–technical context to the 3-layer contexts described in i-PARIHS (ie, local, organizational, and external) to capture the unique features of

social media platforms, which is substantiated by the behavior change model for internet interventions (described above). We also included three types of knowledge translation outcomes—conceptual, instrumental, and persuasive research use [33,34]—in recognition of the fact that not all evidence on social media was appropriate for practice or behavior change. Rather, we recognize that a large amount of social media evidence affects understanding, attitudes, or collective actions.

The other four theories and models were used to develop two further aspects of our framework: using social media and using the messages. In the first aspect, the four theories and models were employed to understand social media use from two main construct levels: recipients and the virtual–technical context. In the second aspect, derived from the COM-B model and the Fogg behavior model, we built subconstructs for the active ingredient of message use, named as trigger in our framework.

We then reviewed published papers that incorporated the 5 long-standing social media initiatives (described earlier) and used strategies such as citation tracking from the papers we reviewed. The forward citation search was conducted using Google Scholar, and the backward citation search was conducted by screening the reference lists. We also conducted a citation snowballing search using Google Scholar and consulted experts from the 5 social media initiatives and our team members to further locate relevant empirical studies. The studies we identified were primarily about factors that influenced people's use of social media and its messages and strategies for promoting message use. We used the key findings of these studies to substantiate and fine-tune our initial framework. Through an iterative process, we went back

and forth from the initial framework to social media initiatives, theories, and empirical studies and developed the Social Media for ImpLementing Evidence (SMILE) framework. Implementation in the SMILE framework refers to instrumental, conceptual, and persuasive knowledge translation.

3.4 Results

3.4.1 Overview

Through a review of social media initiatives (n=5), theories (n=5), and empirical studies (n=58), including papers (15/58, 26%) relevant to the 5 social media initiatives [7,8,10,24,26,27,35-43] and papers (43/58, 74%) [9,13,15,44-83] from citation tracking, snowballing, or consultation, we developed the SMILE framework (Figure 3.1). Table 3.1 summarizes the key constructs and their supporting evidence. The SMILE framework provides a preliminary understanding of how social media can be used as a knowledge translation strategy to inform health care practices and decision-making. It has six key constructs: (1) developers, (2) messages and delivery strategies, (3) recipients, (4) context, (5) triggers, and (6) outcomes. For social media to enable recipients to use research evidence in their practice or decision-making, the framework proposes that developers respond to the needs and context of target recipients to develop relevant messages and appropriate delivery strategies. Recipients' use of social media messages is influenced by the virtual–technical, individual, organizational, and system contexts and can be activated by different types of triggers, described as sparks, facilitators, and signals. Next, we describe the constructs of the SMILE framework.

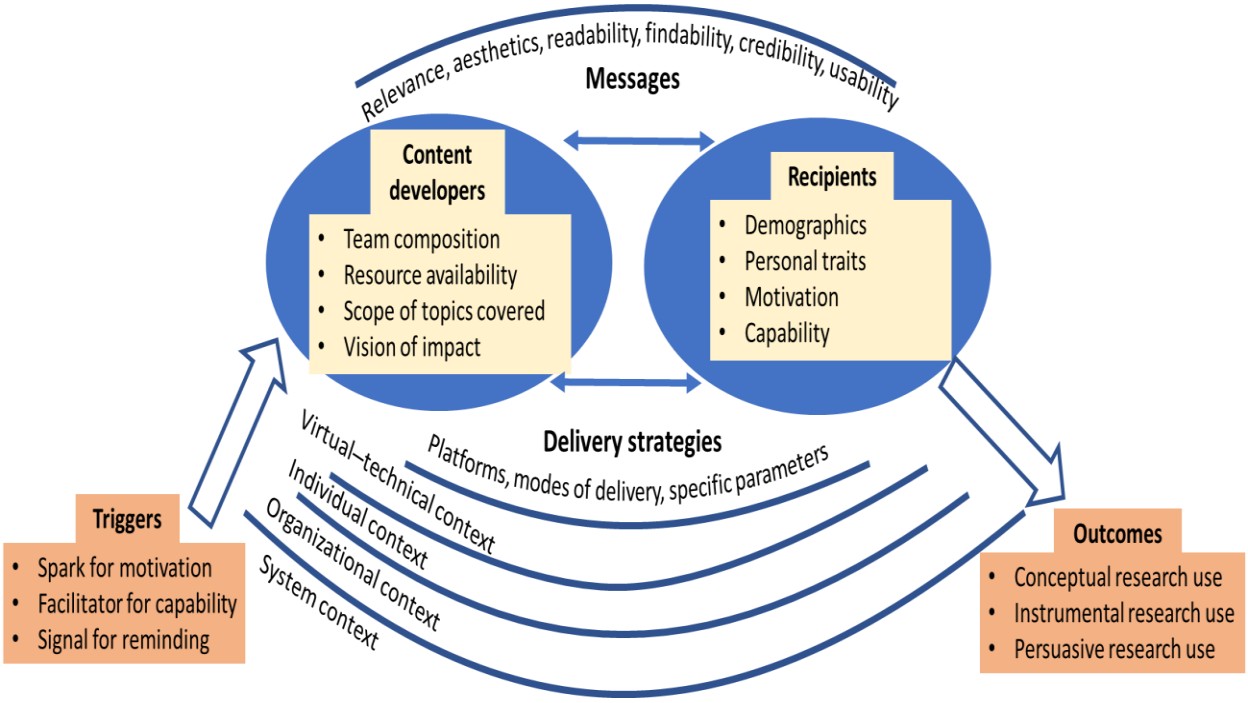

Figure 3.1 SMILE (Social Media for ImpLementing Evidence) framework.

Table 3.1 Key constructs in the SMILE framework and the supporting evidence

Constructs	Theory origins	Empirical studies	Social media initiatives
Developers	—[a]	[9,78]	Fudan JBI[b] Initiative [7,8,24,84]; BUCM[c] Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26,85]; *Be Sweet to Babies* initiative [27]; ECHO[d] [28,43]
Team composition	—	[9]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [85]; *Be Sweet to Babies* initiative [27]; ECHO [28]
Resource availability	—	[9]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27]; ECHO [28]
Scope of topic covered	—	[9]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27]; ECHO [28,43]
Vision of impact	—	[51,79]	Fudan JBI Initiative [84]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt*

				initiative [10,26,85]; *Be Sweet to Babies* initiative [27]; ECHO [28,43]
Messages and delivery strategies		i-PARIHS[e] framework (innovation) [29]	[51,57]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27]; ECHO [28,43]
	Messages	Behavior change model for internet interventions (website) [17]	[44,47,49, 52,54,56, 58-63,80]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27]; ECHO [28,43]
	Delivery strategies	Behavior change model for internet interventions (website) [17]	[13,82,83]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27]; ECHO [28,43]
Recipients		i-PARIHS framework (recipients) [29]	[15,48,55, 65]	—
	Demographics	Behavior change model for internet interventions (user characteristics [17]	[15,45,53, 55]	—
	Personal traits	Behavior change model for internet interventions (user characteristics) [17]	[46,64]	—
	Motivation	COM-B[f] model (motivation and capability) [30]; Fogg behavioral model (motivation and capability) [31]	[48,50,55, 65]	—
	Capability	COM-B model (motivation and capability) [30]; Fogg behavioral model (motivation and capability) [31]	[48,50,55, 65]	
Context		i-PARIHS framework (context) [29]	[81]	—
	Virtual–technical context	Behavior change model for internet interventions (website) [17]; theory of innovation diffusion (innovation characteristics) [32]	[48,65,69, 70,75,77]	Fudan JBI Initiative [7,8,24]; BUCM Cochrane Initiative [25]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27,39,40]; ECHO [28]
	Individual context	Behavior change model for internet interventions (environment) [17]; COM-B model (environment) [30]	[67,68]	Fudan JBI Initiative [8,24]; *It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [39,40]
	Organizational context	Behavior change model for internet interventions	—	*It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [39,40]

		(environment) [17]; COM-B model (environment) [30]		
	System context	Behavior change model for internet interventions (environment) [17]; COM-B model (environment) [30]	[71]	*Be Sweet to Babies* initiative [39,40]
Triggers		i-PARIHS framework (facilitation) [29]	[13,66,73, 74]	—
	Spark for motivation	Fogg behavioral model (trigger) [31]; COM-B model (motivation and capability) [30]; behavior change model for internet interventions (support) [17]	[55,67,74, 79]	*Be Sweet to Babies* initiatives [41]
	Facilitator for capacity	Fogg behavioral model (trigger) [31]; COM-B model (motivation and capability) [30]; behavior change model for internet interventions (support) [17]	[13,72,76]	*Be Sweet to Babies* initiatives [27,42]
	Signal for reminding	Fogg behavioral model (trigger) [31]; COM-B model (motivation and capability) [30]; behavior change model for internet interventions (support) [17]	[13,55,74]	—
Outcomes		i-PARIHS framework (successful implementation) [29]	[33,34]	—
	Conceptual research use	—	—	*It Doesn't Have to Hurt* initiative [10,26]; *Be Sweet to Babies* initiative [27,35-39];
	Instrumental research use	—	[76]	*Be Sweet to Babies* initiative [41]
	Persuasive research use	—	—	—

[a]—: Data not available

[b]JBI: Joanna Briggs Institute.

[c]BUCM: Beijing University of Chinese Medicine.

[d]ECHO: Evidence in Child Health to Enhance Outcomes.

[e]i-PARIHS: integrated Promoting Action on Research Implementation in Health Services.

[f]COM-B: capability, opportunity, motivation, and behavior.

3.4.2 Developers

Developers are individuals, groups, and organizations responsible for the management of social media contents. Developer activities may include designing and periodic uploading of information, monitoring operations, collecting data on impact, and answering questions or comments from viewers. Developers can be health care researchers who produce research evidence and share it directly via social media for public access. Barton [78] proposed a new research-to-practice continuum where researchers not only disseminate research findings through traditional journal publications but also create multimedia messages and disseminate them to the public. Developers can also be intermediaries who serve as a link between research producers and end users by translating research evidence into user-friendly messages for dissemination on social media.

Although it might be simple for individuals to develop and upload research findings to social media, a fast, frugal, and hope-the-change-happens approach has limitations. One of the propositions embedded in the framework is that the composition of the development team, availability of resources, scope of topics, and vision of impact influence the development of relevant and appropriate social media interventions, thus affecting recipients' engagement with and use of the messages.

We suggest bringing together a multidisciplinary collaborative team of health care professionals, target users, social media experts, and audiovisual technicians (eg, camera operators and video editors) to best support the development of social media interventions [9]. Health care professionals can assist with the identification of different types of evidence resources; target users can strengthen the relevance and accessibility of messages; social media

experts can contribute to the operation of the platform; and audiovisual technicians can provide support when the team wants to deliver messages using videos or animations. For example, the It Doesn't Have to Hurt initiative has built a large interdisciplinary collaborative team of researchers, trainees, patients, and other stakeholders to facilitate the stable operation of their social media program [10,26,85]. Similarly, the ECHO research program has created various videos, animations, and posters on child health with a multidisciplinary team [28]. With different knowledge, skills, and perspectives, the team can generate high-quality and influential social media products. The long-term collaborative approach can additionally promote the sustainability of these initiatives.

The availability of resources to develop and manage social media initiatives, such as time and budget, must be taken into consideration when planning it. In the It Doesn't Have to Hurt initiative, it cost the team Can $15,000 (US $11,802) and considerable efforts to develop and promote their YouTube video, and the developers stated that financial and time costs could be a hindrance for individual researchers to undertake the work [10]. In their social media initiative to disseminate Cochrane Child Health evidence, Dyson et al [9] also found that the team invested enormous time and human resources in managing the platform. Therefore, we suggest that adequate time and budget be allocated to social media initiatives before their commencement.

The scope of topics covered is closely linked to the amount of time and resources invested. Some initiatives, such as the Fudan JBI Initiative [7,8,24] and BUCM Cochrane Initiative [25], have broad scopes that are open to a range of topics in nursing and medicine.

Some initiatives focus only on specific topics; for example, the It Doesn't Have to Hurt [10,26] and Be Sweet to Babies initiatives [27] target reducing procedural pain for children and infants, respectively. Other initiatives center on a certain field, such as the ECHO initiative, which covers common childhood conditions. The topics covered should be balanced with the consideration of practical issues. Dyson et al [9] suggested that starting from a specific content area and engaging with a stable social media community was more effective for developing a social media network.

It is also essential that the development team builds a shared vision of the impact they are looking to achieve and tracks the performance of their social media initiatives [51]. Building and sustaining a social media initiative is demanding work that requires collaboration and investment. An explicit team vision of the impact of social media can motivate the team to work toward a common goal. For example, since 2016, the Fudan JBI Initiative has openly shared its social media vision in its annual center report and at conferences [84]. Gates et al [79] also emphasized the importance of setting goals and tracking achievements after the evaluation of their social media initiative.

In the SMILE framework, we propose that the engagement of a multidisciplinary team, time, and resource investments are essential for developing relevant and appropriate social media interventions to influence research use. Developers should balance the topics covered with practical considerations and create a shared vision of the goals of their social media initiatives.

3.4.3 Messages and Delivery Strategies

3.4.3.1 Overview

The second construct in the SMILE framework is messages and delivery strategies. Developers should respond to recipients' needs and their context to create messages and delivery strategies. Through a systematic literature review, Schein et al [57] observed that collaborating with target users to create social media interventions contributed to heightened authenticity of messages and improved trust in developers. Korda and Itani [51] suggested that social media messages should account for user characteristics and information preferences and should be customized through an iterative interaction with target users. On the basis of 4 years of experience in social media operations, the Fudan JBI Initiative recommended that developers could improve the usability and uptake of research evidence on WeChat through the full use of WeChat's interactive functions to capture users' needs [7,24].

3.4.3.2 Messages

To date, a limited number of studies have investigated the attributes of social media messages that influence its uptake, despite the development of tools and models to assess the quality of web-based information [44,47,49,54,59,61-63,80]. On the basis of the content of these tools and models, as well as the unique features of social media platforms, we posit six interrelated attributes that influence the uptake of social media messages: relevance, aesthetics, readability, findability, credibility, and usability.

A relevant message is directly related, connected, or pertinent to target users. The more relevant messages are to the target users, the higher their level of engagement and the likelihood of being used. In their systematic review, Schubart et al [58] concluded that internet

interventions that addressed the primary concerns of patients with chronic health conditions were the most successful.

An aesthetic message is characterized by the artistic design and visual appeal of the social media content; for instance, the layout of content, color and size of words, and graphics [17]. A first impression is made after a brief glimpse of the format and structure of content, and a user will quickly decide whether to stay on it or leave [56]. For example, ECHO uses art-based approaches, such as animations and e-books, to disseminate child health evidence on social media [43]. As many social media platforms impose restrictions on the design and presentation of messages, flexibility with visual appeal is often limited. For example, Twitter only allows 140 characters and 4 pictures per tweet.

A readable message is easy to follow. The US National Institutes of Health recommend that the readability of content on websites be at the sixth- to eighth-grade level [44]. Readability also encompasses accessibility and understandability. Health information that is hard to read will be hard to understand and therefore remain inaccessible, particularly for people with low health literacy [52]. For example, the It Doesn't Have to Hurt initiative developed YouTube video storyboards and scripts in collaboration with a communication company, which was further verified by parents for its readability [10,26].

The messages must also be findable, meaning that they are easy to locate. Search boxes, navigation menus, and links are likely to improve the findability of health information on social media [62,63]. Both the Fudan JBI Initiative [7] and BUCM Cochrane Initiative used the

navigation function in WeChat to organize and categorize the evidence sources, which allowed users to easily locate the specific evidence item they wanted.

A credible message refers to the trustworthiness of the message and is described as accurate, believable, and factual [59,63,80]. The Journal of the American Medical Association considers four elements to judge the credibility of medical information on the internet: currency of information; declaration of authorship; presentation of a list of references; and the disclosure of any conflicts of interest, funding, or sponsorship [60].

Finally, the usability of a message is the extent to which it can be actionable in practice. For the purpose of affecting research use, clear behavioral recommendations or prescriptions within the message can promote its usability [44]. Together, the six attributes of relevance, aesthetics, readability, findability, credibility, and usability influence the use of a social media message in practice.

3.4.3.3 Delivery Strategies

Delivery strategies are the ways through which social media messages are conveyed to recipients. We conceptualize them as comprising three distinct layers: the social media platforms, modes of delivery, and specific parameters. One of the first decisions that developers need to make is which social media platform to use. Although social media platforms have burgeoned in recent years, only a few are popular for disseminating health care information, such as Facebook, YouTube, and Twitter in Western countries and WeChat and Weibo in Asia. Messages are delivered on social media platforms through different modes of delivery, such as text, infographics, videos, audios, animations, vignettes, testimonials,

and stories [17]. The modes of delivery differ in their impact on users'engagement with the messages, and research has found that visual abstracts attract a significantly greater number of engagements than basic texts [82,83]. Webb et al [13] conducted a systematic review in which they classified the modes of delivery of internet-based behavior change interventions into three types: automated functions (eg, automated tailored feedback), communicative functions (eg, access to an adviser to request advice), and the use of supplementary modes (eg, SMS text message). It should be noted that the options for the mode of delivery vary for different social media platforms. The specific parameters of the delivery strategy are the characteristics of the mode of delivery, such as the length of videos, size, color and limits of words, frequency, and interval of message uploading. In the 5 initiatives we reviewed, all used a variety of social media platforms such as WeChat, YouTube, and Twitter. In addition, they used diversified modes of delivery, such as videos, podcasts, animations, stories, and texts, to deliver their social media messages.

Overall, the attributes of messages and delivery strategies affect the reach and successful use of messages by people and are a key construct in the SMILE framework. The 6 attributes of messages and the 3 layers of delivery strategies should be considered during the social media content development process to promote the likelihood of message use.

3.4.4 Recipients

Recipients are the target audience of social media messages and have the potential to direct, influence, or be affected by messages. In our framework, we consider health care providers, policy makers, and health care consumers as recipients. We also propose that using

social media messages in health care decision-making involves two distinct, interconnected layers: using the social media and then using the message. It is a prerequisite for recipients to first accept and use the social media before they can engage with the messages. We distinguish between these 2 layers and consider the factors that influence each layer separately. We contend that the characteristics of recipients and the virtual–technical context are the two main domains that influence people's use of social media, and the individual, organizational, and system contextual domains shape the message use.

Together with frameworks from the social media and technology research field [15,48,55,65], the i-PARIHS framework [29], behavior change model for internet interventions [17], COM-B model [30], and Fogg behavior model [31] have provided valuable insights into the characteristics of recipients that influence social media use. On the Basis of their theoretical constructs, four aspects of recipients' characteristics were incorporated into our framework: demographics, personal traits, motivation, and capability.

Demographics include age, gender, geography, socioeconomic status, ethnicity, and lifestyles [15,17,55]. Large quantities of research data from Twitter and Facebook revealed differences in social media use by gender, ethnicity, and geography [45,53]. Personal traits of openness, conscientiousness, extraversion, agreeableness, and neuroticism—rooted in genetics—are perceived as one of the fundamental theories that explain personal behavior [15]. They are closely associated with social media use [64]. In a national survey in the United States, Correa et al [46] found that although extraversion and openness were positively related to

social media use, emotional stability—a central measure of neuroticism—was a negative predictor. These findings differed by gender and age [46].

Motivation and capability are 2 summative characteristics of social media recipients that the SMILE framework identifies as affecting social media use. These characteristics are based on the Fogg behavior model [31] and the COM-B model [30]. Within motivation, perceived needs [65], attitude [50], intention [48,50,55], self-efficacy [17], and goals [55] are factors motivating individuals to use social media. Within capability [48,50], knowledge and skills [17,31] enable individuals to use social media. Together, all four characteristics of recipients (demographics, personal traits, motivation, and capability) are determinants affecting social media use in the SMILE framework.

3.4.5 Context

3.4.5.1 Overview

In the SMILE framework, context is defined as "a set of characteristics and circumstances that consist of active and unique factors that surround the implementation... (It) interacts, influences, modifies and facilitates or constrains the intervention and its implementation" [81]. We identify four interrelated layers of contextual factors that influence social media use and further message use: virtual–technical, individual, organizational, and system contexts.

3.4.5.2 Virtual–Technical Context

The virtual–technical context is the context surrounding the social media platform. Dawot and Ibrahim [69] summarized its composition into three core elements: individual-level, conversation-level, and community-level elements. Through a systematic review, Elaheebocus et al [70] created a taxonomy of social media features that included identity representation, communication, peer grouping, data sharing, competition, activity data viewing, and web-based social networks.

We posit that seven characteristics of the platform influence social media use: relative advantage, complexity, observability, compatibility, usefulness, interactivity, and playfulness [48,65,75,77]. Relative advantage, complexity, observability, and compatibility originate from the theory of innovation diffusion [32] and are all considered important factors influencing social media use [65]. Relative advantage is the degree to which one social media platform is perceived to be better than other alternatives. Complexity is the extent to which social media is perceived as being difficult to use. Observability is the degree to which the benefits of social media use are visible to others. Compatibility is the degree to which social media is perceived as consistent with the existing values, past experiences, and needs of potential users [65]. Each of these factors is positively associated with social media use, except for complexity [75]; the more complex the social media is perceived, the lower the level of engagement by users. Usefulness is the degree to which social media can directly or indirectly benefit individual performance. Data show that usefulness can predict up to 62% of the intention to use social media [48]. Interactivity is the degree to which social media enables 2-way communication rather than 1-way transmission or distribution of information. Multiple research studies have demonstrated the positive effects of interactivity on social media use [75,77]. Playfulness is the

hedonic value of social media and can influence the perceived usefulness and direct use of social media [48]. In the 5 social media initiatives included for developing the SMILE framework, all of them use popular platforms that contain these 7 characteristics, attesting to their importance. We posit that all 7 aspects of the platform in the virtual–technical context affect social media use.

3.4.5.3 Individual Context

The context of an individual plays a crucial role in shaping one's behavior of message use. Brouwer et al [67,68] found that being motivated to visit the web-based intervention, being curious about the content, and perceiving the web-based intervention as personally relevant were important influencers for participants to engage with the web-based intervention. In a qualitative and a cross-sectional study conducted by Hu et al [39,40] to understand the barriers of implementing the Be Sweet to Babies pediatric pain management strategies in China, they found that insufficient knowledge, beliefs, and self-efficacy of health care providers were common individual-level barriers hindering the implementation of social media messages in clinical practices by nurses.

3.4.5.4 Organizational Context

Organizational context is considered an indispensable layer of the context affecting one's use of a social media message in practice. In the Be Sweet to Babies initiative, the hierarchical managerial system, low authority of nurses, and staff shortage were factors impeding nurses from changing their practice and incorporating the evidence in China [40]. In the It Doesn't Have to Hurt initiative, researchers found that the cost for using topical

anesthetic cream [10] and the unit routines of disallowing parental presence during painful procedures [26] hindered the implementation of pain management strategies for children. The Fudan JBI Initiative also stated explicitly in every WeChat post that users should consider the local context to determine the appropriateness of implementing the evidence.

3.4.5.5 System Context

People's use of social media messages in health care practices is also influenced by the broader system context, namely the social, political, economic, and cultural environment. From a social perspective, one study found that popular opinion leaders on the internet played a positive role in changing sexual behaviors among men who have sex with men [71]. Some countries impose restrictions at the judicial level on accessing certain social media, which may be attributed to ideological, political, or economic reasons. Culturally, Hu et al [40] found that the negatively escalating relationships between patients and health care professionals in China made nurses reluctant to introduce the Be Sweet to Babies pain management strategies, despite a strong evidence base for the practices.

As illustrated above, we have made distinctions between the four types of contexts that influence social media and its message use in the SMILE framework. Specifically, the virtual–technical context concerns the determinants of social media use; the individual, organizational, and system contexts are considered as the micro-, meso-, and macro-level factors shaping message use.

3.4.6 Triggers

3.4.6.1 Overview

The concept of the trigger in the SMILE framework describes the strategies adopted to activate social media message use. On the basis of the i-PARIHS framework [29], for social media to be effective in facilitating research use, there needs to be an active ingredient to energize the message implementation process, in addition to having relevant messages. The trigger is derived from the Fogg behavioral model [31] and includes behavior change techniques (active triggers) or events (passive triggers) that activate a recipient to use social media messages. One behavior change technique, as an active trigger, is an“observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behavior” [73]. Michie et al [73] created a behavior change technique taxonomy to standardize the reporting of the active content of behavior change interventions. These techniques have been widely adopted in social media interventions. Webb et al [13] found, in their systematic review, that internet interventions that incorporated more behavior change techniques had larger effects than interventions that incorporated fewer techniques. In a systematic review of the characteristics of internet-delivered healthy lifestyle promotion interventions, Brouwer et al [66] reported that feedback, interactive elements, and email or phone contact were the most commonly used techniques. In a recent systematic review in 2020, Simeon et al [74] conducted a detailed analysis of the behavior change techniques used in social media interventions. They found that 46 techniques had been used in the identified 71 studies. An event, as a passive trigger, is an emergent, unexpected, or accidental incident that pushes recipients to use social media messages in a passive way. These events require people to think and act in alternative ways, and social media provides relevant information to perform

an alternative behavior. Fogg [31] classified triggers into three different types in persuasive technology design: sparks, facilitators, and signals. We adopted these 3 types of triggers and enriched their connotations in our framework, as discussed in the following sections.

3.4.6.2 Spark for Motivation

A spark is a trigger that motivates recipients to use a message. It can be used when recipients' motivation to use a social media message is low or needs to be further enhanced. Developers can apply various behavior change techniques such as problem solving, feedback and monitoring, and social support and reward [55,74] to help activate behavior change. For example, Modanloo [41] used motivational interviewing to improve parents' use of Be Sweet to Babies pain management strategies for infants during vaccination. Although no significant differences were found between the 2 comparative groups, approximately all participants used at least one strategy in the vaccination [41]. Through a Delphi study approach, Brouwer et al [67] identified that two behavior change techniques—the provision of tailored feedback on behavior and credible information source [73]—were related to an extended engagement with internet interventions. After implementing their social media initiative, Gates et al [79] suggested that web-based opinion leaders' endorsements would be a promising strategy for motivating recipients to use the messages.

3.4.6.3 Facilitator for Capability

A facilitator is a trigger that improves recipients' capability to use social media messages, such as knowledge and skills. Social media interventions that incorporate different behavior change techniques, such as instructions on behavior performance and demonstrating the

behavior [73], are likely to improve the capability of recipients. In the Clinical Excellence Through Social Media trial, Tunnecliff et al [76] linked every tendon management practice point on Twitter and Facebook to supplementary information to enhance the knowledge of recipients. Webb et al [13] found that the use of communicative functions within internet interventions to provide access to and schedule contacts with an adviser could have a small to medium effect on behavior. Developers made full use of the visualization function of a YouTube video in the Be Sweet to Babies initiative to demonstrate pain management techniques and help the recipients build skills [27]. Watching this video doubled the chance of using an analgesic strategy and increased breastfeeding 1.5 times and skin-to-skin care 4.6 times by parents in a nonrandomized pragmatic trial in Brazil [42].

3.4.6.4 Signal for Reminding

A signal indicates or reminds recipients of social media messages. This type of trigger is useful when recipients need external reminders to use messages or, in other cases, when events emerge, and the developers want to push recipients to use the messages, such as wearing masks during the COVID-19 pandemic. The signal can be an active prompt or cue in the form of an SMS text message delivered by developers [31,55]. Among the 71 included studies in the systematic review by Simeon et al [74], 10 studies reported the use of prompts or cues as a behavior change technique in self-directed social media programs. Webb et al [13] also found that SMS text messages were highly effective for behavior change in internet interventions when they provided cues to action. A signal, on the other hand, is an event that is emergent, accidental, or unexpected such as an adverse event that happened on a unit, a new health care

regulation or policy, or a global pandemic. These events remind people of the relevant resources on social media platforms that can help tackle the situation. Together, the SMILE framework proposes sparks, facilitators, and signals as triggers to activate recipients to use social media messages.

3.4.7 Outcomes

In the SMILE framework, we specify the knowledge translation outcome as research use, which is a multidimensional concept that involves conceptual, instrumental, and persuasive use of research findings [33,34]. Conceptual research use refers to using research evidence to change the levels of knowledge, understanding, or attitude of a recipient. Both the It Doesn't Have to Hurt initiative [10,26] and Be Sweet to Babies initiative [27,35-39] have demonstrated that when recipients receive relevant and appropriate messages on social media that respond to their needs and context, they are highly likely to improve conceptual research use. Instrumental research use involves the direct application of research evidence in practice to change behavior. Modanloo et al [41] and Tunnecliff et al [76] have shown, in their randomized controlled trials, that different types of triggers, such as sparks or facilitators, are essential for the active uptake of research evidence and behavior change by recipients. Persuasive research use refers to using research evidence as a political or persuasive tool to justify an action, attain power, or achieve goals [33,34]. One of the most typical examples is the #WearingMasks social media campaign during COVID-19, which has made a huge impact on public behavior and government policy making.

3.5 Discussion

3.5.1 Principal Findings

In this paper, we present the SMILE framework, which is based on a review of 5 social media initiatives, 5 theories, and 58 empirical studies. The framework provides a preliminary understanding of how social media works as a knowledge translation strategy for health care providers, policy makers, and patients to inform their health care decision-making.

The SMILE framework has implications for research by offering a heuristic device for the development of social media interventions to promote evidence use. We suggest that it be used in combination with process frameworks, which provide step-by-step guidance on implementing web-based knowledge translation interventions [86] or evaluation frameworks to evaluate the multilevel outcomes and impacts of social media interventions [54].

3.5.2 Implications for Social Media Strategy Development

On the basis of this framework, we offer several suggestions for researchers and organizations who intend to use social media to promote research use. First, in the preparation stage, it is important for developers to assess their readiness to start a social media initiative. Some probing questions may be considered during this stage, such as is there an explicit topic to be covered? Does the team have enough time, resources, and expertise to develop the intervention and monitor the operation?

Once the infrastructure has been built for the social media initiative, the team begins developing a message and delivery strategy. Developers should recognize target users' needs

and their context and, if possible, engage them in the development process. The six attributes of messages (ie, relevance, aesthetics, readability, findability, credibility, and usability) and three dimensions of delivery strategies (ie, social media platform, mode of delivery, and specific parameters) need to be taken into account when creating the social media interventions.

The team can then start the activation stage, where they make efforts to embed triggers into the social media delivery mechanisms for recipients to use the messages. Developers may interact with multilevel stakeholders and investigate the enablers of and barriers to recipients' use of the messages. By tailoring behavior change techniques to identified barriers and enablers, the development team can develop a social media strategy that has the greatest potential to affect message use in practice.

3.5.3 Acknowledgment of Complexity Within This Framework

We fully acknowledge the complexity of developing and implementing social media interventions and incorporate the notion of complexity within this framework in several ways. As information and communication sciences are fast-growing fields, new features and functions for social media platforms are continually emerging. Consequently, the approaches to developing messages and delivery strategies may become more diversified as technology advances. The dynamic interactions between constructs within the SMILE framework, such as the interaction between developers, recipients, and their situated contexts, make it challenging to undertake firm predictions [87,88]. Developers should immerse themselves in the human–social media system and capture underlining interactive patterns to inform the development of the most relevant and targeted activating techniques.

We also acknowledge the nonlinear aspect of the social media implementation processes, in which different levels of context influence and shape behavior. Promoting research use through social media is not a linear, straightforward process, and constant adaptations should be expected and embraced to optimize interventions. Finally, as each construct within this framework does not have a fixed and predetermined effect, and the interactions between constructs are dynamic and complex, we recognize that the framework has not been empirically validated and may not reveal all of the mechanisms at play for social media to influence research use. Nevertheless, the framework is based on current empirical evidence and well-recognized theories to provide plausible explanations for the successes and failures of social media interventions. Overall, the framework explicates the complexities of using social media in real-world practice and elucidates the key domains that developers, recipients, and researchers should attend to when developing or evaluating social media interventions.

As Maloney et al [72] suggested, “rather than looking at whether or not social media is effective for health professional education, it may be time to look at how various modalities can be optimized, both in terms of how the messages are delivered and how learners can be supported to engage.” Using social media to disseminate research evidence has become such an inexorable global trend that researchers should go beyond the investigation of the effectiveness of social media interventions and delve into the theoretical field on how to make it effective. The next stage of our project will be to test and refine the SMILE framework through a realist methodology that unpacks the mechanisms of how and under what

circumstances social media works as a knowledge translation strategy for health care professionals to improve the delivery of research-based care.

3.5.4 Limitations

The SMILE framework and its development process have 2 limitations. First, because of the multiple interactive components involved in developing and using social media for knowledge translation, as well as the massive amount of literature available from the relevant disciplinary fields, it was challenging to retrieve all pertinent theories and studies using a full systematic review approach. Instead, we used a targeted and flexible approach to select studies that allowed us to prioritize articles based on our framework's development needs. It is possible that we missed some research and embedded our own values into the propositions by using this approach; thus, our next step is to test and refine the framework. Second, as the use of social media for knowledge translation in real-world practice is still in its infancy, we could not locate studies that captured all the SMILE framework's propositions. More empirical studies of social media initiatives are needed to test the propositions of this framework.

3.6 Conclusions

In this paper, we propose the SMILE framework based on a review of social media initiatives, theories, and empirical studies as a preliminary understanding of how social media works as a knowledge translation strategy in health care decision-making. We provide a detailed description of each construct in the framework and offer suggestions for researchers and developers who intend to develop social media initiatives and interventions. For social media to be effective in enabling recipients to use research evidence in their practice decision-

making, the SMILE framework purports that developers respond to target recipients' needs and context to develop relevant social media messages and appropriate delivery strategies. Recipients'use of messages is influenced by the virtual–technical, individual, organizational, and system contexts and can be activated by three types of triggers: sparks, facilitators, and signals. The SMILE framework maps the factors that are hypothesized to influence recipients' social media message use and offers a heuristic device for social media developers and researchers to develop social media interventions. More empirical studies and social media initiatives are needed to test the propositions of the SMILE framework.

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Chapter 4: Understanding how and under what circumstances social media supports healthcare providers' knowledge use in clinical practice: a realist review

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In the previous chapter— theory gleaning phase of the thesis, I described in detail the process of how I developed the SMILE framework and the constructs and propositions of the SMILE framework. This framework, as a preliminary theoretical understanding of how social media supports healthcare practice and decision making, serves as the initial program theory for theory refinement in this chapter. In this chapter—theory refining phase of the thesis, I draw on the realist review method to gain a deeper theoretical understanding by synthesizing literature. The findings of the chapter will serve as the foundation of the theory consolidation phase described in the next chapter.

Abstract

Background: Although theoretical frameworks exist to guide social media interventions, few of them make it explicit how social media is supposed to work to improve the knowledge use by healthcare providers. This study aimed to synthesize literature to understand how and under what circumstances social media supports knowledge use by health care providers in clinical practice. Methods: We followed the realist review methodology described by Pawson et al. It involved six iterative steps: (1) develop an initial program theory; (2) search for evidence;

(3) select and appraise studies; (4) extract data; (5) synthesize data; and (6) draw conclusions. Results: Of the 7,175 citations retrieved, 32 documents were prioritized for synthesis. We identified two causal explanations of how social media could support health care providers' knowledge use, each underpinned by distinct context-mechanism- outcome (CMO) configurations. We defined these causal explanations as: (1) the rationality-driven approach that primarily uses open social media platforms (n =8 CMOs) such as Twitter, and (2) the relationality-driven approach that primarily uses closed social media platforms (n = 6 CMOs) such as an online community of practice. Key mechanisms of the rationality-driven approach included social media content developers' capabilities and capacities, in addition to recipients' access to, perceptions of, engagement with, and intentions to use the messages, and ability to function autonomously within their full scope of practice. However, the relationality-driven approach encompassed platform receptivity, a sense of common goals, belonging, trust and ownership, accessibility to expertise, and the fulfillment of needs as key mechanisms. Conclusion: Social media has the potential to support knowledge use by health care providers. Future research is necessary to refine the two causal explanations and investigate their potential synergistic effects on practice change.

Keywords: social media, knowledge translation, realist review, implementation science

4.1 Background

With its unique features of free access, widespread reach, and interactive communication, social media has become a popular means for translating knowledge. It has been widely used to disseminate research evidence in medicine,[1] nursing,[2] and specific areas of

health care such as pain management,[3] rehabilitation,[4] and child care.[5] For example, a social media initiative called ‘‘It Doesn’t Have to Hurt’’ developed a short YouTube video to share evidence-based strategies for reducing procedural pain in children. Five years after its launch, it had 237,132 views from 182 countries with both patients and health care professionals reporting strong acceptance and high intention to use the strategies.[3] Social media has shown great promise in disseminating research evidence to the general public.[6]

Despite the growing popularity to disseminate research evidence, little attention has been paid to understanding how social media works in influencing health care providers’ use of knowledge in clinical practice,[6] recognizing that multiple forms of knowledge exist, including (but not limited to) knowledge that has been generated from research data, organizational culture and context, and patient experiences and preferences.[7] Understanding the mechanisms of how social media works as a knowledge translation strategy is necessary to inform the development of social media interventions, thus promoting evidence-based practice and improving health care delivery.

In the literature on social media, Ngai et al[8] conducted a systematic review of 46 papers and classified 31 social media theories/models/frameworks into 3 theoretical categories: personal behavior, social behavior, and mass communication. Few of the included theories/models/frameworks, however, specifically linked social media with practice change or considered the impact of context, particularly the features of social media platforms in changing practice. A systematic review conducted by Arguel et al[9] uncovered the theories used in social media interventions for patients’ behavior change. Of the 15 studies included, 5 used

social cognitive theory, whereas others used the theory of planned behavior, technology acceptance model, and internet popular opinion leader model. Although these theories provide valuable insights into an individual's behavior change through social media, they tend to neglect contextual complexity. Little research has been done that examines the mechanisms of social media for knowledge translation with considerations to the unique features of social media and the multi-layered contexts surrounding its use.

In the science of knowledge translation, implementation theories informed by psychosocial perspectives provide insights into the factors that influence the processes and outcomes of implementing research evidence in practice, for example, the Behavior Change Wheel[10] or the Normalization Process Theory.[11] However, to our knowledge, little research has applied these theories to understand how social media influences evidence use in health care. Ritterband et al[12] developed the Behavior Change Model for Internet Interventions, which has guided the development and evaluation of social media interventions, for example, communicating harm reduction strategies for alcohol and drug use.[13] Nevertheless, Ritterband's model does not make the mechanisms of change explicit.

Given the knowledge gap about how social media interventions work to influence health care providers' knowledge use, this study aimed to synthesize literature to unpack the mechanisms by which social media supports health care providers' knowledge use in clinical practice and the contextual factors that trigger these mechanisms to operate.

4.2 Methods

We followed the realist review methodology described by Pawson et al[14,15] Realist review is designed to unpack the black box of complex social interventions or programs[16] to provide explanations of ‘‘what works for whom, in what circumstances, in what respects and how’’(p. S1:21), operationalized as context-mechanism-outcome (CMO) configurations.[14] Context is considered the backdrop of an intervention or program that has an impact on outcomes,[17] such as the pre-existing social, political, and organizational structures. Mechanisms are defined as the resources offered through an intervention or program and the ways people respond to them.[17–19] Mechanisms are hidden but real, are sensitive to variations in context, and generate outcomes. Outcomes are the intended or unintended and short-term or long-term effects of the context–mechanism interactions.[17]

A CMO configuration, which can be presented as a ‘‘C + M= O’’ equation, implies that outcomes are caused by invisible mechanisms that are sensitive to context.[20] For example, Aunger et al developed CMO configurations in their realist review to understand how inter-organizational collaboration works; one of the CMO was: high trust (context) + partnership synergy (mechanism) = collaborative performance (outcome). [21] A realist approach is useful in our study to uncover the mechanisms of how social media works to promote knowledge use, and the ways in which context affects the mechanisms and contingent outcomes. This review (not registered) involved six iterative steps, as described next.

Step 1: develop an initial program theory

Drawing on a review of 5 active social media initiatives, 5 theories, and 58 empirical studies, we developed an initial program theory for this review described as the Social Media for ImpLementing Evidence (SMILE) framework.[22] The general proposition of the framework is that for social media to be effective in enabling recipients to use research evidence in decision making, social media content developers (hereafter referred to as ''content developers'') must respond to target recipients' needs and context to develop messages and delivery strategies. Recipients' use of social media messages is influenced by the virtual–technical, individual, organizational, and system-level contexts, and it can be activated by three triggers: sparks for motivation, facilitators for capability, and signals for reminding.

Here, content developers ''are individuals, groups, and organizations responsible for the management of social media contents. Content developers activities may include designing and periodic uploading of information, monitoring operations, collecting data on impact, and answering questions or comments from viewers''(p 6).[22] Content developers can be knowledge purveyors (i.e., producing knowledge and sharing them via social media directly) or knowledge brokers (i.e., an intermediary between knowledge purveyors and end users by translating existing research evidence into user-friendly information and presenting them on social media).[22] A detailed description of this framework was published elsewhere.[22]

Step 2: search for evidence

The search was conducted using a combination of electronic databases, one existing scoping review, expert consultation, and reference tracking. We searched literature from seven English databases: CENTRAL, MEDLINE, EMBASE, CINAHL, PsycINFO, ERIC, Communication and

Mass Media, and two Chinese databases: CNKI and SINOMED to capture literature on social media within a variety of disciplines. In our search, we found 1 scoping review on the use of social media among health care professionals published in 2013 that had searched 11 databases from 2000 to 2012.[23] We included their search results of 96 papers in our screening and continued our search from 2012 to 2020 in the English databases. In the two Chinese databases, we searched from 2001 to 2020 as commonly used social media platforms were developed in 2001.[24] Our search strategies were developed with the assistance of a health science librarian. We also referred to published systematic reviews on social media to inform our search strategy (see Appendix 1 for the search strategy in MEDLINE).[24,25] All the electronic database searches ended in October 2020.

To complement database searches, we contacted content developers for suggestions on papers that might be useful for understanding health care providers' knowledge use through social media. Reference lists of papers that were used for synthesis (described below) were also hand searched for relevant studies.

Step 3: select and appraise studies

Table 4.1 described the eligibility criteria for this review. We (J.Z. and M.H.) pilot tested the eligibility criteria by screening 15 randomly selected papers. After a consensus was reached, we then independently screened titles and abstracts using Covidence (https://www.covidence.org/home). The full texts were then retrieved, reviewed, and screened to produce a provisional shortlist of documents. Disagreements were discussed and resolved by consensus or with a third member (W.G.).

We appraised the quality of included documents according to relevance and rigor.[14,15] In terms of relevance, documents were rated from 1 (little relevance) to 3 (high relevance) based on their relevance to the general propositions of the initial program theory (see Appendix 2 for the relevance rating criteria). To assess rigor, the Mixed Methods Appraisal Tool[26] was used to determine the methodological quality of documents (or their segments). No documents were excluded based on rigor scores, rather results were used to gain insights into the state of studies in this field.[27] Two reviewers (J.Z. and M.H.) independently assessed the quality of included documents with discrepancies resolved through discussion.

Table 4.1 The Inclusion and exclusion criteria for the realist review

	Inclusion criteria	**Exclusion criteria**
Relevance	The document has content describing any aspect of social media use, such as social media intervention development, outcome evaluation, and experience with social media use.	The document is irrelevant to social media use and social media is only mentioned without further detailed description.
Recipients of social media programs	Healthcare providers or trainees. In cases where it is not explicit as to the target recipients being healthcare providers, we will include those studies.	Patients, the public, and students in educational settings.
Types of social media	Must allow for interaction including two-way communication between the user and peers. • Blogs and microblogs that allow for multi-way interactions between users, eg, twitter, weibo; • Content communities, eg, YouTube, Youku, TikTok; • Mobile apps that allow for communication and interaction with a group of people; • Virtual social networks, eg, Facebook, WeChat; • Web pages that allow for multi-way interaction, eg, Wikipedia, Baidu Baike.	Only offers one-way communication. • E-health or telemedicine interventions that use technology to deliver healthcare; • Studies that assess mobile health (eg, apps that track clinical information with communication between an individual and their healthcare provider) and content that is transmitted unidirectionally (eg, text message reminder interventions in which the recipient is unable to reply); • Web-based interventions based on the exchange between a single care provider and an individual participant.

Purpose of social media use	The purpose of social media use described in the document includes delivering clinical research evidence or interventions	The purpose of social media use is to recruit participants, collect and analysis data or understand citation metrics.
Study designs	Any study designs	Conference proceedings, editorial, letters, news, and correspondence. Reviews on any aspect of social media messages in a certain field (eg, reviews on YouTube videos or Twitter content with a specific hashtag).
Language	No limitations on languages	-

Step 4: extract data

A data extraction form was created based on the initial program theory[22] and refined during the data extraction process. The form was used to obtain basic study characteristics such as the country, study design, social media initiative, tools, content developers, and recipients, and to capture information on the context, proposed/described mechanisms of action, and outcomes of each document. We conducted document appraisal, extraction, and synthesis in parallel[20] and we prioritized documents rated as highly relevant for synthesis. Data exaction was completed by J.Z. and checked for accuracy by M.H.

Step 5: synthesize data

To synthesize data, we referred to the categorizing and connecting strategies proposed by Maxwell[28,29] and conducted it in two phases: within-study analysis and cross-study analysis. For the within-study analysis: (1) J.Z. and W.G. developed a coding framework based on the constructs of the initial program theory[22]; (2) J.Z. read each document thoroughly, taking analytic notes to capture key information on contexts, mechanisms, or outcomes that were used to facilitate later synthesis work; (3) J.Z. coded data based on the coding framework and

grouped codes into themes; and (4) J.Z. formulated chains of inference using narrative summaries when the text indicated relationships between themes. The narrative summaries, at this stage, were close to the document texts with limited interpretations from the reviewer so that the team could accurately integrate chains of inference during the cross-study analysis.

During the cross-study analysis phase: (1) four reviewers (J.Z., S.M., J.H., and W.G.) familiarized themselves with the narrative summaries to identify recurrent patterns. Reviewers were all knowledge users (i.e., ‘‘an individual who is likely to be able to use research results to make informed decisions about health policies, programs, and/or practices’’[30]) with experiences of developing social media interventions or conducting social media research; (2) J.Z. proposed initial CMO configurations based on the recurrent patterns identified, and the reviewers met to discuss the CMOs; (3) J.Z. had several rounds of refinement of the CMOs based on feedback from the reviewers and the entire research team members (G.H., A.V. and W.G.); and (4) we refined the initial program theory diagram based on the CMOs.

A retroductive reasoning approach was used during the cross-study analysis to identify the hidden mechanisms.[31,32] The reviewers relied not only on the inductive logic from extracted data and deductive logic from the initial program theory, but also abduction reconceptualization based on personal insights, experiences, and prior knowledge, to propose generative mechanisms and the basic prerequisites for that mechanism to work.

We primarily used three strategies to assist the synthesis: juxtaposition, reconciliation, and adjudication.[33] When the context information from one paper helped to inform observed outcomes in another paper, we juxtaposed data sources and used evidence from one to clarify

the other. When contradictive findings were found between studies, we reconciled data sources to identify contextual and implementation differences that could explain opposing outcomes, or adjudicated between them based on their methodological strengths or weaknesses. We made decisions on the use of these strategies through discussion and consensus during the cross-study phases.

Step 6: draw conclusions

After synthesis, we invited six knowledge users to help finetune and provide comments on the CMOs. The knowledge users were either health care providers who used social media in practice or content developers from Canada or China. We provided them with two questions to facilitate reviewing the CMOs: (1) From your experience of using social media in practice or developing content, do these CMOs make sense? (2) How can the CMOs be optimized to make better sense? We integrated their feedback and finalized the CMOs through team discussions and updated the program theory diagrams to explain how social media can support health care providers' knowledge use in practice.

4.3 Results

4.3.1 Basic characteristics of synthesized documents

Of the 7,175 citations retrieved, 32 documents were prioritized for synthesis (Figure 4.1). Within them, 22 were classified as highly relevant documents,[4,34–54] 4 were reference papers,[55–58] and 6 were from the medium relevance category.[3,5,59–62] Table 4.2 presented the basic characteristics of the 32 documents.

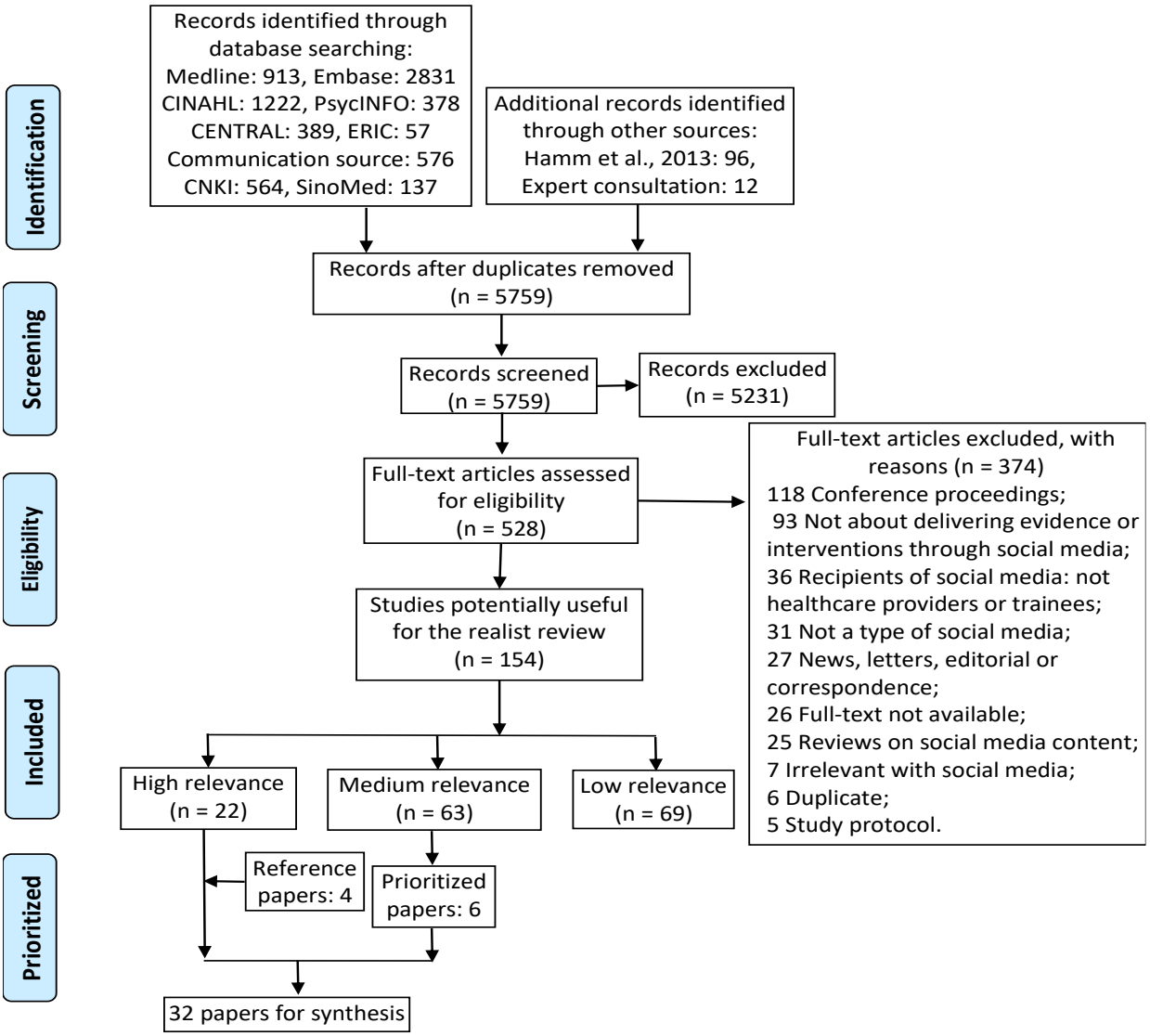

Figure 4.1 PRISMA diagram

Table 4.2 Basic characteristics of synthesized documents (n=32)

Study ID, country	Aim of study	Study conclusions	Study design	Discipline/ topic	Participants (No.)	Content developers	Initiative (Launch time)	Social media tool	Recipients
Highly relevant documents (n=22)									
Brooks 2004, UK	Report on a 2-year study that enabled midwives to use computer-mediated communication to create a forum for the collective discussion of	Through their use of the system, midwives successfully discussed and implemented changes in the delivery and organization of care	Case report	Midwifery	Midwives (- [a])	-	AEC (Assisted Electronic Communication) (-)	Digital discussion forum	Midwives

	midwifery practice								
Chambers 2021, Canada	Evaluate the use of virtual learning collaboratives to support long-term care homes in implementing a quality improvement program focused on reducing unnecessary urine culturing and antibiotic overprescribing	Rates of urine culturing and urinary antibiotic prescriptions declined among the participating long-term care homes. The results have refined a model to scale this program in long-term care	controlled before-and-after study	Urine culturing and antibiotic prescribing in long-term care	Long-term care homes (45)	Public Health Ontario	The Urinary Tract Infection Programme: a de-implementation program (2018)	Virtual learning collaboratives	All long-term care homes in Ontario
Frisch 2014, Canada	Report on factors necessary to attract and sustain HCPs use of a network designed to increase nurses' interest in and use of health services research and to support knowledge utilization activities.	Virtual professional networks can make a significant contribution to professional practice and to creating environments supportive of information sharing, mentoring, and learning.	Multi-method study	Nursing	Network members (survey 1: 125; survey 2: 210; Member Interviews: 23)	-	InspireNet (2009)	Interactive website, Twitter, Facebook, YouTube	Nurse clinicians, managers, educator, researchers, and students
Hirakawa 2018, Japan	Assess the acceptance and usefulness of an online end-of-life care educational program through popular social media designed to supplement traditional end-of-life care education among HCPs	Found evidence of the beneficial effect of the social media strategies on participants' knowledge and practice toward end-of-life care.	Pre-post study	End-of-life care	Nurse (20) Care manager/ worker (75) Others (12)	Department of Public Health and Health Systems, Nagoya University, funded by JSPS KAKENHI	NU-SPOCs (Nagoya University Small Private Online Courses) (2014)	Line	HCPs involved or interested in community-based end-of-life
Hughes 2009, UK	Examine Web 2.0 use by 35 junior physicians in clinical settings to further understand their impact on medical practice	Effective use derives from the mitigating actions by the individual physician	Qualitative descriptive study	-	Junior physicians (35)	-	-	Web 2.0 in general	-
Hurtubise 2016, Canada	Describe the roles of, and strategies used by, four knowledge brokers involved in a virtual COP to guide and inform future online knowledge broker interventions	Three roles: 1) context architect, 2) knowledge sharing promoter, and 3) linkage creator. Strategies reflected invitational, constructivism, and connectivism approaches	Qualitative descriptive study	Pediatric Physiotherapy	Physiotherapists functioned as knowledge brokers (4)	-	Physiotherapy management of children with motor coordination problems	Virtual COP	Physiotherapists in Québec Canada
Ikioda 2016, UK	Describe the use and evaluation of an Online COP to	A secure virtual environment allowed health visitors to	Realist evaluation	Delivery of Healthy Child	Health visitors (250)	-	Health Visitors COP	Virtual COP	Health visitors

	enhance and support practitioners to share issues, resolve recurring problems and collaborate to share best practices and robust evidence	discuss key issues arising from everyday practice as a coherent professional group, which in turn produced peer-reviewed knowledge that prioritized clients' needs		Programme			Evidence hub (2012)		
Lacasta Tintorer 2020, Spain	Find out the degree of loyalty among Online Communication Tool between Primary and Hospital Care (ECOPIH) users; evaluate the degree of fulfillment of users' expectations	The use of a COP by primary care and specialist care professionals helps to reduce the number of referrals among medical professionals	Survey + randomized trial	Communication between Primary and Hospital Care	Study 1: physicians (111) Study 2: physicians (178)	-	ECOPIH (2009)	Virtual COP	Primary care and specialist care professionals
Lei 2019, China	Explore the behaviour of new media use by doctors and patients and the impact on practice	Three ways to realize the influence of new media use behaviour on medical practice behaviour	Survey design	-	Doctors (603)	-	-	Social media in general	-
Lu 2020, Canada	Seek opinions from those respected for their academic social media work to generate a list of good practices and potential pitfalls about the usage of social media for education and/or knowledge translation	Key to building online engagement were the following: 1) Culture-building strategies; 2) Tailoring the message; 3) Responsiveness; and 4) Heeding rules of online engagement	Qualitative study	-	Educator, clinician, researcher, academic leader, implementation specialist, (17)	-	-	Twitter, Facebook, Slack, LinkedIn, WhatsApp, Instagram, Reddit, Snapchat	-
Maloney 2015, UK, Australia, US, India, Malaysia	Determine the efficacy of social media as an educational medium to effectively translate emerging research evidence into clinical practice	Social media may be an effective educational medium for improving knowledge of HCPs, fostering use of research evidence, and changing clinical behaviours	Mixed methods	Medicine, physiotherapy, podiatry and others	Clinicians (317)	Developed by tendon researchers with educational and clinical experts	Clinical Excellence Through Social Media (2014)	Twitter and Facebook	Public access. For the research: primary clinical affiliates and students.
Narayanaswami 2015, US	Develop a dissemination strategy by adding social media-based methods to traditional methods for a clinical practice guideline and evaluate whether the addition improves awareness and knowledge, and	Social media-based dissemination methods did not confer additional benefit over print-, email-, and Internet-based methods in increasing guideline awareness and changing intent in physicians or patients	Longitudinal observational Study	Complementary and alternative medicine use in multiple sclerosis management	Patients (348) and physicians (622)	-	Complementary and alternative medicine use in multiple sclerosis (2014)	Facebook, Twitter, LinkedIn, YouTube, audio podcast on Neurology	Patients and physicians

	affects implementation								
Oliffe 2015, Canada	Detail how findings from a study of prostate cancer support groups were repackaged in a knowledge translation website using Web 2.0 and five lessons from developing the website	The details are shared to guide the e-knowledge translation efforts by other psychosocial oncology researchers and clinicians	Case report	Prostate Cancer	-	The research team and website developers	Prostate Cancer Help Yourself (/)	Interactive website	Prostate cancer patients, family members, HCPs
Rolls 2016, / (Review)	Review literature on the use of social media by HCPs in developing virtual COPs that facilitate professional networking, knowledge sharing, and evidence-informed practice	HCPs use social media to develop virtual COPs to share domain knowledge. These virtual COPs reflect tribal behaviours of clinicians that may continue to limit knowledge sharing.	Integrative Review	31 of 36 were a virtual COP in a single healthcare discipline	-	-	-	Listservs, Twitter, Wiki, Facebook, discussion forums, Web 2.0, virtual COP	HCPs
Rolls 2019, Australia	Understand why members join a virtual COP and remain a member; identify what purpose the COP serves in their professional lives, how a member uses it and used the knowledge or resources shared on it	A closed specialty-specific virtual COP can create a broad heterogeneous professional network, overcoming current ineffective networks	Qualitative Study	Intensive care clinicians	members of the ICUConnect listserv (27)	New South Wales Health state–based unit (the Intensive Care Coordination and Monitoring Unit)	ICUConnect (an Intensive Care Virtual COP) (2003)	Listserv	Intensive care clinicians
Swords 2020, UK &USA	Report experience with a global multidisciplinary tracheostomy virtual learning	Virtual learning is feasible for disseminating best practices, engaging a diverse audience. Learning complex technical skills need hands-on experience for technical mastery	Controlled before-after study	multidisciplinary tracheostomy	Nurses, pathologists, therapists, others (pre: 225, post: 103)	The Global Tracheostomy Collaborative	Virtual learning COP for tracheostomy care (2020)	GoToWebinar, message boards, and email	Otolaryngologists, speech pathologists, respiratory therapists, specialist nurses, patients, caregivers
Tunnecliff 2015, Australia, India, Malaysia	Explore health researchers' and clinicians' current use of social media and their beliefs and attitudes towards the use of social media in professional contexts.	Training in the use of social media for professional development and methods to improve trustworthiness of information may enhance the utility of social media for	Mixed methods	-	HCPs and researchers (856 for questionnaire, 69 for interviews)	-	-	Social media in general	-

		communicating research evidence							
Tunnecliff 2017, Australia, India, Malaysia, US, UK etc.	Compare the change in knowledge of HCPs and their intended practice following exposure to research information delivered by either Twitter or Facebook	Research information delivered by either Twitter or Facebook can improve clinician knowledge and promote behaviour change. No differences in these outcomes were observed.	Randomized controlled trial	Tendon management	Clinicians (494)	Educational, clinical, research experts	Clinical Excellence Through Social Media (2014)	Twitter and Facebook	Public access. For this study: clinicians
Unnikrishnan 2018, India	Find out the pattern of use of social media among HCPs and perception, facilitators, and barriers to using social media, to translate evidence into clinical practice	It enables evidence spread, poses a threat to privacy, cannot replace face-to-face interaction. Perceived barriers were privacy concern, unprofessional behaviour, lack of reliability, and information overload.	Cross-sectional study	-	HCPs (183)	-	-	YouTube, WhatsApp, Facebook, LinkedIn, Blogs, Instagram, etc.	-
Vinson 2014, US	Examine issues that key stakeholders believed should be addressed to create and sustain government-sponsored virtual COPs to integrate cancer control research, practice, and policy.	Virtual COPs can address the needs of researchers, HCPs, and intermediaries by using input from these key stakeholders. Increasing linkages between them can improve knowledge translation	Concept mapping	Cancer	Members of the Cancer Control P.L.A.N.E.T website listserv (n=1500) were invited	Government-sponsored	Cancer Control P.L.A.N.E.T. website listserv	Virtual COP	-
Wales 2012, UK	Report Scotland's online knowledge service for health and social care---The Knowledge Network	It supports key components of the knowledge-to-action cycle – acquiring, creating, sharing, and disseminating knowledge to improve performance and innovate	Case report	Health and social care	-	National Health Service Education for Scotland	The Knowledge Network (2012)	Interactive website	HCPs and social care professionals
Wales 2015, UK	Report The Knowledge Network experience on translating knowledge into action.	It is contributing to quality and safety outcomes across NHS Scotland, building clinicians' capacity and capability in applying knowledge in frontline practice and service improvement	Case report	Health and social care	-	National Health Service Education for Scotland	The Knowledge Network (2012)	Interactive website	HCPs and social care professionals
Reference documents (n=4)									
Barnett 2012, / (Review)	Examine current evidence relevant to virtual COP in General Practice	Facilitation, champion & support, objectives & goals, a broad church, supportive	review	General practice	-	-	-	Virtual COP	HCPs

	training, identify evidence-based principles that might guide their construction	environment, measurement benchmarking & feedback, technology & community are key themes for COP construction							
Green 2002, US	Develop a psychometric instrument that classified physicians' response styles to new information	Physicians can be classified as seekers, receptives, traditionalists, or pragmatists	Cross-sectional study	Primary care	Primary care physicians (1393)	-	-	-	-
Scott 2013, / (Review)	Review key issues on sports and exercise-related tendinopathies, and to integrate them into a shared conceptual framework.	The current literature dedicated to the facilitation of evidence-informed clinical practice	Narrative review	Sports and exercise-related tendinopathies	-	-	-	-	-
Young 2013, Canada	Describe the community management strategies, resources, and expertise needed to build and maintain a thriving online health community	There are different effective community building practices that can ensure the survival and steady growth of an online health community	Case study	Health in general	-	-	-	Virtual COP	-
Prioritized medium relevant documents (n=6)									
Archambault 2012, Canada	Identify and compare the beliefs of emergency physicians and allied health professionals about using a wiki-based reminder that promotes evidence-based care for traumatic brain injuries	The most frequently reported advantage of using a wiki-based reminder was that it refreshes the memory and rapid access to protocols	Qualitative study	Trauma Care	emergency physicians (25) and allied health professionals (25)	-	-	Wiki	Emergency physicians and allied health professionals
Archambault 2016, Canada	Describe the use of a wiki to create structured order sets for a single emergency department; evaluate intention to use; and the impact on the behavioural determinants	Emergency physicians' intention and attitude to use wiki-based order sets increased after having access to and being motivated to use a wiki for 6 months	Pre/post intervention study	Emergency care	emergency physicians (28)	Emergency department at Hôtel-Dieu de Lévis together with Université Laval research team.	Urgence HDL Informatisation	Wiki	Emergency physicians
Chambers 2020, Canada	Develop, implement, and evaluate the implementation	This parent-directed YouTube video was an acceptable and	Quantitative descripti	Needle pain managem	Parents (n=163) and HCPs	Research team in Dalhousie	*It Doesn't Have To Hurt*	YouTube	Parents and HCPs

	effectiveness of a parent-directed YouTube video on evidence-based strategies to manage needle pain in children	appropriate way to disseminate evidence about the procedure of pain management to a large number of parents	ve evaluation	ent in children	(n=278)	University			
Dyson 2017, Canada, Portugal	Implement and evaluate a structured social media strategy to disseminate Cochrane Child Health evidence to healthcare providers caring for children	Engagement with blog and Twitter account increased steadily over time and was geographically diverse. However, our approach was resource intensive and required the involvement of several content experts	Quantitative descriptive evaluation	Child Health	-	Cochrane Child Health team	-	Blog and Twitter	Online HCPs and health consumers
Gates 2018, Canada	Evaluate the uptake of *TRanslating Emergency Knowledge for Kids (TREKK)* Bottom Line Recommendations and Cochrane systematic reviews.	There was increased traffic to *TREKK* knowledge products and Cochrane reviews during the social media promotion. Blogging and tweeting are dissemination strategies for evidence-based knowledge products	Quantitative descriptive evaluation	Paediatric emergency	-	TREKK and Cochrane Child Health	*TREKK*	Blog and Twitter	online HCPs and health consumers
Harrison 2016, Canada	Evaluate the reach and impact of a consumer-targeted YouTube video demonstrating use of effective pain reduction strategies during infant vaccinations	Using YouTube videos for knowledge dissemination has an extensive reach, however, it is difficult to evaluate the impact on behaviours and practices	Quantitative descriptive evaluation	Effective Vaccination Pain Treatment for Babies	-	Children's Hospital of Eastern Ontario CHEO, and University of Ottawa	*Be Sweet to Babies*	YouTube	online HCPs and parents

a—: Data not available

4.3.2 Refined program theory

Based on the synthesis of the 32 documents, we identified 2 causal explanations of how social media can support healthcare providers' knowledge use underpinned by 14 CMO configurations: (1) the rationality-driven approach that primarily uses open social media platforms (8 CMOs); and (2) the relationality-driven approach that primarily uses closed social media platforms (6 CMOs) (Table 4.3). We defined open social media platforms as Web 2.0-

based applications that are accessible to everyone after successful registration and allow the creation and exchange of user-generated content, such as Twitter or WeChat; and defined closed social media platforms as online groups or communities where the group organizers develop parameters of eligibility to determine which applicants are allowed to join in, such as a Facebook private group or an online community of practice. We elaborated the two approaches in detail next.

Table 4.3 The CMO configurations developed in the realist review

CMO	Context	Mechanism	Outcome	Quotes
How do open social media platforms support knowledge use by healthcare providers?				
Outcome 1: social media products				
CMO-1: Content developers invest in social media initiatives	Content developers undertake training or gain guidance on the use of social media in healthcare, invest resources, and build a multidisciplinary collaborative team for social media initiatives	Content developers increase the capabilities and capacities to develop and maintain social media products	Relevant social media products will be developed and promoted for target populations	*"…it cost Can $10,000 to professionally develop and produce this video and an additional Can $5000 to promote the video. It took considerable effort on the part of the team to promote the video"* [3] *"Before the production of the video, a storyboard and a script were developed in collaboration with a communication company based on the synthesis of existing evidence-based information that was verified by the research team, partners, and parents"* [3]
Outcome 2: Reach				
CMO-2: Healthcare organizations support social media use	Healthcare organizations support the use of social media as a valid source of evidence	Healthcare providers feel more comfortable and confident accessing health information from social media	Healthcare providers actively access information from social media to inform practice, and improve attitude towards social media use for professional purposes	*"To address clinical practice variation, healthcare organizations can leverage low-cost social media technologies to improve interprofessional and interorganizational* networks." [48]
Outcome 3: Engagement				
CMO-3: Development and delivery of messages	Content developers involve target users to develop concise social media messages and deliver them using multimodal integrated approaches through accredited bodies and/or social media influencers	Healthcare providers are receptive to messages and perceive the messages as relevant and trustworthy	Healthcare providers engage with social media messages	"*Our data indicates that brief messages, when obtained from a reputable source and linked to full sources of information may be acceptable to clinicians*" [4] *"Social influence is a powerful change inhibitor or facilitator and the opinions of peers and leaders play a major part in influencing individual practitioners' behavior, especially with regards to acting on new information"* [50]
CMO-4: Content developers	Social media messages are tailored to address healthcare	Healthcare providers perceive social media messages as	Healthcare providers engage with the social	*"In terms of the purposes for which Physicians used Web 2.0, two types of information need were articulated. Firstly, to solve an immediate defined problem and secondly, for*

tailor social media messages	providers' information needs	responsive and useful	media messages	*background reading on a subject. The former, articulated by 55% (19/35) of the sample, is to advance an immediate task in the clinical context and forms a closed question with a specific answer. The latter, noted by 58% (20/35) of physicians, is an open question such as the need for more in depth knowledge on a subject, or to find information for patients."* [38]
Outcome 4: Knowledge use				
CMO-5: Content developers use triggers to promote message use	Content developers embed different behaviour change techniques into the social media messages	Healthcare providers engage with the messages	Healthcare providers conceptually and/or instrumentally use social media messages in practice	*"Social media promotes online social interactions, which may enhance learning and promote change through social influence"* [4]
CMO5-1: Content developers promote interaction	Content developers interact with and promote interactions among healthcare providers regarding the messages, and if possible, offer targeted feedback	Healthcare providers experience social support on message use		*"Social media promotes online social interactions, which may enhance learning and promote change through social influence"* [4]
CMO5-2: Content developers include behaviour prescription and behaviour demonstration	Content developers include behaviour prescription and, in some cases, behaviour demonstration in the messages	Healthcare providers have increased implementation capabilities		*"Any evidence that requires skill development can be disseminated by videos in YouTube as it provides direct visualization of process"* [51] *"know what (actionable knowledge)" + "know how"* [53, 54]
CMO5-3: Content developers use reminders in their social media initiative	Content developers use reminders or other reinforcement strategies in their social media initiative	Healthcare providers have increased awareness of and attention to the messages	Healthcare providers sustain engagement with and conceptually and/or instrumentally use social media messages in practice	*"Among EPs, the most frequently reported advantage of using a wiki-based reminder was that it refreshes the memory (n = 14)"* [60] *"…monitoring progress with practice changes and delivering reminders"* [35]
CMO-6: Healthcare providers' evidence-seeking behaviour	Healthcare providers actively seek for research evidence to inform clinical practice	Healthcare providers value the role of research evidence in clinical practice and have the intrinsic motivation to find and use research evidence on social media	Healthcare providers use the research evidence on social media conceptually and/or instrumentally	*"…physicians' response styles to new information as seekers, receptives, traditionalists, or pragmatists. This classification was based on specific combinations of 3 scales: (a) belief in evidence vs experience as the basis of knowledge, (b) willingness to diverge from common or previous practice, and (c) sensitivity to pragmatic concerns of practice. …Seekers consider systematically gathered, published data (rather than personal experience or authority) the most reliable source of knowledge..."* [56]
CMO-7: Healthcare providers keep vigilant about social media messages	Healthcare providers keep vigilant about social media messages by using professional judgment and crosschecking	Healthcare providers become more confident about the credibility of messages	Healthcare providers use the social media messages judiciously	*"Despite awareness of information credibility risks with Web 2.0 content, it has a role in information seeking for both clinical decisions and medical education. This is enabled by the ability to cross check information and the diverse needs for background and non-verified information...physicians in our study believe that the benefits exceed the risks, and that certain techniques exist*

	techniques			*to mitigate these risks"* [38]
CMO-8: Healthcare organizations promote professional autonomy to staff	The professional autonomy of staff is maximized in healthcare organizations	Healthcare providers are able to practice to their full scope	Healthcare providers decide to use or not to use social media messages	Rationale: While social media can impact individual behaviour, it may be very challenging for social media to have an impact on one organization. We see from several included studies that practice change often comes from these healthcare professionals who have high professional autonomy in general, such as physicians, or the practice change is often within their professional autonomy: tendon management [4, 44] : 317 clinicians (physiotherapists, physicians, osteopathist, and podiatrist)
How do closed social media platforms support knowledge use by healthcare providers?				
Outcome 1: Functionality				
CMO-1: Preparing technical support	There is technical support to make the closed platform accessible, compatible, and easy-to-use	Group members are receptive to the platform	The group activities operate easily and efficiently	*"To use social media, clinicians required a positive attitude that the media was easy to use (usability), they were able to have a practice run to see how it worked (trialability), the platform worked better than current solutions (relative advantage), and the technology was accessible in the workplace and fitted in with current work practices."* [47]
CMO-2: Defining the domain of interest	The closed platform clearly defines its domain, purposes, and values	Group members share a common goal	Group members contribute to its growth	*"Clear objectives provide members with responsibilities and motivate them to contribute more actively"* [55]
Outcome 2: Engagement				
CMO-3: Preparing different roles in the online group	CMO3-1: There are online facilitators who actively engage in group activities and facilitate networks and knowledge exchange	Group members strengthen their bonds, gain access to resources and expertise, and experience social influence to engage in group activities	A supportive learning online environment may be built, and the group may grow and flourish with increased member engagement	*"…with proper facilitation and well managed knowledge brokering activities, online CoPs can become a mechanism that can equip health visitors with peer reviewed knowledge that prioritises clients' needs in relation to local community needs"* [40]
	CMO3-2: The closed platform involves disciplinary experts and/or interdisciplinary professionals	Group members gain access to expertise and knowledge and improve motivation to learn, network, and collaborate	Group members engage in group activities and conceptually and/or instrumentally use the knowledge learned in the group	*"The ability to partner and learn from other researchers and having the opportunity to develop partnerships with healthcare practitioners and intermediaries may be key to engaging researchers in a virtual community"* [52]
	CMO3-3: Group organizers regularly assess the needs of members and base the group activities on the identified needs; track group performance and optimize its operation accordingly	Group members have expectations fulfilled and gain continuous support from the group	Group members sustain engagement in group activities	*"Understanding a community's life cycle stage by monitoring its growth and activity (ie, posts, chats, events, and private messages) will help community managers decide when to adjust their community tactics …A community's life cycle is not linear and managing its growth, activity, and design is an iterative process that must adapt to the needs of the members and the community's purpose."* [58]
CMO-4: Nurturing a supportive learning	A supportive learning online environment is built	Group members feel a sense of belonging, trust, and ownership	Group members actively engage in group activities, share knowledge	*"…the contributions reveal a process of voicing experiences of day-to-day problems and options being discussed both supportively and openly… The system not only functioned to increase midwives' ability to communicate with each*

online culture			and expertise, and exchange on professional issues	*other, but also the discursive nature of the contributions served to enhance midwives' sense of belonging to a professional community"* [34]
Outcome 3: Knowledge use				
CMO-5: Facilitating everyday interaction	Group members have everyday interaction in a supportive learning online environment	Group members build collective knowledge relating to needs or interests	Group members conceptually and/or instrumentally use the knowledge in practice	*"The advantage of a secure virtual environment allowed health visitors to discuss key issues arising from everyday practice as a coherent professional group, which in turn produced peer reviewed knowledge that prioritised clients' needs in relation to local community needs"* [40]
CMO-6: Providing training and tailored support on knowledge translation	In a closed platform that has an explicit focus on knowledge translation, group organizers arrange interactive training sessions and provide tailored support to members based on needs assessment	Group members improve capabilities and build readiness for knowledge translation	Group members conceptually and/or instrumentally use knowledge through knowledge translation projects	*"A sensitivity analysis showed that those attending all scheduled sessions did not necessarily have better outcomes. This further supports the idea that different LTCHs may require tailored support, dependent on their needs"* [35]

4.3.2.1 The rationality-driven approach.

We classified 16 studies as using open social media platforms[3–5,38,42–45,50,51,56,57,59–62] and developed 8 CMOs for the rationality-driven approach. We also used data from six studies belonging to closed social media platforms [35,46,48,52–54] as supplementary supporting evidence since their findings were also applicable to open platforms. We grouped the CMOs into four distinct outcomes identified in the program theory: relevant products—content developers create social media products relevant to target populations (CMO1); reach—social media products reach the target populations (CMO2); engagement—target populations engage with the messages on social media by reading, commenting on, and sharing the messages (CMO3–4); knowledge use—using social media to change levels of knowledge, understanding, attitude (i.e., conceptual knowledge use), or the direct application of the knowledge in practice (i.e., instrumental knowledge use)[7] (CMO5–8). The following was a summary of each CMO with the supporting evidence.

CMO1: When content developers receive training or guidance on social media use in health care, invest resources, and build a multidisciplinary collaborative team for social media initiatives (C), they are likely to increase capabilities and capacities (M) to develop, maintain, and promote social media products that are relevant to target populations (O).

Nine studies supported the theoretical statement in CMO1.[3,4,43,44,46,50,51,61,62] Tunnecliff et al[50] found in their multinational study that 53.3% of participants felt a need for training on using social media for professional development. Appropriate guidelines on the guarded and judicious use of social media were essential to tackle issues of privacy, copyright, and unethical behavior.[51] Three social media initiatives, focusing on pain management for children,[3] child health,[61] and prostate cancer support,[46] illustrated time, budget, and human resources investments in maintaining the initiatives. Social media initiatives, such as the ‘‘Be Sweet to Babies’’[62] and the ‘‘It Doesn’t Have To Hurt’’,[3] reported filming videos with the assistance of hospital audiovisual team and developed the storyboard and script in collaboration with a communication company. All these studies highlighted the importance of improving content developers’ capabilities and capacities to develop and maintain social media products through training, investments, and teamwork.

CMO2: When health care organizations support the use of social media as a valid source of evidence (C), health care providers are likely to feel more comfortable and confident (M) in accessing information from social media, and will develop an improved attitude toward using social media for professional purposes (O).

Six studies contributed to the theoretical statement in CMO2.[4,38,44,48,50,52] Tunnecliff et al[50] found in their mixed methods study that there were stereotypes attached to using social media for professional purposes, for example, participants felt that information obtained via social media was less valid than that from peer-reviewed journals. Such stereotypes could be countered by support from health care organizations that offered guidance on the wise use of information on social media and provided resources to facilitate its use, such as Internet access.[38] Rolls et al[48] also suggested that health care organizations could leverage social media technology to improve networks and access to new information. Health care providers were shown to have an improved attitude toward social media for professional development when they were exposed to relevant and well-developed social media products.[4,44]

CMO3: When content developers involve target health care providers to develop concise social media messages and deliver them using multimodal integrated approaches through accredited bodies and/or social media influencers (C), health care providers are likely to be more receptive to the messages and perceive them as relevant and trustworthy (M), and as a result, engage with the messages (O).

Ten studies explicitly described the message development and delivery approaches that supported the theoretical statement in CMO3.[3–5,43,46,50,51,53,54,62] In a qualitative study with social media experts, Lu et al[43] found that all participants underscored the importance of being knowledgeable about end users, understanding the strengths of different platforms, and using a multimodal integrated approach for dissemination. Tunnecliff et al[4] found in a randomized controlled trial that brief messages when obtained from a credible source and linked to full

sources of information were acceptable to clinicians. However, there appeared to be a need for content developers to establish a balance between information brevity and information overload: if too brief, it might run the risk of misinformation; if too abundant, audiences might lose interest or get lost in the details.[50] Dissemination through accredited bodies and/or social media influencers was highlighted by researchers.[50] For example, Harrison et al[62] described the use of popular parent bloggers and professional organization mailing lists to facilitate the dissemination of the ‘‘Be Sweet to Babies’’ video.

CMO4: When social media messages are tailored to address health care providers' information needs (C), health care providers are likely to perceive the messages as responsive and useful (M), and as a result, engage with the messages (O).

Three studies indirectly contributed to this theoretical statement,[38,43,44] meaning that this theoretical statement was not directly stated in the synthesized papers, but in keeping with the realist methodology, was an emergent finding based on abductive reasoning from team discussions of the literature. Hughes et al[38] identified in their qualitative study that physicians used Web 2.0 tools primarily for two types of information: closed question—to find answers to an immediate clinical question, and open question—to advance professional knowledge on a specific subject. When content developers tailored the social media message structures, formats and contents based on health care providers' information needs[43] and platform requirements, health care providers would perceive the information as useful to increase knowledge or inform clinical decision making,[44] thus engaging with the messages by reading, sharing, or commenting on them.

CMO5: When content developers embed different triggers (i.e., behavior change techniques) in the social media messages (C), health care providers are likely to engage with the messages (M), and as a result, use the messages in practice conceptually and/or instrumentally (O).

Twelve studies substantiated this theoretical statement. [4,35,42,43,50,51,53,54,57,59,60,62] CMO5 included three sub-CMOs.

CMO5-1: When content developers interact with and promote interactions among health care providers regarding the messages, and if possible, offer targeted feedback (C), health care providers are likely to experience social support (M) to use social media messages (O).[4,42,43,50,54]

Lei[42] used structural equation modeling to investigate the relationship between health care providers' new media use and clinical behavior. He found that social support played a mediating role in using social media for practice change. Other studies also highlighted the ''social influence,''[4,50] ''being responsive to others,''[43] and ''human dynamics of communication'' [54] as powerful catalysts to promote practice change.

CMO5-2: When content developers include behavior prescription and, in some cases, behavior demonstration in the messages (C), health care providers are likely to have increased capabilities (M) for message use (O).[51,53,54,57,62]

Wales et al[53,54] reported in their case study of Scotland's Knowledge Network that the network provided not only ''know-what'' knowledge—knowledge about the effectiveness of interventions, but also, the ''know-how'' knowledge— knowledge about how to implement.

They described the development of actionable knowledge to support clinical quality improvement. It was suggested that behavior demonstration through videos could highly improve practice skills, because they offered direct visualization of the process. [51] The ‘‘Be Sweet to Babies’’ YouTube video was one example.[62]

CMO5-3: When content developers use reminders or other reinforcement strategies in their social media initiative (C), health care providers are likely to have increased awareness of and attention to the messages (M), and as a result, sustain engagement with and use of the messages (O).[4,35,59,60,62]

Archambault et al[59,60] implemented wiki-based reminders to promote best practices in the emergency department, which was considered helpful to refresh memory. Chambers et al[35] used reminders as one component of complex interventions in virtual learning collaboratives to promote the deimplementation of urine culturing and antibiotic prescribing, which decreased the culturing and prescription rates significantly over 4 months.

CMO6: When health care providers actively seek for research evidence to inform clinical practice (C), they are likely to value its role and have the intrinsic motivation (M) to find and use the research evidence from social media conceptually and/or instrumentally (O).

This theoretical statement was substantiated by three studies.[44,56,57] Green et al[56] classified health care providers’ responses to new information as seekers, receptives, traditionalists, or pragmatists based on their beliefs in evidence versus experience as the basis of knowledge, intention to diverge from common or previous practice, and sensitivity to pragmatic concerns. It was believed that when health care providers actively sought evidence

to inform practice, they would have the intrinsic motivation to find and use evidence from social media.[56] However, seekers make up the smallest percentage of clinicians[57]; the majority of clinicians are pragmatists who evaluate calls to change by weighing the anticipated impact on time, workload, and patient flow rather than the scientific validity of evidence. Scott et al[57] suggested that packaging evidence into actionable resources or toolkits was likely to facilitate practice change for pragmatists.

CMO7: When health care providers keep vigilant about social media messages by using professional judgment and crosschecking techniques (C), they are likely to become more confident about the credibility of messages (M), and as a result, may use the messages judiciously (O).

Four studies supported the theoretical statement in CMO7.[5,38,43,44] Hughes et al[38] revealed that although there were serious concerns about the poor-quality information spreading on social media, junior physicians turned to social media for health care information because of its accessibility, ease of use, and immediacy. They employed different crosschecking techniques to mitigate the risks of using noncredible information.[38,43] Gates et al[5] suggested that individuals could use various cognitive heuristics to rapidly appraise the credibility of online sources, such as the reputation heuristic and endorsement heuristic, but these indicators were not always reliable.

CMO8: When the professional autonomy of staff is lifted in health care organizations (C), health care providers will be able to function at their full scope of practice (M), and as a result, decide to use or not to use social media messages in their practice (O).

Four studies contributed to the theoretical statement in CMO8 indirectly.[4,38,42,44] From the included studies, we identified that health care providers with high professional autonomy in general, such as physicians, were more likely to report the use of research evidence from social media,[38,42] and the recommended practice on social media was within their full scope of practice with little constraints from organizations. [4,44] For example, physicians may adjust the dosage and usage of a specific drug, lab test items, or a specific surgical procedure based on guidelines disseminated on social media. In these cases, physicians have control over their professional practices and can implement these practices based on their own judgments. Therefore, we propose that when health care providers can self-direct their professional work, they will have the capacity to decide whether or not to use evidence from social media that are within their scope of practice. This may require explicit policies and regulations from organizations on professional autonomy.

4.3.2.2 The relationality-driven approach.

We classified 16 studies[34–37,39–41,46–49,52–55,58] as using closed social media platforms and developed 6 CMOs for the relationality-driven approach based on the 16 studies, with 2 studies[43,44] from open platforms as supplementary supporting evidence. The six CMOs were grouped into three distinct outcomes: (1) functionality— the closed social media platform functions well (CMO1, 2); (2) engagement members engage with each other and engage in group activities (CMO3, 4); and (3) knowledge use—the conceptual and/or instrumental knowledge use (CMO5, 6).

CMO1: When there is technical support to make a closed social media platform accessible, compatible, and easy to use (C), group members are likely to be more receptive to the platform (M), and as a result, group activities operate easily and efficiently (O).

Nine studies highlighted the significance of technical support for social media activities, especially for closed online group activities.[34,36,37,41,46–49,55] Rolls et al[47,48] found that the compatibility, complexity, and relative advantage of social media technology were a prerequisite for clinicians to use virtual communities. Based on the experience gained from organizing an online community on tracheostomy quality improvement, Swords et al[49] suggested that it was necessary to rehearse the technology before learning sessions to ensure that group activities would run smoothly. Hirakawa et al[37] concluded in a formative study that one of the reasons why their online education for health care professionals did not reach statistically significant improvements lay in participants' failure to access the platform.

CMO2: When a closed social media platform clearly defines its domain of interest, purposes, and values (C), group members are likely to share a common goal (M), and as a result, contribute to its growth (O).

Five studies supported the theoretical statement in CMO2.[35,39,46,55,58] One of the crucial characteristics of an effective community of practice was a clearly defined domain of interest.[39] ''Clear objectives provide members with responsibilities and motivate them to contribute more actively (P7).''[55] Oliffe et al[46] shared learned lessons from their prostate cancer online support group that the target audiences of the platform were poorly defined, which caused confusion among group members.

CMO3: There were three aspects to this CMO, which were about preparing different roles in the closed social media platforms.

CMO3–1: When there are facilitators who actively engage in group activities and facilitate networks and knowledge exchange in a closed social media platform (C), group members are likely to strengthen the bonds, gain access to resources and expertise, and experience social influence to engage in group activities (M). As a result, a supportive learning online culture may be nurtured, and the group may grow and flourish with increased member engagement (O).

Six studies substantiated this theoretical statement. [36,39,40,48,52,55] Ikioda and Kendall[40] conducted a realist evaluation to understand the mechanisms of an online community for transforming health visiting services in England. They revealed that effective facilitation and brokering activities equipped community members with peer-reviewed knowledge concerning their needs, and the commitment of community members encouraged the participation of other members. Hurtubise et al[39] identified three crucial roles of virtual knowledge brokers in changing pediatric physiotherapist practice: context architect, promoter of knowledge sharing, and linkage creator. Other studies also described the intermediaries,[52] champions,[55] and volunteer leadership roles[36] in strengthening bonds and promoting growth of closed online groups.

CMO3-2: When a closed social media platform involves disciplinary experts and/or interdisciplinary professionals (C), group members are likely to gain access to expertise, and

improve motivation to learn, network, and collaborate (M), and as a result, engage in group activities and use the knowledge learned in the group conceptually and/or instrumentally (O).

Five studies highlighted the importance of involving multidisciplinary professionals and experts in closed platforms to promote networking and learning.[36,40,48,52,55] In an evaluation study of a virtual nursing network, Frisch et al[36] found that 52% of participants cited opportunities to network, learn, and collaborate as reasons for becoming a member; 40.8% of participants indicated that they were learning new knowledge and skills through the network membership. Ikioda and Kendall[40] showed in their realist evaluation that accessing expertise and bouncing ideas with other practitioners were mechanisms explaining member engagement in closed online groups. However, it was suggested that group organizers should be cautious about the heterogeneity of group members, as this could result in poor communication or antagonistic viewpoints between competing members.[55]

CMO3-3: When organizers of a closed social media platform regularly assess the needs of members and base the group activities on these needs, track group performance, and optimize operations accordingly (C), group members are likely to have expectations fulfilled and gain continuous support (M), and as a result, sustain engagement in group activities (O).

This theoretical statement was supported by seven studies. [35,37,39,40,46,47,58] Hirakawa et al[37] found in a social media initiative that some participants considered that the program failed to meet their learning needs due to a lack of preassessment of their knowledge levels. ‘‘A community’s life cycle is not linear and managing its growth, activity, and design is an iterative

process that must adapt to the needs of the members and the community's purpose (P5).''[58] In addition, monitoring community growth and activities were considered critical to inform the adjustment of community tactics.[58] Oliffe et al[46] learned from their prostate cancer support group that the group activities should build in evaluation by analyzing, reporting, and comparing data across time to optimize the operation.

CMO4: When a supportive learning culture is nurtured in a closed social media platform (C), group members are likely to feel a sense of belonging, trust, and ownership (M), and as a result, actively engage in group activities, share knowledge and expertise, and exchange in professional issues (O).

Six studies contributed to this theoretical statement. [34,40,43,47,48,55] Roll et al[47] found that knowledge sharing among health care professionals in virtual communities was facilitated by a web-based culture of collectivism, reciprocity, and a respectful non-competitive environment. Other studies also described the ''non-judgemental environment,''[40] ''open, welcoming environment,''[43] ''collegiality and constructive atmosphere,''[48] and the ''supportive and positive culture''[55] in encouraging participation, engagement, and exchange.

CMO5: When group members of a closed social media platform have everyday interaction in a supportive learning culture (C), they are likely to build collective knowledge relating to needs or interests (M), and as a result, conceptually and/or instrumentally use the knowledge in practice (O).

CMO5 was substantiated by four studies.[34,40,53,54] To promote evidence-based practice and quality improvement, Wales et al[53,54] suggested that health care professionals needed not

only knowledge about the effectiveness of clinical interventions, but also knowledge about how to implement interventions. In an online community, the ‘‘know-how’’ knowledge was described to be generated from the interaction among group members who discussed key issues arising from everyday practice and shared experiences, cases, and practical tools to support implementation.[34,40,53]

CMO6: In a closed social media platform that has an explicit focus on knowledge translation, when organizers provide interactive training sessions and tailored support to members based on their needs (C), group members are likely to improve capabilities and build readiness (M) for conceptual and/or instrumental knowledge use (O).

The theoretical statement was supported by three studies. [35,44,53] Chambers et al[35] concluded from a sensitivity analysis that their virtual community on de-implementing urine culturing and antibiotic prescribing would benefit from more tailored support to participants to build readiness for practice change. In Scotlands' Knowledge Network, Wales et al[53] also suggested that providing tailored support to frontline clinicians was essential to translating knowledge into practice.

4.3.2.3 Refined program theory diagrams and propositions.

Based on these 14 CMOs, we developed 3 program theory diagrams to explain how social media can support health care providers' knowledge use (Figures 4.2–4.4). There are two causal explanations of how social media can support health care providers' knowledge use: the rationality-driven approach that primarily uses open social media platforms (Figure 4.2), and the relationality-driven approach that primarily uses closed social media platforms (Figure 4.3).

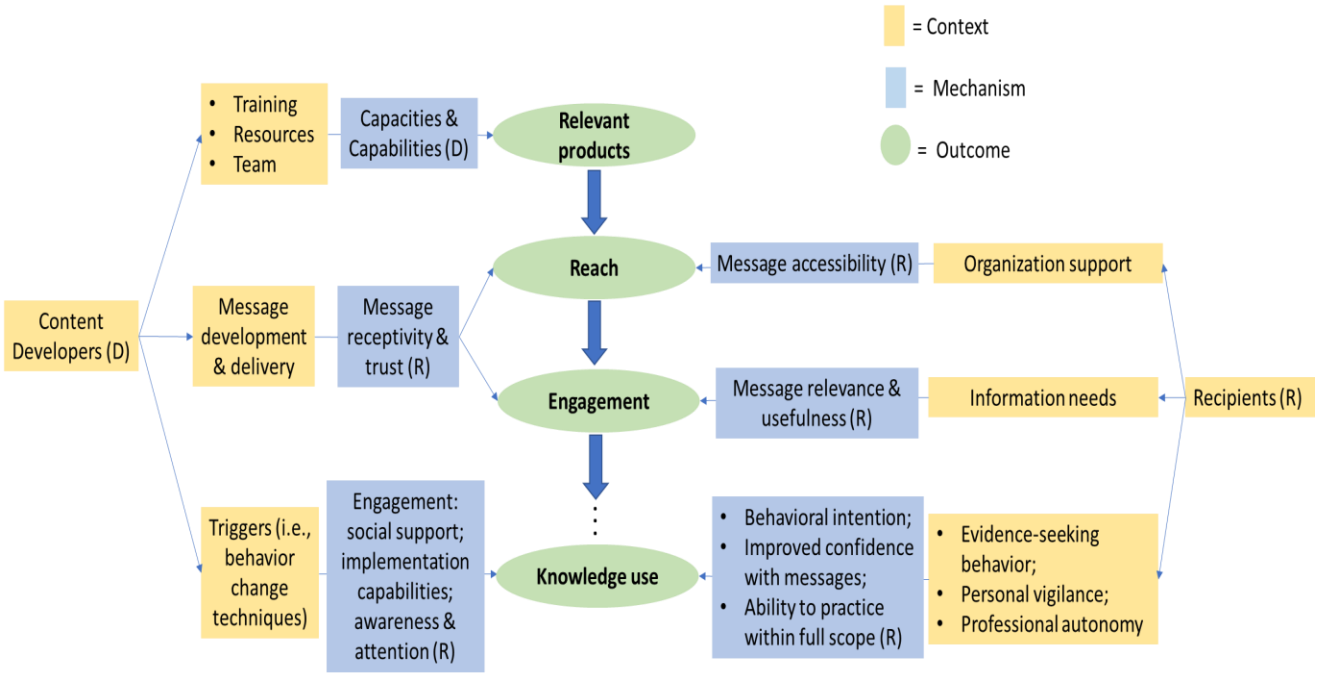

Figure 4.2 Refined program theory on using open social media platforms to support knowledge use

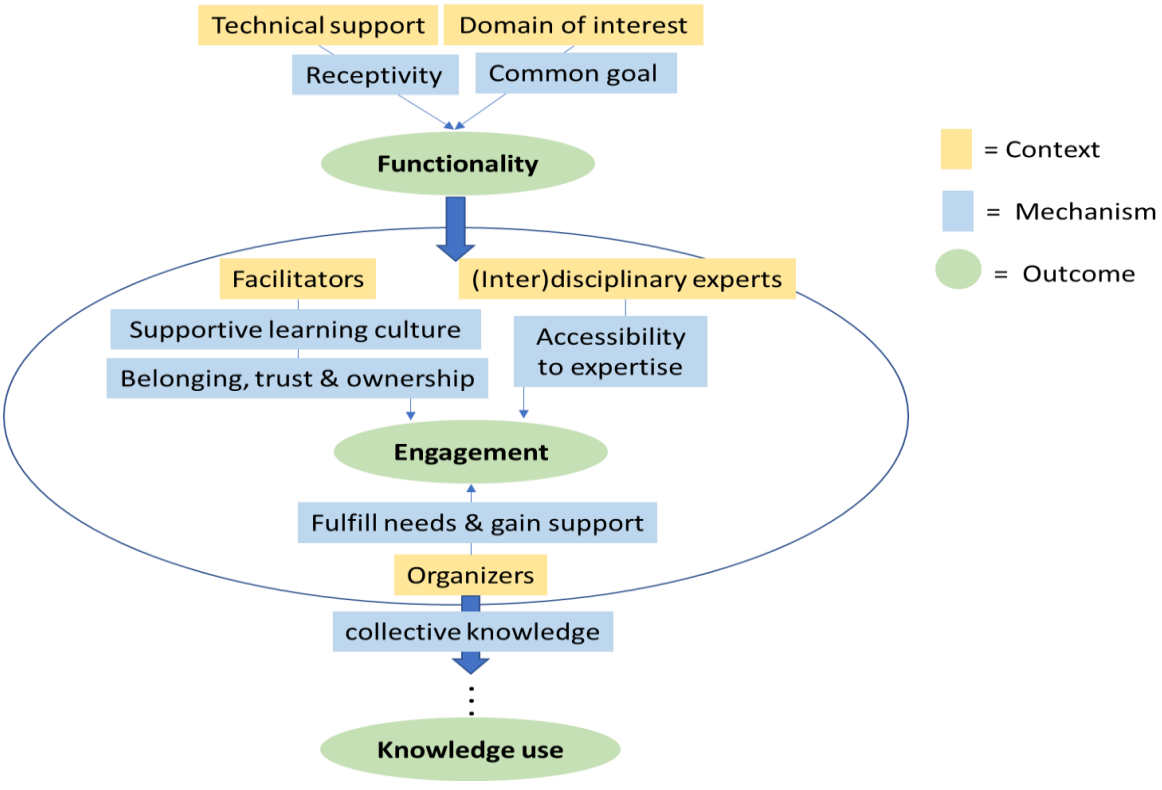

Figure 4.3 Refined program theory on using closed social media platforms to support knowledge use

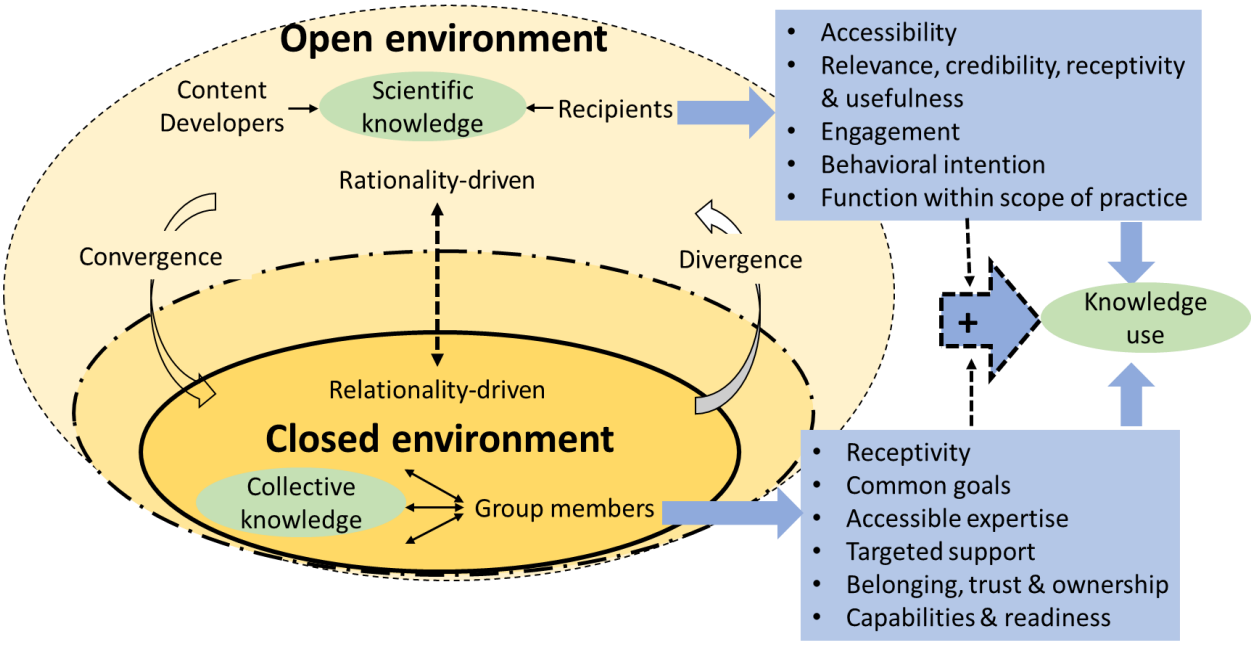

Figure 4.4 Refined program theory on using social media to support knowledge use

In the rationality-driven approach, content developers and recipients are two distinct roles. Content developers require training, resources, and team support as prerequisites to improve capabilities and capacities to content developers relevant social media products. When it comes to the messages, content developers can employ various strategies to make messages receptive, trustworthy, and useful to reach the recipients, and more importantly, to persuade recipients to engage with the messages. Content developers can also use different triggers to promote recipients to use the messages through mechanisms such as increased social support, implementation capabilities, and message awareness. Recipients' use of social media messages can be facilitated by organizational support and are dependent on their information needs, evidence-seeking behaviors, personal vigilance, and professional autonomy.

The ‘‘Be Sweet to Babies’’ initiative led by Harrison et al would be an exemplary case for this approach. The team filmed a short video, together with an audiovisual team in a children’s hospital outpatient clinic, on using breastfeeding and sucrose to reduce procedural pain for infants (outcome 1—relevant products). After posting the video on YouTube, they edited keywords and tags, such as ‘‘baby injection’’, to maximize the chances of the video being retrieved (outcome 2—reach).

They used plain and concise language to describe the procedure and demonstrate the evidence base in this video. They also tailored the messages to different social media platforms and disseminated the video through various online (e.g.: radio interviews, television interviews, popular parent blogger groups) and offline (e.g.: outreach to hospitals and professional organizations) strategies (outcome 3—engagement). To trigger the use of these evidence-based strategies in the video, the development team employed different implementation strategies such as: visualizing the behavior in a real clinical setting to show impact; posting and disseminating the video with annual national and regional flu vaccination promotion efforts; and using motivational interviewing to persuade its use (outcome 4—knowledge use). The ‘‘Be Sweet to Babies’’ YouTube video received high acceptance and intention to use among health care providers.[62–65]

In the relationality-driven approach, content developers and recipients are no longer distinct roles, as all are group members who co-create knowledge. It is a prerequisite for a closed platform to have technical support and a clear domain of interest to ensure its functionality. To promote member engagement in group activities, three key roles are essential:

facilitators who nurture a supportive learning online culture to build a sense of belonging, trust, and ownership among group members; (inter)disciplinary experts who provide members access to knowledge and expertise; and group organizers who assess member needs and measure group performance to fulfill member expectations. Through engagement and everyday interaction, group members build collective knowledge to inform practice change.

An exemplary case for the relationality-driven approach would be the global multidisciplinary tracheostomy virtual learning community during COVID-19, which involved more than 1,500 registrants spanning 22 countries and 197 institutions. The organizing team rehearsed the technology before each learning session and recorded the audio-video quality to ensure the functionality of the community activities (outcome 1—functionality). Within the online community, experts in pediatric and adult decannulation and intensive care were invited to give presentations; the organizing team coordinated times, sent reminding emails, and facilitated discussion through message boards, which resulted in a learning culture, trust, and growing engagement of participants (outcome 2—engagement). Through discussions, fellow otolaryngologists and other specialists found common solutions for their common problems (outcome 3—knowledge use).[49]

Although we distinguish these two approaches with separate causal explanations, there are no distinct boundaries between them, nor are they binary and static. Rather, they represent a dynamic continuum with one side being primarily rationality-driven and the other primarily relationality-driven (Figure 4.4). As group members of a closed social media platform expand, they will likely have different or even competing interests and goals that can lead to a division

of the group with features of an open platform emerging. Vice versa, when members in open platforms have similar interests and goals, they may converge and build closed groups for more focused interactions. It is our hypothesis that when content developers consider both the rational and relational dimensions to create social media interventions, they are likely to accelerate knowledge use.

4.4 Discussion

Based on a realist review of 32 documents, we generated 14 CMOs and built causal explanations of how social media could support health care providers' use of knowledge from social media in their professional practices. These CMOs were situated in two approaches: the rationality-driven approach and the relationality-driven approach. We discuss three prominent aspects of the findings.

4.4.1 Healthcare providers' engagement with social media messages

In our program theory, health care providers' engagement with social media messages was considered a critical outcome as well as a key mechanism of knowledge use. Content developers could incorporate multiple strategies when developing and delivering social media messages, such as involving target users and structuring the content, to encourage health care providers' engagement with the messages.

Barger et al[66] proposed a model of consumer engagement with social media, in which they considered the antecedents of engagement as including consumer, content, brand, product and social media factors, and operationalized engagement into reacting to,

commenting on, sharing and posting contents. Similarly, Ritterband et al[12] posited in the Behavior Change Model for Internet Interventions that the characteristics of the website, such as appearance, content, delivery, and behavioral prescriptions, impacted consumers' engagement with the messages.

Empirically, an analysis of social media posts confirmed that the effectiveness of social media content in engaging users was moderated by the platform environment and format of content.[67] Key characteristics of the content that strongly influenced consumers' engagement included being utilitarian, authentic, and visually appealing.[68] Further, consumer characterizations of engagement with social media content were found to differ greatly from content developer characterizations, [68] which underscored the importance of involving target users in the content development process.

In an experimental study, Gough et al[69] framed Twitter messages on skin cancer prevention into five broad categories: humor, shock or disgust, informative, personal stories, and opportunistic. They found that shocking messages got the greatest Twitter impressions, humorous messages generated the greatest engagement, whereas informative messages resulted in the greatest number of shares. In an analysis of social media strategies by top business brands, Ashley and Tuten[70] found that functional appeals (i.e., utility of products), resonance (i.e., an echoing between image and words), experiential appeals (i.e., associating product with desirable images or symbols), and emotional appeals (i.e., meeting psychological/ social needs) were the most commonly employed strategies to improve consumer engagement. However, a recent review did not find conclusive results on the impact of content

characteristics on consumer engagement with social media.[71] Visual appeal and high media richness (e.g., the inclusion of pictures or videos) seemed to have a positive effect on engagement behaviors, whereas these results were found highly context-dependent.[71]

4.4.2 Embedding behaviour change techniques in social media interventions

In our program theory, behavior change techniques were considered the triggers that content developers could employ to promote health care providers' knowledge use through social media. Webb et al[72] found in their systematic review that online interventions that incorporated more behavior change techniques had larger effects than interventions that incorporated fewer techniques. Behavior change techniques have been increasingly used in social media interventions for patients and the public,[73,74] in which social support, instruction on how to perform the behavior, and credible sources of evidence were commonly used.[74]

In our review targeting health care providers, we identified similar behavior change techniques that had been used or advocated for use, such as social support through promoting interaction among content developers and recipients,[4,42] instruction on how to perform the behavior through video demonstrations,[62] and prompts by various reminder strategies. [59,60] Nevertheless, limited research has been done to understand the behavior change techniques used in social media interventions for health care providers, their feasibilities and effectiveness.

4.4.3 Online community of practice for knowledge translation

Some scholars have argued that there is a need to broaden the scope of knowledge translation to include not only explicit knowledge acquired through research but also tacit

knowledge gained during daily practice.[75] In our program theory, the rationality-driven approach emphasized the use of explicit knowledge gained from research on open social media platforms, whereas the relational approach highlighted the utility of tacit and collective knowledge produced by online group members.

An online community of practice has been suggested as a promising strategy to facilitate the translation of tacit knowledge.[76,77] Participants within a community of practice often have shared interests and purposes, thus mutually guiding each other through their understandings of the same problems and building collective knowledge through ‘‘thinking together.’’[78,79] The online community of practice has been reported to support knowledge translation activities,[80] promote evidence-based clinical practice,[81] and improve patient care capacities.[82]

4.4.4 Strengths and Limitations

This realist review was conducted systematically following the Realist and Meta-Review Evidence Synthesis quality standards.[83] The program theory was developed based on the published SMILE framework[22] and iteratively refined through a synthesis of research evidence and regular team discussions. In addition, we engaged with knowledge users in multiple steps of the review to ensure the relevance our program theory and the alignment with realist philosophy.[83]

We identified the following limitations. First, social media is a broad term and a fast-growing area with new platforms continually emerging. In our search strategies, we might not have exhausted all the search terms for social media, which may have resulted in the omission of some relevant papers.

Second, our initial understanding of knowledge use through social media focused primarily on open platforms, which guided our development of the initial program theory and literature search. The use of closed social media platforms, such as the online community of practice, emerged from the synthesis of the literature. After identifying this new theory area, we did not go back and conduct a more targeted search on those closed social media platforms, rather we synthesized the extensive literature we already had from the initial search.

Third, it should be acknowledged that not all of the [32] documents had high methodological quality, which added layers of difficulties to uncover the hidden mechanisms. We, therefore, turned to the analytic strategy of adjudication to help explain opposing outcomes, which helped strengthen our understanding of mechanisms.

4.4.5 Implications for Practice and Future Research

Based on the findings of this realist review, we offer several suggestions on social media intervention development for knowledge translation: (1) invest in and prepare the resources and team for intervention development; (2) engage target users in the development process; (3) strategically choose the platform, delivery, and presentation of the content to promote user engagement; (4) embed appropriate behavior change techniques into social media interventions; and (5) build an online community to support knowledge sharing and learning.

We highlight three research areas that require further investigation to determine the contribution of social media to health care providers' knowledge use: (1) a realist evaluation of real-world social media initiatives is necessary to further consolidate the program theory; (2) both systematic and realist reviews would be beneficial to further investigate the effectiveness

and mechanisms of closed social media platforms for knowledge translation; and (3) empirical studies are necessary to explore the synergistic effect of the two approaches identified in the review.

4.5 Conclusion

Based on a realist review of 32 documents, we identified two causal explanations of how social media could support health care providers' knowledge use: the rationality-driven approach that primarily uses open social media platforms, and the relationality-driven approach that primarily uses closed social media platforms. Each of these approaches encompasses complex causal chains. These two causal approaches are not static but are connected dynamically. Future research is necessary to refine the two causal explanations and investigate their synergistic effects.

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Chapter 5: Consolidating the program theory on how social media supports healthcare providers' knowledge use in clinical practice: a realist-informed qualitative study

To be submitted: Zhao, J., Vandyk, A., Harvey, G., Huang, & Gifford, W. Consolidating the program theory on how social media supports healthcare providers' knowledge use in clinical practice: a realist-informed qualitative study. (Target journal: Telemedicine and e-health)

In the previous chapter—theory refining phase of this thesis, I drew on the synthesis of 32 documents and developed two causal explanations of how social media can support healthcare providers' knowledge use: the rationality-driven approach that primarily uses open social media platforms, and the relationality-driven approach that primarily uses closed social media platforms. In this chapter—theory consolidation phase, I focus on the open social media platforms and aim to consolidate the program theory developed from the realist review to further understand how social media supports knowledge use by healthcare providers.

Abstract

Background: This study aimed to consolidate a program theory developed from a realist review to further understand how and under what circumstances social media supports healthcare providers' knowledge use. Methods: This is a realist-informed qualitative study. We conducted in-depth interviews with 11 participants from China, Australia, and Canada. The categorizing and connecting strategies informed the data analysis. Results: Ten context-mechanism-outcome (CMO) configurations were developed to consolidate the program theory, in which four CMOs confirmed the original CMOs in the realist review, four refined the original CMOs, and two were new propositions. They considered content developers' capabilities and

capacities, along with healthcare providers' increased attention; fulfillment of information needs; access to social influence and support; perception of message value and implementability; behavior capabilities, self-efficacy, intention, and awareness; and ability to exercise professional autonomy as the key mechanisms. Conclusions: Social media has the potential to promote knowledge use by healthcare providers. Future research needs to be conducted to further optimize the theoretical understanding.

Keywords: social media, knowledge translation, implementation science

5.1 Background

Social media has changed how healthcare providers access and engage with research evidence. It also offers unprecedented opportunities for knowledge translation (ie, application of knowledge into practice). A scoping review of 628 papers on the use of social media for knowledge translation with physicians and trainees found a steady increase of literature in this field since 1996 (Chan et al., 2020). An online survey with healthcare trainees revealed that social media was considered a promising strategy for promoting knowledge translation (Newman et al., 2015), with various "push strategies", such as blogs for dissemination, communication, and education, and "engagement strategies", such as Twitter journal clubs, having been increasingly used (Chan et al., 2020). Another survey with 658 registered nurses in China showed that 84.5% of them believed that social media had positively influenced their clinical practice (Wang et al., 2019).

Along with healthcare providers' engagement with and use of research evidence on social media is the rising popularity among research groups and organizations who use social

media to deliver research evidence. Barton (2017; Barton & Merolli, 2019) proposed a new research-to-practice pathway where researchers not only disseminate research findings through traditional journal publications but also create multimedia messages for dissemination to the general public. After analyzing four social media initiatives, Elliott et al (2020) provided several suggestions for developing a social media knowledge translation strategy, such as setting goals, using theories, understanding intended audiences, choosing the right platforms, and tailoring messages. In a qualitative study with 17 social media experts, Lu et al (2021) found that to harness social media for knowledge translation, it was essential to know the nuances of specific platforms, manage social media teams, use strategies to promote online engagement and effective knowledge sharing, and cultivate a culture of e-professionalism. Despite the increasing attempts to explore how to best use social media for knowledge translation, existing literature tends to provide practical suggestions on what to do. There remains a lack of theoretical understanding about how social media can work to support knowledge translation with healthcare providers (Korda & Itani, 2013). Such theoretical endeavors are necessary to unpack the complex causal chains from social media products to knowledge use, inform the development of social media interventions, and help explain their successes and failures.

This paper presents the third part of a research project, the overarching goal of which is to develop a theoretical understanding of how social media can support healthcare providers' knowledge use in clinical practice. This project has three interlinked phases: theory gleaning, refining, and consolidation (Manzano, 2016; Mukumbang et al., 2020). In the first phase, drawing on a review of five active social media initiatives, five theories on social media studies and knowledge translation, and 58 empirical studies, we developed an initial program theory

described as *the Social Media for ImpLementing Evidence (SMILE)* framework (Zhao, Harvey, Vandyk, & Gifford, 2022). In the second phase, we refined the SMILE framework through a realist review of the literature and built context-dependent explanations, operationalized as CMO configurations (ie, an outcome of interest is the result of mechanisms being activated in specific contexts (Wong et al., 2013)), to understand healthcare providers' knowledge use through social media interventions (Zhao, Harvey, Vandyk, Huang, et al., 2022). While the refined program theory advanced our theoretical understanding, we do not know how the theory is operationalized or perceived by healthcare providers and content developers in the real-world context. Understanding how healthcare providers and content developers interact with their social contexts and develop social media products or use social media in their clinical practice is necessary to consolidate the program theory. This consolidated theory will further advance our knowledge in the field of social media and knowledge translation, and has the potential to optimize healthcare delivery and improve health outcomes.

In phase two of the project, we identified two causal explanations of how social media supports knowledge translation: the rationality-driven approach that primarily uses open social media platforms and the relationality-driven approach that primarily uses closed social media platforms. Given the distinctions between these two causal explanations, in this phase, we narrow the focus to open social media platforms and consolidate the rationality-driven program theory. The relationality-driven program theory will be consolidated at a later stage.

5.2 Objectives

This qualitative study aimed to consolidate a program theory on how and under what circumstances open social media works as a knowledge translation strategy to support healthcare providers' clinical practice. The specific objectives were:

1) To understand the mechanisms by which open social media results in healthcare providers' practice change;
2) To identify the contextual factors that activate the mechanisms;
3) To consolidate the program theory developed in the previous realist review.

5.3 Methods

5.3.1 Design

This was a realist-informed qualitative study (Maxwell, 2012) situated within an applied scientific realism paradigm (Jagosh, 2020). A realist qualitative design is consistent with the philosophical positioning of the entire project and is ideal for building context-dependent explanations of healthcare providers' use of knowledge on social media.

5.3.2 Participants

From a realist sense, consideration of the knowledgeability of interviewees—"who knows what with regard to the program (p. 492)"— is important to identify the key informants (Mukumbang et al., 2020; Pawson & Tilley, 1997). Participants, therefore, were recruited from two groups: healthcare providers who use social media to inform clinical practice and content developers. The inclusion criteria for healthcare providers were: 1) a registered/licensed healthcare professional or allied healthcare professional in medicine, nursing, rehabilitation,

dietetics, or pharmacy; 2) following at least one English or Chinese social media account which disseminates healthcare evidence; 3) following at least one of the social media accounts for over one year; d) has used evidence from the social media in clinical practice. Inclusion criteria for content developers were: 1) the primary work of the social media account was to disseminate healthcare evidence; 2) the social media account has been running for more than three years; 3) the content developers were responsible for the management and daily running of the social media, eg, designing and periodic uploading of information, sending notification messages to recipients, and answering questions or comments from users.

We used purposeful sampling to maximize variability among participants and explore whether the program theory has explanatory power across different contexts that were identified to impact social media use in the previous study (Emmel, 2013; Manzano, 2016; Zhao, Harvey, Vandyk, Huang, et al., 2022). Participants were recruited based on variations in content developers' and recipients' characteristics, and the social media platforms. The content developers were recruited from three teams that were using social media to disseminate healthcare evidence. Healthcare providers were recruited by disseminating recruitment posters on the three teams' social media accounts and online knowledge translation interest groups. This study received ethical approval from the University of Ottawa Research Ethics Board (H-04-21-6774).

5.3.3 Program theory used to guide the study

The study was guided by a program theory developed through the previous realist review (Zhao, Harvey, Vandyk, Huang, et al., 2022), which encompassed eight CMO

configurations for four interconnected levels of outcomes, namely social media products, accessibility, engagement, and knowledge use. The program theory proposes that for social media to enable knowledge use, it is a prerequisite for content developers to obtain training, resources, and team support to improve capabilities and capacities for social media product development. Content developers can employ various strategies to make social media messages receptive, trustworthy, and useful to reach the target populations, and more importantly, persuade them to engage with the messages. In terms of knowledge use, content developers can use different triggers (ie, behaviour change techniques) to promote recipients to use the messages through mechanisms of increased social support, implementation capabilities, and message awareness. Recipients' use of social media products can be facilitated by organizational support and are dependent on their information needs, evidence-seeking behaviours, personal vigilance, and professional autonomy (see Table 4.3 for the eight CMOs). The program theory informed the interview guide development and data analysis described below.

5.3.4 Data collection

Semi-structured individual interviews were conducted using a teacher-learner technique (Manzano, 2016; Mukumbang et al., 2020; Pawson & Tilley, 1997). The teacher-learner technique is a commonly used method in realist interviews and requires that researchers actively "teach" participants the program theory under investigation. Having learned the theory, participants can construct meanings and teach back how they think the theory can be optimized based on their lived experience (Manzano, 2016; Mukumbang et al., 2020; Pawson &

Tilley, 1997). See Table 5.1 for the interview guide for healthcare providers (and the logic behind the interview questions) which was developed based on the realist review findings (Zhao, Harvey, Vandyk, Huang, et al., 2022) and guiding literature on realist interviews (Manzano, 2016; Mukumbang et al., 2020). The interview guide for content developers was similar with minor modifications (see Appendix 6).

We stopped data collection once a sense of data adequacy (ie, a high level of richness, depth, diversity, and complexity of data for refining the program theory (Braun & Clarke, 2021)) is gained. Individual interviews were all conducted virtually in Mandarin or English, digitally audio-recorded and transcribed verbatim.

Table 5.1 Interview guide for healthcare providers

	Questions	**Logic**
1	Can you share with me one of your recent experiences in applying healthcare evidence on social media into clinical practice?	Exploring the causal process of healthcare providers' knowledge use through social media and potential CMOs linking the process
2	What are the lessons you have learned during the process of applying evidence from social media into practice?	Looking for key CMOs linking the causal process
3	What kind of factors promoted you to apply the evidence from social media to clinical practice?	Identifying mechanisms
4	What key characteristics of the social media (virtual), healthcare providers (individual), organization, or system do you suggest are likely to influence the use of evidence on social media in practice? [We further probed into specific factors in these three dimensions based on the participants' responses]	Exploring triggering contexts of mechanisms from different levels
5	Are there any other important outcomes that result from reviewing evidence on social media?	Exploring intended and unintended outcomes
6	This is how we think social media might work for healthcare providers' evidence-informed clinical practice based on our review of the literature. Does it make sense to you based on your experience? Why or why not? [We sent participants the program theory diagram with plain-language explanations two days before the interview (see	Gaining healthcare providers' insights on the program theory based on their lived experience

	the appendix). During the interview, the interviewer showed the diagram to participants and asked participants whether a further explanation is needed].	
7	Where do you think this model can be optimized to make it clearer and more aligned with what happens (or are likely to happen) in practice?	Drawing on the teacher-learner technique to refine the program theory
8	Are there any other aspects that you think are relevant and crucial for our understanding of how social media can support healthcare providers' use of evidence in practice?	Recapping key mechanisms or contextual factors impacting the causal process

5.3.5 Data analysis

The data analysis process was guided by the realist evaluation data analysis and synthesis methods suggested by Gilmore et al (2019). The categorizing (ie, coding) and connecting strategies (ie, identifying key relationships) proposed by Maxwell (2012; Maxwell & Miller, 2008) informed the method of analysis. we uploaded the transcripts to NVIVO version 12 software (2018) to facilitate analysis.

Specifically, we conducted the analysis in five steps: 1) the eight CMO configurations developed through the realist review were used as a guiding framework (ie, eight themes) for analysis; 2) Two researchers (JZ, MH) read the transcripts thoroughly to familiarize themselves with the data and coded relevant passages into the eight predetermined CMO categories. We also looked for data that could not be mapped into the CMO categories and inductively developed new ones as needed; 3) We identified relationship statements from the categorized passages that could explain the causal process, extracting the context, mechanisms, and outcomes components and building linkages based on the identified relationships (eg, context-mechanism, mechanism-outcome, context-outcome, or context-mechanism-outcome linkages);

4) Three researchers (JZ, MH, WG) synthesized the linkages and compared them with the original eight CMO propositions to confirm, refine, or dispute them, and update the program theory accordingly. When the synthesized linkage was consistent with the original CMO in context, mechanism, and outcome, we "confirmed" the original CMO (wording modification is not considered a substantial change of content); when the synthesized linkage differed from the original CMO in either one of the context, mechanism, or outcome, we "refined" the original CMO; when the synthesized linkage was not manifested in the original CMO, we considered the linkage as a "new proposition"; otherwise the original CMO were considered "disconfirmed"; 5) We sent the updated CMOs and updated program theory to participants for clarity and optimized the program theory based on their feedback. The data were analyzed in Mandarin or English depending on the language used for interviews; findings and quotes in Mandarin were translated into English.

5.3.6 Rigor assurance

The six criteria for judging qualitative research within the realism paradigm proposed by Healy and Perry were used to assure the rigor of this study (Healy & Perry, 2000). A brief description of the criteria and the techniques that were used to ensure rigor was illustrated in Table 5.2.

Table 5.2 Quality criteria for qualitative research under the realism paradigm

Criteria	**Brief description of the criteria**	**Techniques used to ensure rigor**
Ontological appropriateness	The research problem deals with complex social science phenomena involving reflective people	Our research aimed to understand how social media supports healthcare providers' knowledge use. This phenomenon involves a complex interaction among social media, content developers, and recipients
Contingent	Open "fuzzy boundary" systems	Our research question emphasized that context could

validity	that involve generative mechanisms rather than direct cause-and-effect. The causal impacts are not fixed but are contingent on their context	enable/inhibit social media to generate practice change. The pursuit of context-dependent mechanisms was manifested in the interview guides and analytic process. The research findings were presented using CMO configurations to illustrate the context-dependent mechanisms
Multiple perceptions	Neither value-free nor value-laden, rather value-aware. Realism relies on multiple perceptions about a single reality and involves the triangulation of several data sources	Cross-case triangulation. The data analysis was conducted by three researchers, one of whom was a knowledge user. The research findings were sent back to participants for clarity and confirmation
Methodological trustworthiness	Trustworthy -the research can be audited	We explicitly described the participants' selection, interview procedures, and analytic process. We built a database for the interview transcripts and used quotations to support propositions in the written report
Analytic generalization	Analytic generalization (ie, theory-building) rather than statistical generalization (ie, theory testing)	Building on a program theory developed through a realist review, this qualitative study aimed to develop, refine, or refute the theory. In the data analysis, we looked for surprising and unexpected data that could not be mapped to the program theory and built rival or new understandings.
Construct validity	Constructs in the theory being built are measured in the research	The consolidated program theory was originally from an initial program theory named the SMILE framework, which was developed drawing on 5 well-recognized theories (ie, the i-PARIHS framework, COM-B model, Fogg's Behaviour Model, theory of innovation diffusion, and Behaviour Change Model for Internet Interventions). The constructs in the consolidated theory were also derived from the SMILE framework.

5.4 Findings

5.4.1 Basic characteristics of participants

Eleven participants were recruited from China, Australia, and Canada (see Table 5.3). Four participants were content developers and eight were healthcare providers with one of them having a dual role. The content developers varied on the platform used (ie, WeChat,

YouTube, and Twitter), scope of topics (ie, general nursing, general medicine, nephrology, and reducing procedural pain in babies), evidence sources (ie, JBI, Cochrane, content developers' own research findings, and latest research findings from impactful journals), and target population (ie, people in China and people in western countries). Healthcare providers (including nurses, physicians, surgeons, and therapists) were from different disciplines (ie, stroke, dermatology, nephrology, endocrinology, and intensive care) with different positions. Their cases of using knowledge on social media included post-stroke dysphagia screening, patient education on drug use, patient education on diabetic diet, injection spot pressure, mixing nutrient solutions, and performing a specific surgical procedure.

Table 5.3 Basic characteristics of participants (n=11)

Label	**Country**	**Social media content developers**			
		Platform (s)	**Topics**	**Duration**	**Evidence sources**
N1	China	WeChat	Nursing in general	7 years	Various sources, mostly from Jonna Briggs Institute
N2	China	WeChat	Medicine in general	6 years	Cochrane
N5*	Canada	Twitter, blog & podcast	Nephrology	8 years	Their own systematic review findings
N7	Australia	YouTube & Twitter	Reducing procedural pain in babies	8 years	Various sources, mostly from the latest research findings
Label	**Country**	**Healthcare providers**			
		Discipline	**Position**	**Social media use case**	
N3	China	Stroke	Physical therapist	Implemented post-stroke dysphagia screening after gaining evidence from a clinical practice guideline on *WeChat* and systematic training supported by the hospital	
N4	China	Dermatology	Staff nurse	Implemented patient education on drug use after reading the descriptions of a well-received drug for chloasma from *Xiaohongshu* and additional verification from experts	
N5*	Canada	Nephrology	Staff nephrologist	Implemented new drug prescription practice after gaining information on the side effects of a commonly used drug from patient stories and physicians' narratives on *Twitter*	

N6	China	Neurology	Staff nurse	Implemented practice on whether to press the injection spot for low molecular weight heparin after reading a practice guideline from *Dingxiangyuan*
N8	China	Endocrinology	Staff nurse	Implemented patient education on diabetic diet based on the evidence from a reputable WeChat account
N9	China	Intensive care	Head nurse	Implemented practice on how to properly mix nutrient solutions from a consensus statement shared on a reputable *WeChat* account
N10	China	Nephrology	Staff nephrologist	Implemented patient education on the targeted level of uric acid for gout patients after accessing a clinical practice guideline on *Medlive*
N11	China	Orthopedics	Orthopedic surgeon	Implemented practice on the dosage and usage of a specific drug and how to perform a specific surgical procedure after reading experts' consensus on *Dingxiangyuan*

*: N5 has a dual role as both content developers and healthcare providers

5.4.2 Consolidated CMOs

Drawing on the program theory developed in the realist review (Zhao, Harvey, Vandyk, Huang, et al., 2022) and interviews with 11 participants, we developed ten consolidated CMOs (see Table 5.4). As with the realist review, the ten CMOs in the consolidated version were situated in four interconnected levels of outcomes: 1) social media products—content developers generate social media products relevant to target populations (CMO-C1); 2) accessibility—target populations are able to access the social media products (CMO-C2 and CMO-C3); 3) engagement—target populations engage with the messages on social media by reading, commenting on, and sharing the messages (CMO-C4 and CMO-C5); and 4) knowledge use—conceptual knowledge use (ie, the use of social media to change levels of knowledge, understanding, and attitude), and instrumental knowledge use (ie, the direct application of knowledge in practice) (CMO-C6 ~ CMO-C10). Among the ten CMOs, four CMOs confirmed the original CMOs in the realist review; four refined the original ones; two were new CMO

propositions. The relationships between the consolidated and the original CMOs were presented in Appendix 7.

Table 5.4 The consolidated CMO configurations developed in the qualitative study

Outcome 1: Social media products	
CMO-C1: Content Developers invest in social media initiatives	When content developers invest resources, have content and social media expertise, and involve end-users as team members (C), they have increased capabilities and capacities (M) to develop, maintain and promote social media products to target populations (O).
Outcome 2: Accessibility	
CMO-C2: Content developers choose a specialized and widely accepted social media with search and navigation functions	When content developers edit and post their product on social media platforms that are specialized for and widely accepted by peer healthcare providers and preferably have advanced search and navigation functions (C), platform users fulfill their individualized information needs (M), and access relevant information promptly (O).
CMO-C3: Content developers' reputation, influencer endorsement, and/or positive *(electronic) word-of-mouth*	When content developers have a high reputation in the field, or the social media product is endorsed by reputable people or organizations, or it receives positive *(electronic) word-of-mouth* (C), target audiences perceive the message as credible and be socially influenced (M) to access and engage with the product (O).
Outcome 3: Engagement	
CMO-C4: Content developers use marketing strategies to disseminate social media products	When content developers use online and/or offline marketing strategies to disseminate the social media products to targeted audiences (C), the target audiences pay increased attention to (M), and engage with them (O).
CMO-C5: Social media message features	When the social media messages meet recipients' information needs with signs of high credibility and preferably, in a clear and vivid format (C), recipients perceive the messages as valuable for professional development or solving clinical problems (M), and engage with the messages (O).
Outcome 4: Knowledge use	
CMO-C6: Content developers use triggers to promote message use	When content developers embed different triggers (ie, behaviour change techniques) in the social media messages (C), healthcare providers experience increased behavioural capabilities, self-efficacy, intention, or awareness (M), and use the messages in practice (O).
CMO-C6.1: Content developers promote interaction	When content developers actively interact with healthcare providers and promote interactions among healthcare providers regarding the messages, and if possible, offer targeted feedback (C), healthcare providers experience social support (M), and use the messages in practice (O).
CMO-C6.2: Content	When content developers use reminder strategies in their social media

developers use reminders	initiative (C), healthcare providers have increased awareness (M), and use the messages in practice (O).
CMO-C6.3: Content developers include behavior prescription, demonstration, and/or offer learning resources	When content developers prescribe and demonstrate how to perform the behaviours in the social media message, and/or offer additional resources for systematic learning (C), healthcare providers have increased capabilities and self-efficacy (M), and use the message in practice (O).
CMO-C6.4: Content developers embed clinical cases or patient stories	When content developers embed real clinical cases or patient stories into the social media messages (C), healthcare providers have improved trust in the practice and expectations of implementation outcomes (M), and use the message in practice (O).
CMO-C7: Healthcare provider' evidence-seeking behavior	When healthcare providers actively seek for research evidence to inform clinical practice (C), they have the intrinsic motivation (M) to find and judiciously use the message on social media in practice (O).
CMO-C8: Healthcare providers critically appraise and verify social media messages	When healthcare providers critically appraise and verify the social media message through various sources (C), they become confident about the credibility of the message (M), and judiciously use the message in practice (O).
CMO-C9: Behavior recommendation is within healthcare providers' scope of practice	When the behavioural recommendations in a social media message are within the healthcare provider's scope of practice with few constraints from their working and professional organizations (C), healthcare providers have the capability to exercise professional autonomy (M), and use the message in practice (O).
CMO-C10: Behavior recommendation has low implementation complexity	When the behavioural recommendations in a social media message have low implementation complexity at the individual level (C), healthcare providers gain an improved perception of its implementability (M), and use the message in practice (O).

CMO-C1: When content developers invest resources, have content and social media expertise, and involve end-users as team members (C), they have increased capabilities and capacities (M) to develop, maintain and promote social media products to target populations (O).

CMO-C1 largely supported the original CMO-1 in the realist review with an emphasis on the availability of resources, content, and social media expertise. In the interviews, participants described the human resources, evidence resources, and time investment to improve capacities

for social media initiatives. *"The reasons (why we failed to update our WeChat contents more frequently) are simple: we don't have people to do this; we don't have stable evidence sources like before, which also involves copyright considerations—whether we can edit and post published systemic reviews on our WeChat account. It's impossible to conduct systematic reviews by members in our center to support the operation of the WeChat account"* (N1).

Participants also emphasized that content developers should have the capabilities for social media initiatives—be knowledgeable about the content field and the operation of social media platforms. The end-user voice was described as necessary to ensure the relevance and accessibility of social media products. "*The very basic requirement (for starting and sustaining a social media evidence dissemination initiative) is that you have the content expertise in your team who understand the real-world impact of the evidence. Besides, the team should know about social media, for example, how to structure the content and how to reach the target audiences… It would be great if you can involve end-users and ask for their feedback and suggestions*" (N2).

CMO-C2: When content developers edit and post their product on social media platforms that are specialized for and widely accepted by peer healthcare providers and preferably have advanced search and navigation functions and (C), platform users fulfill their individualized information needs (M), and access relevant information promptly (O).

CMO-C2 was a new proposition. In the interviews, participants strongly suggested using social media platforms that are specialized for and widely accepted by peer healthcare providers to access credible health evidence. They spoke highly and unanimously of two social

media platforms specialized for healthcare providers in China, both of which offered extensive learning resources, up-to-date research findings, and engagement opportunities. On these platforms, members were verified and thus the information posted could be more trusted than on other platforms.

participants also envisioned that "*in the near future, social media could become a quick browser with more advanced search and navigation functions, and people could find the information they want more easily*" (N11). Such functions of social media were considered important to fulfill users' information needs and promote evidence accessibility in that "*the premise of using evidence is that I can get the evidence in time*" (N4). Whereas "*current social media generally have poor search function… and social media algorithms make it very difficult to find the needed information again if you forgot to store it the first time you saw it*" (N1).

CMO-C3: When content developers have a high reputation in the field, or the social media product is endorsed by reputable people or organizations, or it receives positive (electronic) word-of-mouth (C), target audiences perceive the message as credible and be socially influenced (M) to access and engage with the product (O).

CMO-C3 refined the original CMO in the realist review. The original CMO only considered the role of social media influencers in recipients' access and engagement with social media messages and lacked clarity on the causal configuration (ie, stating that various contextual factors jointly activate various mechanisms). In CMO-C3, the contextual factors were further elucidated and their correspondence with mechanisms was made explicit. Participants repeatedly emphasized the social influence they experienced in accessing and engaging with

social media messages. Such social influences were gained mostly from developers' reputations. "*If the social media account is run by a renowned field expert, or a hospital unit leading the field, we would click and read the content...(because) they are authoritative in the field; whereas when it's run by a junior nobody like me, even if the content is well-written, maybe few people would read*" (N11). "*There are many things which I think are really important (to make knowledge use through social media possible). One is that the person (content developer) should be trusted*" (N5).

Not only developers' reputations, the endorsement of influential people or organizations, and the positive (electronic) word-of-mouth also socially influence recipients to access evidence from social media. One participant (content developer (N1)) cited their backend WeChat data to illustrate that normally the viewers of their WeChat content reached a peak the first two days, whereas occasionally the viewers would reach other small peaks weeks or months later. This phenomenon, as the participant suggested, was caused by the circulation of content through WeChat groups or by influential people.

CMO-C4: When content developers use online and/or offline marketing strategies to disseminate the social media products to targeted audiences (C), the target audiences pay increased attention to (M), and engage with them (O).

CMO-C4 refined the original CMO in the realist review. The original CMO lacked recognition of the offline strategies in catching recipients' attention to social media messages. In the CMO-C4, grabbing target audiences' attention was considered a key mechanism for their engagement with social media messages, which would likely be triggered through various

online and offline marketing strategies. One participant highlighted that "*you can't just stick it up and hope for the best… You have to target more directly*" (N7). Participants suggested some online marketing strategies, such as using ambiguous headings and small incentives, to grab people's attention. Some participants considered that mere online strategies were not enough for message engagement, and that "*we had to go to the site to persuade leadership buy-in*" (N7). One participant described her team's experience of approaching hospitals and persuading leaders to post the team's YouTube video on their official website and pediatric units to increase nurses' attention.

CMO-C5: When the social media messages meet recipients' information needs with signs of high credibility and preferably, in a clear and vivid format (C), recipients perceive the messages as valuable for professional development or solving clinical problems (M), and engage with the messages(O).

CMO-C5 refined the original CMO in the realist review. The original CMO detailed the various mechanisms for recipients' engagement with social media messages (eg, the perceived relevance, receptivity, and trustworthiness) without a high-level abstraction. In the CMO-C5, the perceived value of social media messages was considered an overarching mechanism that influenced recipients' engagement with the messages, and three summative factors worked jointly to activate the mechanism: information needs, content credibility, and format acceptability. "*Two factors are decisive in people's engagement with social media content: ambiguity and value. Ambiguity is that the heading of content should be ambiguous so that it allures audiences' interest and desire to open the content. This is often the first key step to*

ensuring engagement; Value is the overall value of content to audiences. If the content is poor, all other efforts will be fruitless" (N1).

Audiences' information needs were considered a premise that impacts their perceptions of the value of messages. From the participants' descriptions, two types of information needs were common: information that enhances professional knowledge and information that solves specific clinical problems. "*My clinical expertise is dialysis, so I would be quite interested in content that is about dialysis or nephrology. I would not spend much time reading content that is irrelevant to my clinical area*" (N10). One participant summarized three situations when he would use social media to access information: 1) traditional approaches (ie, database search) fail to retrieve the information; 2) looking for the latest guidelines and research findings; 3) looking for diverse forms of evidence, eg, instructional videos, quality improvement tools, educational pictures, and infographics (N4).

Content credibility was also considered a fundamental factor that influenced the perception of message value. "*The content should be objective, factual, balanced, new findings rather than well-recognized basic knowledge*" (N10). Participants criticized the common phenomenon of biased information on social media, eg, exaggerating the treatment effects, especially in the headings, and reporting positive effects only. They suggested that content developers should be transparent about the evidence sources (preferably by linking the message to the original documents), declare conflict of interests, and have some quality check mechanisms during the development process. Some cognitive heuristics were mentioned and

used by participants to judge the credibility of content, such as the reputation of the development team, reference check, or its confirmation with pre-existing knowledge.

The format of content relating to its hedonic value impacts audiences' engagement with the messages. Participants described that they wanted the content to be "clear", "concise", "vivid", "short length" and "fun". Other than heavy texts, most participants favored short videos, infographics ("a *picture speaks way more powerful than words*" (N5)), and podcasts ("*people can listen to podcasts in their fragmented time to update knowledge*" (N2)). Some participants further argued that format matters, whereas content eats format for breakfast—when the content is appealing to healthcare providers, they will engage with it, even if the format is unfavorable. "*The key is the content, rather than the format….the format is only a dissemination method to let you see the content. You can use social media, videos, or whatever format to disseminate the content. As long as the content is good, people will read it*" (N11).

CMO-C6: When content developers embed different triggers (ie, behaviour change techniques) in the social media messages (C), healthcare providers experience increased behavioural capabilities, self-efficacy, intention, or awareness (M) to use the messages in practice (O). CMO-C6 was a summative CMO proposition and included four sub-CMOs, among which two (CMO-C6.1 and CMO-C6.2) confirmed the original CMOs, one (CMO-C6.3) refined the original CMO, one (CMO-C6.4) was a new proposition.

CMO-C6.1: When content developers actively interact with healthcare providers and promote interactions among healthcare providers regarding the messages, and if possible, offer targeted feedback (C), healthcare providers experience social support (M), and use the

messages in practice (O). CMO-C6.1 confirmed the original CMO in the realist review. One content developer described that "*people often comment on our social media posts, we would answer these comments individually as possible*" (N2); One healthcare provider confirmed that "*if the content developers can respond to my questions timely, offer tips on overcoming implementation barriers or feedbacks on our implementation efforts, that will be great*" (N3).

CMO-C6.2: When content developers use reminder strategies in their social media initiative (C), healthcare providers have increased awareness (M), and use the messages in practice (O). CMO-C6.2 confirmed the original CMO in the realist review. Content developers in our interview described reposting popular social media content as one strategy to increase recipients' awareness of the knowledge because the social media algorithms make it difficult to find wanted information again once missed it.

CMO-C6.3: When content developers prescribe and demonstrate how to perform the behaviours in the social media message, and/or offer additional resources for systematic learning (C), healthcare providers have increased capabilities and self-efficacy (M), and use the message in practice (O). CMO-C6.3 refined the original CMO by adding another contextual factor—offering additional resources for systematic learning—that could also activate the mechanism of increased capabilities and self-efficacy. One of the key barriers for healthcare providers to use the research evidence, as many participants suggested, was that the information on social media was too concise and often fragmented. "*I don't think the knowledge circulated on social media is very systematic, which in many cases can't help a nurse to make a clinical decision*" (N1). "*Social media is only a guide. It guides you to access the*

evidence. But in terms of its use in my clinical decision making, I still need more systematic reading and learning" (N10). "*Since you will implement the evidence, you have to have a full understanding of all aspects relating to the evidence, not just the content presented on social media"* (N9). Therefore, it is not enough to merely post concise evidence on social media. Along with the evidence, recipients need more systematic educational resources to improve knowledge, skills, and self-efficacy for clinical practice.

CMO-C6.4: When content developers embed real clinical cases or patient stories into the social media messages (C), healthcare providers have improved trust in the practice and expectations of implementation outcomes (M), and use the message in practice (O). CMO-C6.4 was a new proposition. Most healthcare providers in the interview underscored the importance of situating the research evidence in the real clinical setting, either by using real clinical cases or patient stories, to improve trust and outcome expectations. "*If the evidence has been used in other hospitals or organizations, I would feel more confident to use it*" (N6). "*There are many drugs that have side effects. You can't read everything and know everything. But these anecdotes that people talk about help crystallize these things. Saying—hey, this patient took this medicine and he got this rash. This is how it looks like. That's way more impactful than reading something in a textbook or a journal…It remains in your mind...These anecdotes are often sticky*" (N5).

CMO-C7: When healthcare providers actively seek for research evidence to inform clinical practice (C), they have the intrinsic motivation (M) to find and judiciously use the message on social media in practice (O).

CMO-C7 confirmed the original CMO in the realist review. The intrinsic motivation to use research evidence in practice, as one mechanism for healthcare providers' knowledge use, is decided by the personal characteristics of recipients. In the interview, participants illustrated various scenarios in which recipients' characteristics impacted their evidence use, including socio-demographic characteristics such as age, educational background, and seniority, whether the clinician is open or conservative to new treatment approaches; whether they are keen to research. Other factors suggested by participants included learning habits, professional identity, and attitude toward evidence-based medicine. All these factors led to one ultimate determinant which was the response to new evidence—whether the healthcare provider actively seeks and uses research evidence in practice. Therefore, consistent with the findings in the realist review, recipients' response to new evidence was considered the contextual factor that activates their intrinsic motivation to use the message on social media.

CMO-C8: When healthcare providers critically appraise and verify the social media message through various sources (C), they become confident about the credibility of the message (M), and judiciously use the message in practice (O).

CMO-C8 confirmed the original CMO from the realist review. The participants emphasized that healthcare providers should have the basic knowledge to understand and appraise the messages on social media and turn to different sources, such as published literature and field experts, to verify the trustworthiness of messages. "*You must have your own judgment and verify the information… social media posts are often exaggerated to grab your attention. We must keep vigilant*" (N10). "*You need to be knowledgeable about your field to*

make the judgment" (N4). "*After I got this guideline (from WeChat), I feel the information is not enough, so I searched CNKI and Wanfang…I also searched in Medlive. Before I give a presentation about the guideline to our nurses, I also asked doctors in our unit to ensure that my understanding of the guideline is accurate*" (N3)

CMO-C9: When the behavioural recommendations in a social media message are within the healthcare provider's scope of practice with few constraints from their working and professional organizations (C), healthcare providers have the capability to exercise professional autonomy (M), and use the message in practice (O).

CMO-C9 refined the original CMO in the realist review. In the original CMO, healthcare providers' capability to exercise professional autonomy, as a key mechanism for healthcare providers' knowledge use, could be activated by organizations lifting control of the professional practice. In CMO-C9, it was argued that rather than lifting organizational control, which is a rather complex and serious matter, we should emphasize that the message on social media is within professionals' scope of practice with few constraints from their working and professional organizations. Social media, featured with two-way communication, often has its direct impact at the individual level (rather than the organizational level), thus professional autonomy is required for implementing change. "*I'm a physician. I can change things. I can just order it. I don't need to convince anyone else to do something for my patient. Whereas if I've got a fellow or a resident or a nurse, they have to convince me that what they're suggesting is the right thing to do*" (N5). "*I used it (evidence on diet care for diabetic patients on WeChat) in patient education, but only limit to my own patient, not the whole unit*" (N8). One head nurse also

described that "*If the use of evidence is under my own control, I would probably use it directly*" and that individual-level evidence implementation could be beneficial because "*nurses would have more autonomy and be more active at work. And the evidence implementation process would become less complicated than it seems*" (N9).

CMO-C10: When the behavioural recommendations in a social media message have low implementation complexity at the individual level (C), healthcare providers gain an improved perception of its implementability (M), and use the message in practice (O).

CMO-C10 was a new proposition. One participant explicated that "*If they (healthcare providers) feel it's too complicated, too time-consuming, they won't do it regardless of how beautiful their evidence is shared or how widely shared*" (N7). Participants illustrated their experience of using evidence from social media in various scenarios, for example, adjusting the usage of a specific drug, lab test items, or a surgical procedure. They also described the de-implementation of certain practices (eg, stopping using a drug in a population) based on research or anecdotal evidence (eg, patient stories and peer physicians' experiences) shared on social media. Those practices were mostly technical or procedural with low implementation complexity, meaning that neither did they need a systematic change from the organizational level, nor did they demand team efforts, intensive resources, or advanced technical skills, thus leading to a high perception of their implementability (ie, ease of implementation) by healthcare providers.

5.4.3 CMOs from the realist review that were disconfirmed in the qualitative study

Two CMOs were disconfirmed in the qualitative study. The original CMO-2 (see Table 4.3), which was about gaining organizational support to improve social media accessibility, was disconfirmed because participants considered organizational support as an unnecessary condition for social media use. Most participants acknowledged the important role of organizations in "*recommending authoritative social media accounts*" (N8), "*promoting timely access to credible and up-to-date healthcare evidence*" (N3), and "*providing resources and training on online grey literature search*" (N9). Whereas they further argued that "*social media becomes so advanced nowadays; we can get the information we want through different sources even without organizational support*" (N4) and that "*supported or not, it is always our own decision whether to use social media*" (N4).

The original CMO-4 (see Table 4.3), which was about content developers tailoring social media messages to improve recipients' engagement, was also disconfirmed. Although participants described tailoring messages based on platform requirements or "*aligning the messages with public concerns*" (N1), they suggested that these contexts did not necessarily trigger message engagement. Participants highlighted the different information needs between healthcare providers (eg, "*professional, advanced and new information*" (N10)) and the general public (eg, "*simple and basic information*" (N10)) and suggested that "*we need to target towards a specific population*" (N7), rather than tailoring the messages across different populations.

5.4.4 Consolidated program theory proposition

Drawing on the 10 CMOs illustrated above, a consolidated program theory was developed (see Figure 5.1). It is contended that the process by which social media enables knowledge use by healthcare providers is not a linear one. Rather a complex causal chain exists from the development of social media products to their use in practice. If any single causal link breaks, the chain fails and knowledge use by healthcare providers is unlikely to be realized.

For social media to enable knowledge use by healthcare providers, it is a prerequisite for content developers to gain capabilities and capacities to develop social media products relevant to target populations. To make the products accessible to target populations, content developers can edit and post the products on social media platforms that are specialized for and widely accepted by peer healthcare providers and preferably have advanced search and navigation functions. Healthcare providers' access to social media products can be socially influenced by developers' reputations, endorsement of influencers, and (electronic) word-of-mouth. Their engagement with messages is determined by the perceived values of messages, which requires that the messages fulfill needs, manifest signs of credibility, and are in a favorable format. Content developers can turn to various online and offline marketing strategies to grab recipients' attention and promote message engagement. To facilitate knowledge use, different types of triggers (ie, behaviour change techniques) can be employed by content developers to activate the mechanisms of behavioural capabilities, self-efficacy, intention, and awareness. Healthcare providers' intrinsic motivation to use evidence, improved confidence in message credibility, capability to exercise professional autonomy, and perception of evidence implementability are key mechanisms that are likely to lead to their knowledge use.

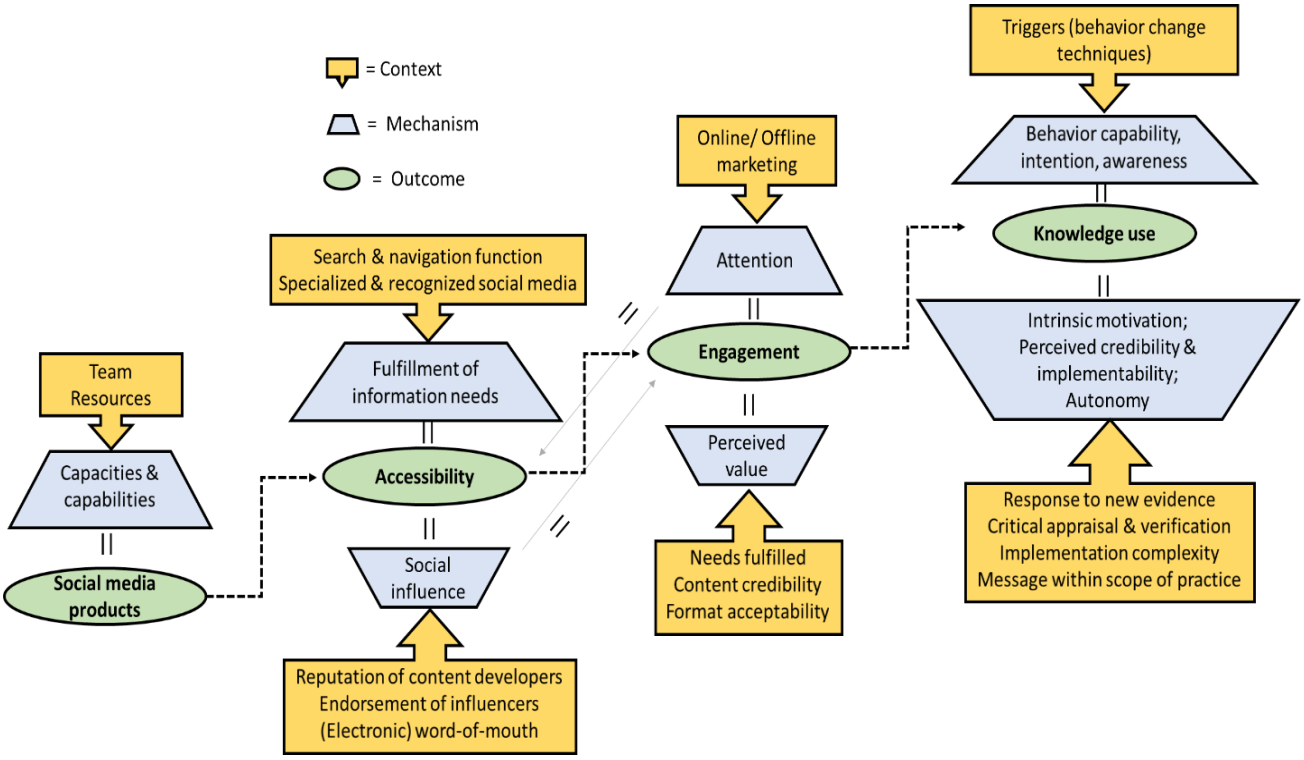

Figure 5.1 Consolidated program theory diagram for open social media platforms

5.5 Discussion

In this qualitative study with 11 participants, we consolidated a program theory for open social media platforms with ten CMOs, which were situated in four interconnected levels of outcomes: social media products, accessibility, engagement, and knowledge use. These ten CMOs considered content developers' 1) capabilities and capacities, along with healthcare providers' 2) increased attention; 3) fulfillment of information needs; 4) access to social influence and support; 5) perception of message value and implementability; 6) behaviour capabilities, self-efficacy, intention, and awareness, and 7) ability to exercise professional autonomy as the key mechanisms. These mechanisms could be activated by 1) resources and team expertise availabilities; 2) online and offline marketing strategies; 3) specialized and

recognized platforms with advanced search and navigation functions; 4) content developers' reputation, people and organization's endorsement, and (electronic) word-of-mouth; 5) needs fulfillment, content credibility, format acceptability, and implementation complexity; 6) triggers (ie, behaviour change techniques); and 7) behavioural recommendation within healthcare provider's scope of practice. In this qualitative study, several new propositions were identified that were not manifested in the realist review. Our discussion primarily focuses on these aspects.

5.5.1 Using cognitive heuristics to evaluate social media message credibility

In this study, developers' reputation, message endorsement, and positive (electronic) word-of-mouth can improve healthcare providers' perception of message credibility and thus socially influence them to access and engage with social media messages. Metzger et al (2010) conducted 11 focus group sessions with 109 internet users and identified that reputation and endorsement were two commonly used cognitive heuristics to evaluate the credibility of online information. The reputation heuristic, rooted in psychological principles, suggests that people are more likely to engage with a source whose name is recognized as credible compared to an unfamiliar source, even without an inspection of the content (Metzger & Flanagin, 2013). The endorsement heuristic implies that people are inclined to engage with information if others do so, even without a scrutiny of content (Metzger & Flanagin, 2013). Yang and Beatty (2016) found in a meta-analysis that online health information provided by an expert rather than a layperson was considered more credible, and the relationship was moderated by demographic characteristics (eg, students or nonstudents, and the age of participants). Other systematic

reviews have also identified the perceived reputation of website owners/sponsors or content creators as a key antecedent of the trust people have in online health information (Kim, 2016; Sun et al., 2019).

Similarly, Lee and Sundar (2013) summarized three types of cues for evaluating the credibility of health messages on Twitter: authority cue (ie, whether the health message source is an expert), bandwagon cue (ie, the number of followers of that source), and source proximity cue (ie, the distance of messages from its original source—tweet and retweet). They found significant three-way interaction effects between these cues— the perceived content credibility was much higher when a professional source had many followers' tweets compared to only a professional source. Whereas users' perceptions of content credibility suffered when there was a misalignment between two cues, such as a professional with few followers (Lee & Sundar, 2013). Electronic word-of-mouth, a concept similar to the endorsement heuristic, has been shown to positively correlate with consumer behaviour in business (Babić Rosario et al., 2016; Ismagilova et al., 2020). In the healthcare sector, electronic word-of-mouth can influence the knowledge, emotions, and behaviours of receivers (Pauli et al., 2022). However, the impact on healthcare providers' engagement with social media information has not been confirmed in empirical studies.

5.5.2 Employing critical appraisal and verification tactics to improve confidence in social media message credibility

Cognitive heuristics are not always reliable in judging the credibility of social media messages (Metzger & Flanagin, 2013), thus critical appraisal and verification tactics are

essential to further improve confidence in message credibility, especially in the healthcare field. D'Souza et al (2022) developed a four-step user guide on how to appraise health information on social media, in which trustworthiness was suggested to be assessed in four dimensions: the source of content, an assessment of the comprehensiveness and evidence base of the content, balanced presentations of views, and independence of conflicts of interest. While the critical appraisal may improve a user's confidence in content credibility, it is limited to the face value of the message, in other words, the content that is shown on social media, without going deeper into the knowledge behind the content. Thus, verification of content from multiple sources is critical to further ensure credibility. The consensus among sources, such as mass media, peer-reviewed literature, and healthcare professionals, is a frequently reported indicator that is likely to improve confidence in content credibility (Sun et al., 2019). Although misinformation and disinformation are becoming ubiquitous on social media, healthcare providers use crosschecking and triangulation tactics to verify sources and judiciously use them in clinical practice (Hughes et al., 2009).

5.5.3 Embedding patient narratives and clinical cases into social media messages

Patient narratives are powerful anecdotal evidence that can be embedded within social media messages to support knowledge use. One of the constantly reported barriers to healthcare providers' use of research evidence lies in the detachment of research evidence from the clinical context (Greenhalgh et al., 2014). Narrative medicine (Charon, 2008) and narrative evidence-based medicine (Charon & Wyer, 2008) is a possible remedial avenue to tackle this dilemma. Patient stories of healthcare experiences on social media can be beneficial

for quality improvement (Zakkar et al., 2022; Zakkar & Lizotte, 2021), for example, the sharing of adverse drug reactions on social media could alert physicians to their prescription behaviour (Matsuda et al., 2017). Drewniak et al (2020) concluded in their systematic review that web-based patient narratives are likely to improve users' understanding of health conditions and have an impact on behaviour change. Nevertheless, the quality of patients' narratives and the professional code of conduct are the main concerns that prevent their wide uptake (Zakkar et al., 2022). Similar to patient narratives, clinical cases and peer healthcare providers' experiences shared on social media, especially in these online communities of practice, are also powerful catalysts to facilitate tacit knowledge flowing (Panahi et al., 2016). Albarqouni et al (2019) analyzed the questions and answers posted in a restricted Facebook group for general practitioners in Australia and New Zealand and found that the clinical questions asked by general practitioners received an average of ten answers, in which 51% offered explanations.

5.5.4 Considering the implementation complexity of behavioural recommendations on social media

This study found that the implementation complexity of behaviour prescriptions on social media is critical for its implementability and successful implementation. The lower level of complexity at the individual level, the higher chance it is to be implemented. While the normative approach conceptualizes knowledge translation as a complex organizational process, this study identified that the procedural and sometimes "cookbook-like" knowledge, such as an adjustment of the usage of a drug, is more or less a straightforward process, and this is where social media can play an important role in changing clinical practice. One interesting finding

from our study is that social media might serve as a powerful de-implementation strategy to remove low-value care practices. A key determinant of de-implementation is the availability of evidence that identifies a clinical practice as having low value (Leigh et al., 2022) and social media has distinctive advantages for circulating such evidence. Healthcare providers, seeing the evidence from influential social media accounts, are likely to reflect on and remove those low-value practices, for example, stopping using a specific drug for a population. Not just research evidence, anecdotal evidence on social media, such as patient narratives on adverse drug reactions as mentioned above, is also a driving force for de-implementation in that many low-value practices are performed because of concerns of malpractice and patient preferences (Leigh et al., 2022).

5.5.5 Exploring the effect of an online and in-person integrated approach for knowledge translation

Although social media has the potential to promote behaviour change in healthcare providers, our study participants consider that exclusive online strategies have limitations, which have also been reported in the literature. For example, compared to the in-personal approaches, social media has shown to be disadvantageous for learning complex technical skills (Swords et al., 2021), building strong bonds and trust with knowledge users, and establishing feedback loops on implementation efforts. Ethical and legal concerns are also prominent in sharing patient stories and clinical cases on social media (Ventola, 2014). In addition, the individual-level practice change through social media is a complex process and full of uncertainty. Failure in any one phase of the causal process could make healthcare providers'

knowledge use unachievable. For example, when content developers use heavy text in their social media messages, healthcare providers are less likely to engage with the message and as a result, would not consider using them. The socio-demographic characteristics of healthcare providers, such as their seniority, age, and educational background, impact the intention to change (Lublóy, 2014). To reduce such uncertainty and improve the likelihood of implementation success, an integrated approach that combines the benefits of both online and in-person strategies has been suggested by our participants and literature (Petkovic et al., 2021). For example, one content developer team in the study developed a YouTube video to demonstrate evidence-based strategies to reduce procedural pain in infants. They took onsite visits to hospitals, persuaded leaders to play the video in the pediatric unit, and gave training to clinical nurses on these strategies.

5.5.6 Strengths, limitations, and implications

This qualitative study building on a previous realist review provides a context-bounded explanation of how social media supports healthcare providers' knowledge use. It can inform the development of social media interventions for knowledge translation and help explain the successes and failures of such initiatives.

This qualitative study has two main limitations. First, the samples of this study were mostly from China with only one from Australia and one from Canada. Nationality is an important contextual factor in healthcare providers' access to social media and bears heavy social, political, and cultural implications on social media use. Although we tried various approaches to recruit participants, such as social media dissemination and influencer

endorsement, we failed to get participants from more nationalities. Second, the primary aim of most current social media initiatives including those from our interview participants is to improve the accessibility of and engagement with research evidence, rather than to promote knowledge use. The content developers in this study, although informative for evidence accessibility and engagement, lacked experience in facilitating knowledge use through social media, and the strategies they suggested to do were not all practiced, but rather were recommendations from their experiences. On the other hand, healthcare providers in the study, who do not have experience in content development, often had excessive demands for content developers that at times seemed unrealistic. Recognizing limitations participants had in providing information, we used the confirmation tactic (ie, described by both sides) to remedy them.

Based on the findings of this study, we propose several implications for social media initiatives that aim to improve knowledge use by healthcare providers: 1) prepare team and resources to develop credible and actionable social media messages in a user-friendly format, preferably with patient voice involved and aligned with the real clinical context; 2) pre-assess implementation barriers to inform the behaviour change techniques to be used in the social media product; 3) edit and post the product on social media platforms specialized for and widely accepted by healthcare providers; 4) use different online (eg, influencer endorsement) and offline (eg, approaching to hospitals and professional organizations) strategies to increase accessibility and engagement; 5) actively offer guidance and feedback on implementation and promote interaction; 6) provide additional learning resources associated with the social media messages; and 7) make use of different opportunities to remind recipients about message use.

We propose three implications for future research. First, qualitative studies using the focus group method with content developers and healthcare providers who have more diverse characteristics would be informative for our understanding of this topic (Manzano, 2022). Within the focus group, participants can mutually guide each other through interaction and build collective knowledge on how we can best use social media for healthcare providers' knowledge use. Second, the digital ethnography approach, which requires researchers to immerse themselves in the virtual field and observe how those real-world influential social media initiatives operate and audiences' responses to them, would enhance our understanding of healthcare providers' engagement and use of knowledge on social media. Third, evaluation studies of social media initiatives that draw on the findings of this study would significantly optimize our theoretical understanding of this complex practice.

5.6 Conclusions

Through a realist-informed qualitative study, we consolidated a program theory of how open social media platforms support healthcare providers' knowledge use with ten CMOs. Social media has the potential to promote knowledge use by healthcare providers, whereas as a complex virtual process, it bears inherent limitations and uncertainty for knowledge translation. Future research is necessary to further understand the working mechanisms of this complex practice and explore the effects of an online and in-person integrated approach for knowledge translation.

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Chapter 6: Integrated discussion

In the previous chapters, I presented research findings of the three-phase realist theory development project. In this closing chapter, I summarize the key findings of this dissertation, discuss them in the context of evolving literature, and provide implications for nursing practice and future research.

6.1 Summary of dissertation findings

Through a three-phase realist theory development process (ie, theory gleaning, theory refining, and theory consolidation), I built a progressive theoretical understanding of how social media supports healthcare providers' knowledge use in clinical practice. In this section, I summarize the key findings of each phase of the dissertation and illustrate the overarching theoretical propositions based on the thesis findings.

For the clarity of the signified theoretical outputs at each phase, in this chapter, I name the initial program theory developed in phase one as "the initial SMILE framework", the refined program theory developed in phase two as "the refined SMILE framework", and the overall theoretical outputs after all three phases as "the consolidated SMILE framework 1.0". I acknowledge that it is premature to label the thesis outputs as a fully consolidated framework given that the theory consolidation phase has only focused on open social media platforms (the rationality-driven approach). Whereas theory development from the realist perspective is a continuous evolutionary process. The consolidated SMILE framework 1.0 here only implies that the framework is consolidated at this theory development circle, rather than the endpoint.

6.1.1 Theory gleaning phase

The purpose of this phase was to propose a conceptual framework to understand how social media works as a knowledge translation strategy for healthcare providers, policymakers, and patients to inform their healthcare practice. I developed this framework using an integrative approach that involved reviewing five longstanding social media initiatives, five theories on social media studies and knowledge translation, and 58 empirical studies. Through an iterative process, I developed the initial SMILE framework. The initial SMILE framework has six key constructs: content developers, messages and delivery strategies, recipients, context, triggers, and outcomes. For social media to effectively enable recipients to use research evidence in their practice, the framework proposes that content developers respond to target recipients' needs and context, and develop relevant messages and appropriate delivery strategies. Recipients' use of social media messages is influenced by the virtual-technical, individual, organizational, and system contexts, and can be activated by three types of triggers: sparks for motivation, facilitators for capability, and signals for reminding. The initial SMILE framework mapped the factors that were hypothesized to influence the use of social media messages by recipients and offered a heuristic device for content developers to create interventions for promoting the use of evidence in healthcare practice.

6.1.2 Theory refining phase

The purpose of this phase was to synthesize literature to understand how and under what circumstances social media supports healthcare providers' knowledge use by using a realist review methodology. Through a synthesis of 32 documents, I identified two causal explanations of how social media could support healthcare providers' knowledge use, which

altogether was named the refined SMILE framework. These causal explanations were: 1) the rationality-driven approach that primarily uses open social media platforms, and 2) the relationality-driven approach that primarily uses closed social media platforms. Key mechanisms of the rationality-driven approach included content developers' capabilities and capacities in addition to recipients' access to, perceptions of, engagement with, and intentions to use the messages, and ability to function autonomously within their full scope of practice. In contrast, the relationality-driven approach encompassed platform receptivity, a sense of common goals, belonging, trust and ownership, accessibility to expertise, and the fulfillment of needs as key mechanisms.

6.1.3 Theory consolidation phase

The purpose of this phase was to consolidate the rationality-driven program theory which is about using open social media platforms to support knowledge use by healthcare providers. Through a realist-informed qualitative study with 11 participants from China, Australia, and Canada, I consolidated the program theory with 10 CMOs which were situated in four interconnected levels of outcomes: social media products, accessibility, engagement, and knowledge use. They considered content developers' capabilities and capacities, along with healthcare providers' increased attention; fulfillment of information needs; access to social influence and support; perception of message value and implementability; behaviour capabilities, self-efficacy, intention, and awareness; and ability to exercise professional autonomy as the key mechanisms.

6.1.4 The overarching theoretical propositions

Based on the research findings of the three phases, I built an overarching theoretical understanding of how social media supports healthcare providers' knowledge use, which was named the consolidated SMILE framework 1.0. This framework encompassed two causal explanations: the rationality-driven approach and the relationality-driven approach.

The rationality-driven approach aligns most with open social media platforms which are Web 2.0-based applications that are accessible to everyone after successful registration and allow the creation and exchange of user-generated content. I argue that in the rationality-driven approach, four critical and interconnected phases need to be considered for social media to enable knowledge use by healthcare providers: social media products, accessibility, engagement, and knowledge use. It is a prerequisite for content developers to gain capabilities and capacities to develop social media products that are relevant to target populations. To make the products accessible, content developers can edit and post the products on social media platforms that have advanced search and navigation functions and are specialized for and widely accepted by healthcare providers. Healthcare providers' access to social media products can be socially influenced by developers' reputations, endorsement of influencers, and (electronic) word-of-mouth. Their engagement with messages is determined by the perceived values of messages, which requires that the messages fulfill needs, manifest signs of credibility, and are in a favorable format. Content developers can turn to various online and offline marketing strategies to grab recipients' attention and promote message engagement. To facilitate knowledge use, different types of triggers (ie, behaviour change techniques) can be employed by content developers to activate the mechanisms of behavioural capabilities, self-efficacy, intention, and awareness. Healthcare providers' intrinsic motivation to use evidence,

improved confidence in message credibility, capability to exercise professional autonomy, and perception of evidence implementability are key mechanisms that are likely to lead to their use of knowledge from social media.

The relationality-driven approach aligns most with closed social media platforms which are online groups or communities where the group organizers develop parameters of eligibility to determine which applicants are allowed to join. I propose that there are three critical phases for closed platforms to support healthcare providers' knowledge use: functionality, engagement, and knowledge use. It is a prerequisite for a closed platform to have technical support and a clear domain of interest to ensure its functionality. To promote member engagement, three key roles are essential: 1) facilitators who nurture a supportive learning online culture to build a sense of belonging, trust, and ownership among group members; 2) (inter)disciplinary experts who provide members access to knowledge and expertise; and 3) group organizers who assess member needs and measure group performance to fulfill member expectations. Through engagement and everyday interaction, group members build collective knowledge to inform practice change.

Although I distinguish the rationality and relationality-driven approaches for healthcare providers' knowledge use, I argue that these two approaches have no distinct boundaries, nor are they binary and static. Rather, they represent a dynamic continuum with one side being primarily rationality-driven and the other primarily relationality-driven. For most real-world social media initiatives, both rational and relational considerations are required to thrive and

make knowledge use possible. Based on my thesis findings, an integrated approach that draws on the advantages of both is most likely to accelerate knowledge use through social media.

6.2 Dissertation findings in the context of evolving literature

In the previous section, I summarized the findings of the thesis and illustrated the overarching theoretical propositions. In this section, drawing on existing literature, I discuss the thesis findings from three aspects: 1) the rationality and relationality-driven approaches for healthcare providers' knowledge use; 2) comparing the consolidated SMILE framework 1.0 with existing theories in the field of social media and knowledge translation; 3) situating the consolidated SMILE framework 1.0 within the broad implementation science literature.

6.2.1 Rationality and relationality-driven approaches for healthcare providers' knowledge use

One of the most important and novel findings of this project is the two causal explanations of how social media supports healthcare providers' knowledge use: the rationality-driven approach using primarily open platforms and the relationality-driven approach using primarily closed platforms.

Understanding these two approaches from the epistemological level, the rationality-driven approach implies a "knowledge then action" conceptualization of translational studies (Greenhalgh & Engebretsen, 2022), which separates knowledge production (usually explicit knowledge from low-biased research findings) from its translation. The scientific knowledge that is to be translated is outside the process of translation, and the process of translation should maintain high fidelity with the original scientific messages (Engebretsen et al., 2020; Engebretsen et al., 2017; Ødemark & Engebretsen, 2022). Accordingly, the use of knowledge

from social media consists of a series of rational decisions on which scientific research findings can be brought to bear (Greenhalgh & Wieringa, 2011). In contrast, the relationality-driven approach conceptualizes knowledge translation as “knowledge through action”, “evolutionary learning” (West et al., 2019), or “adaptive learning” (Sanderson, 2009) that links research and action in complex and fast-evolving situations. The relationality-driven approach considers knowledge translation “an entangled material, textual and cultural process (p. 2)” where the cultural and humanities dimensions are an integral part of knowledge translation, rather than seen as barriers (Engebretsen et al., 2017). Under this conceptualization, the translation of knowledge does not just duplicate the original scientific knowledge, it also completes the original message by situating it in specific contexts and fulfilling one of its possible interpretations to make sense of the message (Engebretsen et al., 2020; Engebretsen et al., 2017; Ødemark & Engebretsen, 2022). Accordingly, the knowledge on social media that is to be used moves beyond explicit knowledge to an appreciation of its multiple forms: the situation-specific practical wisdom that underpins clinical judgment and the tacit knowledge that is built and shared among practitioners (Greenhalgh & Wieringa, 2011); knowledge is tested by its ability to solve specific clinical problems as they emerge. The process of knowledge translation is thus problem-oriented and requires structures that enable interaction and deliberation (Greenhalgh & Engebretsen, 2022; Sanderson, 2009; West et al., 2019).

From the practice level, the rationality-driven approach emphasizes that social media messages created by content developers should be based primarily on evidence from systematic reviews and evidence-based guidelines. Recipients use various strategies, such as critical appraisal skills and verification tactics, to improve confidence in the credibility of social

media messages. In contrast, the relationality-driven approach highlights the importance of knowledge co-creation to solve specific and emerging clinical problems and build a sense of belonging, trust, and a supportive learning online culture for engagement. In the following, I expand the discussion of these two approaches from the practice level.

6.2.1.1 The rationality-driven approach

The rationality-driven approach requires that both content developers and the recipients (ie, healthcare providers) deliberate on the credibility of healthcare information that is shared on or retrieved from social media (Cook et al., 2018; Unnikrishnan et al., 2018), and that healthcare providers use online information in practice judiciously (Hughes et al., 2009; Ventola, 2014). For content developers, a high social responsibility is required to develop credible health information. It is not enough to make the content itself evidence-based, but also to exhibit content credibility to audiences through language, structure, and delivery, in that all of these features positively impact the perceived credibility of content (Sbaffi & Rowley, 2017). Specifically, content developers can use strategies, such as presenting the content reference source, disclosing team affiliations and contact details, adding team logos, and using external links, to improve the perception of content credibility (Sbaffi & Rowley, 2017).

For healthcare providers, a mass of models and tools have been developed to help evaluate the online source credibility, for example, the CRAP model (ie, Currency/Credibility, Reliability, Authority, and Purpose/Point of View) and SIFT model (ie, Stop, Investigate the source, Find better coverage, Trace claims, quotes, and media to the original context) (Kington et al., 2021). Among them, the model developed by Tandoc Jr et al (2018) is very consistent

with the thesis findings in that they proposed two acts of authentication of information on social media: internal and external. Similar to the critical appraisal practice by recipients described in the consolidated SMILE framework 1.0, the internal act of authentication suggests that healthcare providers authenticate a social media message using their knowledge and skills (eg, checking the author, checking for cues, checking the topic). Consistent with the verification tactics described in the consolidated SMILE framework 1.0, the external act of authentication requires healthcare providers to authenticate a social media message using other sources aside from one's knowledge and skills (eg, checking the author's background, checking past posts, crossmatching) (Bautista et al., 2021). This Tandoc Jr model argues that at the most basic level, people rely on their own sense of judgment to determine the validity of information (internal). If this approach fails to determine the validity, individuals then turn to external forms of authentication (Tandoc Jr et al., 2018).

The rationality-driven approach requires that both content developers and healthcare providers deliberate on the usefulness (ie, perceived value) and usability (ie, perceived implementability) of content on social media, both of which are key indicators of online health information quality (Sbaffi & Rowley, 2017; Sun et al., 2019) and facilitating factors of healthcare providers' use of evidence on social media (Tunnecliff et al., 2015; Unnikrishnan et al., 2018). Usefulness implies that healthcare providers, drawing on their professional knowledge and knowledge about their local context, estimate possible outcomes of implementing evidence from social media. My qualitative study highlights that content developers can facilitate healthcare providers' perception of the usefulness of social media messages through the provision of research data or the use of real implementation cases and

patient stories within the messages. Sun et al (2019) suggested in their systematic review that the usefulness of online health information could be enhanced by the provision of tailored and personalized information, contact information, and various level of details for different needs.

Usability, on the other hand, suggests that healthcare providers make a judgment as to whether the evidence on social media can be used in clinical practice easily, efficiently, and safely (Abdel-Wahab et al., 2019) considering time and resource investment and implementation complexity. Antheunis et al (2013) identified that healthcare providers considered the expected inefficiency, eg, perceived extra burden of time and resources and the lack of skills, as the main barrier to the use of evidence on social media. Content developers can facilitate recipients' judgment of usability by clearly presenting behavioural recommendations (D'Souza et al., 2022). A simple AACTT (ie, Action, Actor, Context, Target, Time) framework has been suggested to specify behaviour and clarify who needs to do what differently to make change happens (Presseau et al., 2019). Overall, usefulness and usability are two key dimensions of social media messages that both content developers and healthcare providers need to reflect on to not only facilitate trust formation (Fisher et al., 2008) but also knowledge use.

The rationality-driven approach requires that both content developers and healthcare providers build a sense of e-professionalism. As a complex virtual process, healthcare providers' use of knowledge from social media is full of professional and ethical concerns (Elliott et al., 2020; Unnikrishnan et al., 2018). For example, my research findings suggest that when content developers use real clinical cases and patient stories in the social media message, they are likely

to improve recipients' trust in the messages and outcome expectations. However, the disclosure of patient information could sometimes cause unexpected negative consequences for the patient and thus requires to be dealt with ethically. E-professionalism requires that healthcare providers self-regulate their online behaviour and abide by the professional code of conduct. Specifically, they are suggested to commit to patient confidentiality, maintain appropriate relations with patients, disseminate scientific knowledge, and maintain trust by managing conflicts of interest (Gholami-Kordkheili et al., 2013). Although professional organizations have released recommendations and regulations on the proper use of social media (Farnan et al., 2013), healthcare providers constantly expressed uncertainty about boundaries and strategies for its use (Campbell et al., 2016; DeCamp et al., 2013). It was suggested that a "dual-citizenship" approach that separates public (professional) and private (personal) personae would allow healthcare providers to leverage networks for professional connections and maintain privacy in other aspects (Mostaghimi & Crotty, 2011).

6.2.1.2 The relationality-driven approach

The relationality-driven approach requires that online group members build social trust and a sense of community so that deliberative dialogue and collective knowledge-building and sharing become possible (Plamondon & Caxaj, 2018). Pyrko et al (2017) identified that the process of 'thinking together' was a key mechanism of meaningful communities of practice where group members mutually guide each other through their understandings of the same problems in their area of mutual interest. Such a learning process would be enabled by a supportive learning culture and interpersonal trust among members (Ardichvili, 2008). With

trust, online communities are likely to thrive with group members' social and informational needs being met and relationships being strengthened (Blanchard et al., 2011; Young, 2013). Blanchard et al (2011) developed a model of online trust within virtual communities, in which they argued that exchanging support among group members and having opportunities to develop one's identity is likely to lead to trusting and healthy virtual communities. The sense of community, a concept closely linked to trust building, is a key element of a successful online community (Young, 2013) and requires four basic elements: 1) membership—individuals feel a sense of belonging to the community; 2) integration and fulfillment of needs—the goals of individuals match with those of the membership as a whole and accordingly the satisfaction of individual needs also satisfy the community needs; 3) influence—members feel they matter and can influence the community; and 4) attachment—members share an emotional connection (McMillan & Chavis, 1986; Young, 2013).

The relationality-drive approach recognizes the practical knowledge that is collectively constructed in supporting clinical practice (Greenhalgh & Wieringa, 2011). Building on the seminal ethnographic work by Gabbay and Le May on "mindlines"(2004), Wieringa et al (2018) demonstrated that in virtual communities, physicians employed individual case narratives, personal experiences, and stories to construct knowledge collectively. Different from the conventional evidence-based medicine framework which views knowledge narrowly as factual data, in these virtual communities both explicit (ie, articulated, written down, or published academic knowledge found in books, manuals, papers, etc.) and tacit knowledge (ie, knowledge acquired individually or as a group in the workplace as in the process of learning by doing) inform good practice in a fluid, dynamic, and constantly evolving way (Polanyi, 2009; Wieringa

et al., 2018). Knowledge generated in these virtual communities was described as "knowledge-in-practice-in-context"— practical knowledge that is shaped by the local setting and a need for that knowledge which involves a process of reduction and prioritization from a vast realm of potentially relevant knowledge. This type of knowledge is well needed to tackle specific individual cases (Gabbay & Le May, 2010; Gabbay & le May, 2016; Wieringa et al., 2018; Wieringa & Greenhalgh, 2015). In these virtual communities, a series of knowledge conversion mechanisms occur that allow tacit knowledge to be transformed and new knowledge to be generated to guide clinical practice (Panahi et al., 2013, 2016). These mechanisms are 1) socialization—the process of acquiring tacit knowledge through interaction with and feedback from group members; 2) externalization—the process of making tacit knowledge explicit by codifying it to various forms like documents, manuals, user guides; 3) combination—a process of organizing and integrating different types of explicit knowledge to form a more complicated and systematic knowledge system; and 4) internalization—the process of internalizing the combined knowledge that makes sense to the individual in the light of their own existing knowledge and experience, and applying the knowledge to practice (Nonaka & Takeuchi, 1995; Panahi et al., 2013). Drawing on these mechanisms, Panahi et al (2016) further developed a theoretical understanding of tacit knowledge sharing on social media from the perspective of physicians, which involved five main constructs: socializing, practicing, networking, storytelling, and encountering.

6.2.1.3 The rationality-relationality integrated approach

Although I have distinguished the rationality and relationality-driven approaches for healthcare providers' knowledge use, I propose that an integrated approach that draws on the advantages of both is likely to accelerate knowledge use through social media.

For open social media platforms, knowledge use by healthcare providers is primarily rationality-driven with relational components as additional considerations. One key construct in my program theory that activates behaviour change is the rational use of different types of triggers (ie, behaviour change techniques) based on the identified implementation barriers, which requires content developers to consider the relational elements in terms of their delivery (eg, the appropriate use of language) to build an emotional connection with recipients. Similarly, the rational judgment of the credibility of social media messages, as a key mechanism in my program theory, can be enhanced by some cognitive heuristics that are relational, such as the reputation of content developers and endorsement of social media influencers (Metzger & Flanagin, 2013; Metzger et al., 2010). Through a case study of four social media initiatives for knowledge translation (using open platforms, such as Facebook and Twitter), Elliott et al (2020) found that knowledge translation through social media can be facilitated by the social capital that is built through direct or indirect social relationships among social media users with similar interests. An exemplary case of this type of rationality-relationality integration is the *It Doesn't Have to Hurt* YouTube video, where content developers embed evidence-based pain-relief strategies into the video through a four-year-old girl telling parents what they should and should not do to help make needles hurt less (Chambers et al., 2020). Through this approach, evidence-based practice is conveyed to patients whilst an emotional connection is built at the same time.

For closed social media platforms, knowledge use by healthcare providers is primarily relationality-driven with rational components as additional considerations. While a sense of trust, belonging, and community is essential for online communities to thrive, members within the communities should still maintain reflection on what information is to be shared within the community (ie, ethical and legal considerations); what information shared by whom can be more trusted (ie, information credibility consideration); and what tools and resources suggested by community members can be transferred to the local context (ie, implementability consideration). An exemplary case of this type of rationality-relationality integration is the "InspireNet"—a virtual professional network for health professionals in British Columbia, Canada, which grew to over 3000 members within less than four years. Within the virtual community, a distributed leadership model was used to foster a sense of ownership and support communication and collaboration. Meanwhile, the network managers reflected on community progress by constantly tracking community activities, evaluating impact, and monitoring technical issues; community members also deliberated on the usability of community resources in supporting their clinical practice (Frisch et al., 2014).

6.2.2 Comparing the consolidated SMILE framework 1.0 with existing theories in the field of social media and knowledge translation

As was mentioned in the background chapter, most of the current theories within the social media field detach social media use from its message use. To understand social media use, different theories and models from the field of technology adoption, such as the Technology Acceptance Model (Davis, 1985, 1989; Rauniar et al., 2014), have been used (Arguel

et al., 2018; Heinsch et al., 2021; Ngai, Tao, et al., 2015). To understand message use, theories from the field of behavioural science, such as the COM-B model (Michie et al., 2011), have become popular (Ngai, Moon, et al., 2015; Ngai, Tao, et al., 2015). Such a division is problematic to understanding healthcare providers' use of knowledge from social media in that social media use and message use are interconnected in the knowledge translation process with the former preceding and shaping the latter and in certain circumstances, the latter promoting the former. Therefore, an integrated understanding of these two dimensions of social media interventions for practice change is necessary to capture their interactions and inform social media intervention development.

Among current theories and models in the social media field, the logic model developed by Petkovic et al (2021) in a Cochrane review of social media interventions for health behaviour change is very informative. The Petkovic model illustrated that materials, human resources, and behaviour change techniques implemented through social media and non-social media interventions are expected to change health behaviours and ultimately health outcomes through the mechanisms of knowledge, attitudes, self-efficacy, motivation, and emotions. Along with this model, they adapted a Funnel of Attrition (White, 2018) to describe the different levels of outcomes of using social media for health behaviour change, including awareness, engagement, knowledge, attitude, intention/motivation, health behaviour, and health outcome. Similar to the consolidated SMILE framework 1.0 which considers social media interventions involving multi-phase outcomes shaped by different mechanisms, the Petkovic model acknowledges that social media interventions are complex with multiple interactive components and outcomes, and makes explicit the mechanisms that are likely to lead to change.

It also highlights the importance of offline intervention components to reinforce the message of health-related campaigns, which is consistent with the findings from the qualitative study. Although the Petkovic model targets patients and the public, it offers rich information on the input considerations and mediating factors for social media behaviour change interventions. However, unlike the consolidated SMILE framework 1.0, which explicates the contextual factors that shape different mechanisms, the Petkovic model lacks explanations of the contextual impact.

The Petkovic model above primarily concerns open social media platforms. Next, I compare the consolidated SMILE framework 1.0 with theoretical findings from the community of practice theory—a social learning theory relating to closed social media platforms. Developed by Wenger and colleagues, the theory of community of practice has been evolving (Li et al., 2009) from understanding the interaction between novices and experts (Lave & Wenger, 1991), understanding socialization and learning (Wenger, 1998), to using it as a managerial tool for improving an organization's competitiveness (Wenger et al., 2002). In recent years, communities of practice have been used to facilitate knowledge translation (Barwick et al., 2009; Conklin et al., 2011; Kothari et al., 2015). Consistent with the consolidated SMILE framework 1.0 which perceives knowledge use through closed platforms as primarily relationality-driven, the key mechanisms for knowledge translation through a community of practice involve social capital, trust, access to experts, training opportunities, and interaction (Ranmuthugala et al., 2011; Thomson et al., 2013). Kislov et al (2011) drew on theoretical literature on communities of practice to understand interprofessional and inter-organizational collaboration. They argued that community of practice theory could complement

traditional stage-of-change theories used in implementation research and offer insights for knowledge translation and organizational learning crossing disciplinary and organizational boundaries. While the working mechanisms of closed platforms, like the community of practice, have been captured in my realist study and other literature, limited attention has been paid to the contextual factors that activate these mechanisms, for example, how to build trust and sense of community among virtual community members, and how to facilitate member engagement in community activities. More empirical studies are required to explore these dimensions to consolidate the theory.

Next, I compare the consolidated SMILE framework 1.0 with two of the most commonly used models and frameworks in the field of implementation science: the COM-B model (Michie et al., 2011) and the i-PARIHS framework (Harvey & Kitson, 2015). The COM-B model suggests that capability, opportunity, and motivation interact to generate behaviour that in turn influences these components (Michie et al., 2011). Connected with this model are the Theoretical Domains Framework (Cane et al., 2012; Michie et al., 2005) and the behaviour change technique taxonomy (Abraham & Michie, 2008; Michie et al., 2008; Michie et al., 2013), which are all mapped to the Behaviour Change Wheel (Michie et al., 2011) to guide the identification of behavioural determinants and intervention development. This COM-B model informed the development of the initial SMILE framework in the first phase of this project. One key construct in the initial SMILE framework that activates the use of knowledge from social media is “trigger”, which is considered an active ingredient for knowledge use and is operationalized as different types of behaviour change techniques. Triggers are classified into three types: sparks for motivation, facilitators for capability, and signals for reminding (Fogg,

2009), which corresponds to the three constructs of the COM-B model. The proposition of COM-B is also embedded in the consolidated SMILE framework 1.0 in which I argued that content developers can use different types of triggers (context) to improve behavioural capability, intention, and motivation (mechanisms) for knowledge use (outcome). As a middle-range theory, the COM-B model helps to explain human behaviour and behaviour change in general, and therefore is useful to understand healthcare providers' behaviour change. However, the COM-B model has two limitations when it is singularly used to understand the use of social media for healthcare providers' behaviour change. The COM-B model has a high level of abstraction, therefore lacks specificity when explaining social media interventions. Second, as a complex intervention involving causal chains, the mechanisms of social media interventions can not be fully explained by COM-B alone, nor is the model informative for intervention development. The consolidated SMILE framework 1.0 has a lower level of abstraction and reflects the specific social media context, therefore has greater explanatory power and utility in guiding social media interventions (Im & Meleis, 2021).

The i-PARIHS framework posits that successful knowledge translation relies on the facilitation of three interactive elements: innovation, recipients, and context (Harvey & Kitson, 2015). While the i-PARIHS (and the previous PARIHS) framework has been used in various practice settings, such as primary health and hospital settings (Bergström et al., 2020), telecare (Bauer et al., 2018), and health technology adoption (Harvey et al., 2018), its use in social media programs has not yet been investigated. This framework guided the development of the initial SMILE framework and was embedded in the consolidated SMILE framework 1.0. In the i-PARIHS framework, the framework developers extended the construct of innovation (previously named

"evidence") from research evidence to a broader scope with tacit and practice-based knowledge included. They argued that people rarely apply evidence from systematic reviews and guidelines into practice directly, rather they adapt them to suit particular situations with the explicit knowledge blended with other forms of practice-based knowledge (Harvey & Kitson, 2015). Such an understanding of innovation has been manifested in both the relationality and rationality-driven social media use model. In the relationality model, virtual community members build collective knowledge from multiple sources such as personal working experience, patient stories, and local quality improvement resources, not limited to research findings. In the rationality model, real clinical cases demonstrated within social media messages are contextual factors that trigger the reflection of alignment between external explicit evidence and local practice and priorities which is a type of practice-based knowledge. In the i-PARIHS framework, the contexts include three different layers: local, organizational, and external health system level (Harvey & Kitson, 2015). In the consolidated SMILE framework 1.0, the contexts are extended to include the virtual-technical context relating to social media which has a large impact on the production of social media messages and their accessibility to the targeted population. In the i-PARIHS framework, recipients are the people who are affected by and influence the implementation process. In the consolidated SMILE framework 1.0, there is a nuanced understanding of the actors involved in implementation. In the rationality model, another group of key actors involved in implementation alongside recipients is content developers who often have a decisive role in developing social media products and a facilitation role in activating healthcare providers' knowledge use. In the relationality model, there is no clear distinction between content developers and recipients as all virtual community members

are involved in the knowledge creation and application process. In the i-PARIHS framework, facilitation is the active ingredient that promotes knowledge translation (Harvey & Kitson, 2015), which has been manifested in content developers' use of triggers in the rationality model and the online facilitator role in the relationality model.

6.2.3 Situating the consolidated SMILE framework 1.0 within the broad implementation science literature

6.2.3.1 Comparing the use of social media for knowledge dissemination with its use for knowledge translation

Drawing on the thesis findings, I illustrate the relationship between using of social media for knowledge dissemination and using of social media for knowledge translation from the following aspects (see Figure 6.1).

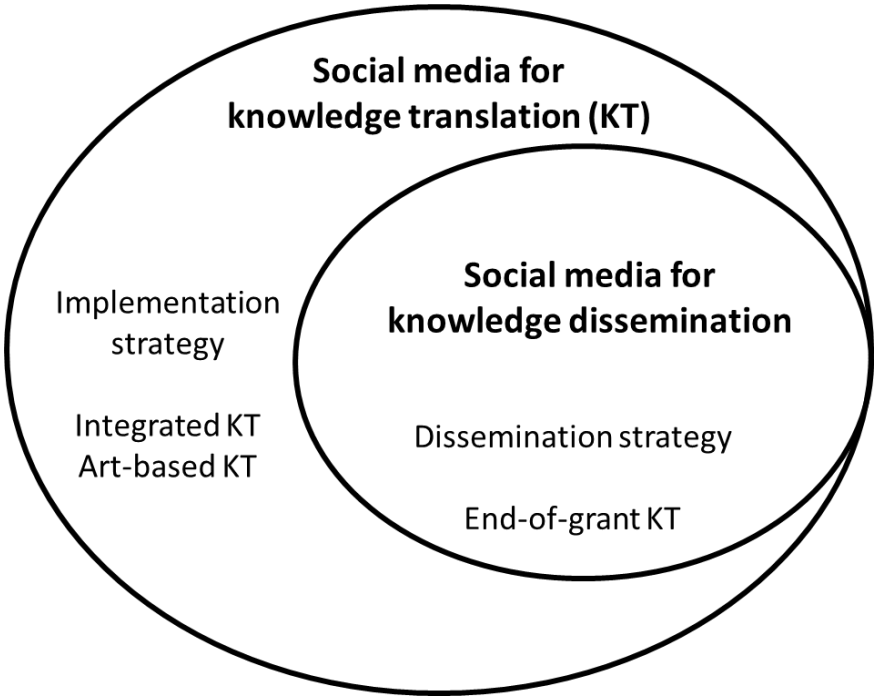

Figure 6.1 An argument for the relationship between social media for knowledge dissemination and social media for knowledge translation

First, there is considerable overlap between the two. Knowledge dissemination, also known as knowledge transfer and end-of-grant knowledge translation, focuses on communicating research findings through tailoring the messages to target audiences (Straus et al., 2013), the goals of which are to ensure that end users are aware of, have access to, and understand the evidence (Munn et al., 2018). Social media, with its unique advantages of free accessibility and interactive communication, has been extensively used as a knowledge dissemination tool (Bhatt et al., 2021; A. K. M. Chan et al., 2020; Gough et al., 2017). As is presented in the consolidated SMILE framework 1.0, two key phases in the process of using social media for knowledge translation are the accessibility of and healthcare providers' engagement with social media products. However, from a knowledge translation perspective, it is not the endpoint to only promote target audiences to access and engage with social media products, we argue in the consolidated SMILE framework 1.0 that content developers can turn to various behavior change techniques to promote target audiences to use the behavior recommendations in practice. Therefore, knowledge dissemination through social media is the precursor and can be considered a subset of using social media for knowledge translation.

Following the argument above, using social media for knowledge translation involves the adoption of implementation strategies, such as instructions on performing a behavior, to alter behaviour. It is beyond the scope of knowledge dissemination which primarily concerns

embedding dissemination strategies, such as infographics, tweetorials, and podcasts, in a social media product to improve accessibility and engagement.

Third, social media may contribute to a novel form of integrated knowledge translation (Kothari et al., 2017). As is shown in the initial SMILE framework, content developers can work together with knowledge users to develop and disseminate a social media product. They can also co-create the implementation strategies to be embedded in the social media product and interpret the impact of social media initiatives together. An exemplary case could be the *Be Sweet to Babies* social media initiative. The team conducted a systematic review of YouTube videos on reducing vaccination pain in neonates (Harrison et al., 2014). Based on the findings, they developed a more concise YouTube video, as a knowledge product, to share evidence-based strategies for pain management (Harrison et al., 2016). They disseminated the YouTube video in various ways and evaluated the impact of dissemination strategies (Bujalka et al., 2022; Hu et al., 2021; Vieira et al., 2020). They shared the YouTube video with pediatric professionals and identified barriers and facilitators of using the behaviour recommendations in practice (Hu et al., 2020). They also conducted several randomized trials to understand its impact on patients and healthcare providers pain management behaviour change (Lavin Venegas et al., 2019; Modanloo et al., 2021). While the team may not strictly abide by the integrated knowledge translation principles in the research process, their initiative manifests the potential of social media to be embedded in the whole process of knowledge creation and application.

Lastly, social media might function as an art-based knowledge translation tool, which has a larger scope than using social media for knowledge dissemination. Art-based knowledge

translation is defined as “a process that uses diverse art genres (visual arts, performing arts, creative writing, multi-media including video and photography) to communicate research with the goal of catalysing dialogue, awareness, engagement, and advocacy to provide a foundation for social change on important societal issues (p. 296)” (Kukkonen & Cooper, 2019). In the consolidated SMIEL framework 1.0, one unexpected finding is embedding patient stories in social media messages to improve recipients’ trust in the practice, which to some extent, can be viewed as an art-based approach. Social media offers the platform for some art-based strategies to be possible.

6.2.3.2 Comparing social media with other implementation strategies

First, unlike other specific forms of implementation strategies, social media can function as a pool where multiple implementation strategies can be embedded (see Figure 6.2). In the consolidated SMILE framework 1.0, we found that content developers can use various “triggers” (ie, implementation strategies) in the social media messages to promote behaviour change, including but not limited to reminders, provision of education materials, behavioural instructions, and incentives. Those implementation strategies can alter behaviour through the mechanisms of reinforcement, improvement of knowledge, skills, motivations, and so on. While other forms of implementation strategies often target specific behaviour change mechanisms, social media can work for behaviour change by using a combination of multiple implementation strategies that address multiple behaviour change mechanisms altogether.

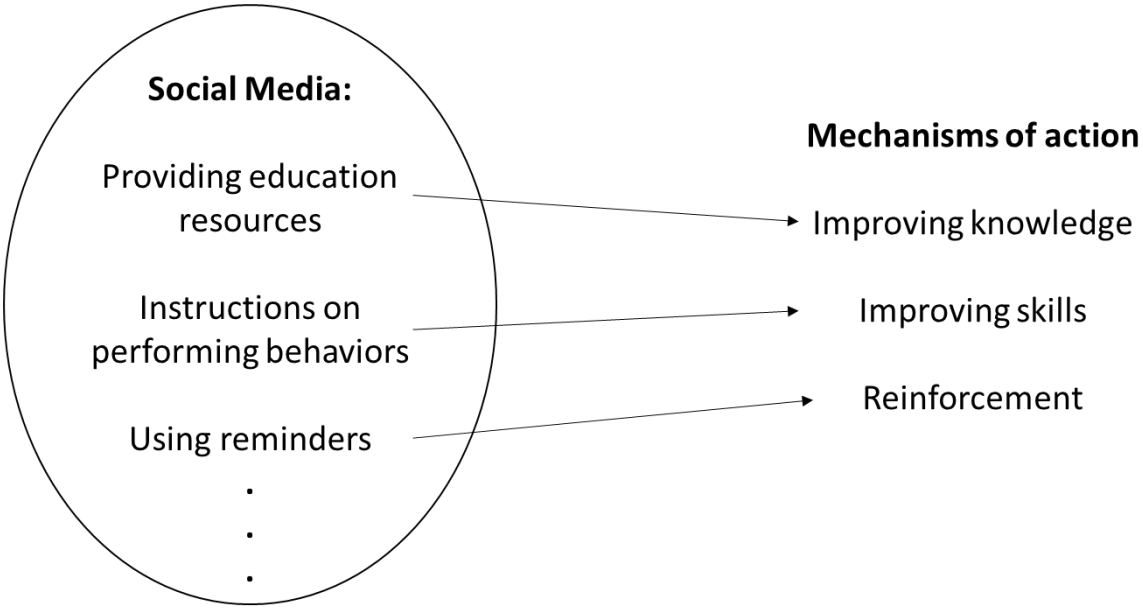

Figure 6.2 An argument for the relationship between social media as an implementation strategy and other forms of implementation strategies

Second, Knowledge translation through social media is a more complex virtual process that involves causal chains compared with other implementation strategies. As is presented in the consolidated SMILE framework 1.0, knowledge translation through social media encompasses multiple interconnected phases (ie, social media product, accessibility, engagement, and knowledge use). The failure of any one phase would result in the failure of knowledge translation. While other implementation strategies can target behaviour change directly, using social media for knowledge translation should consider dissemination strategies, engagement strategies, and implementation strategies to achieve the goal of each phase, therefore much more challenging and full of uncertainties.

6.3 Strengths and limitations of the dissertation

6.3.1 Strengths

The first strength of this thesis is that it follows a three-phase theory development process underpinned by the scientific realism paradigm to build a progressive understanding of how social media supports healthcare providers' knowledge use. Such a structure makes the thesis a coherent whole.

Second, rather than building a decontextualized explanation as many methodologies do, this realist thesis helps to understand the context-mechanism interactions, in other words, how and under what circumstances social media works for healthcare providers' knowledge use. Such theoretical endeavors are helpful to unpack the complex causal chains from social media product creation to knowledge translation, inform the development of social media interventions, and explain the successes and failures of social media initiatives.

Third, although social media has been increasingly studied in the healthcare field to understand consumer behaviours, most of the current social media literature focuses on the health behaviour of patients and the public. Very limited studies focused on changing healthcare providers' behaviours through social media. For example, a recent scoping review of 628 papers on the use of social media for knowledge translation with physicians found that only six studies measured behavioural change (T. M. Chan et al., 2020). The thesis contributes to this underdeveloped research field by providing a novel theoretical understanding.

6.3.2 Limitations

In addition to the specific limitations mentioned in each phase of the thesis, this thesis as a whole has two main limitations. First, as in most realist studies, multiple sources of data are needed to build a robust theory and therefore multiple methods are often used to gather

data and triangulate each other (Wong et al., 2017). In my thesis project, although I used published literature in the realist review and interview data in the qualitative study to build theoretical understanding, these two types of data sources have limitations in theorizing the real-world practice (eg, capturing the key stages of knowledge translation through social media). Other sources of data such as the backend data from the participating social media teams and the data from virtual ethnographic observations of the actual operation of each social media team would provide richer information and increase the robustness of the theory-building process.

Second, because social media is an evolving concept without consensus on its definitions and boundaries (Carr & Hayes, 2015), and new social media platforms with novel functions are constantly emerging, some social media platforms may be missing from this thesis. Although I explicitly defined what social media means in this thesis and operationalized it into specific types, grey areas remain. For example, in the literature screening stage of the realist review, two reviewers have debated whether to consider some platforms as a type of social media (eg: podcasts). In the realist review findings, I classified social media into two general types: open social media platforms and closed social media platforms. Although such a classification has literature support (T. M. Chan et al., 2020; Choi & Lee, 2017), there is no definite boundary between these two. It may sometimes be difficult to judge whether one social media is an open or closed platform.

6.4 Reflections on the PhD project

It is a learning journey for me from developing the thesis idea and writing the thesis proposal to conducting the thesis project. In this section, I reflect on my PhD project from two aspects: 1) the use of CMO heuristic to unpack causal mechanisms; and 2) healthcare providers' social media use for collective action in the COVID-19 pandemic.

6.4.1 Reflection on using the CMO heuristic to unpack causal mechanisms

Drawing on the realist methodology developed by Pawson and colleagues (Pawson et al., 2005; Wong et al., 2014; Wong et al., 2017), I have built a theoretical understanding of how social media supports healthcare providers' knowledge use by formulating CMO configurations. While the CMO heuristic is helpful to contextualize theoretical understanding, it has some limitations in fully capturing the contextual and mechanical complexity of social programs.

6.4.1.1 Potential limitations of using CMO heuristic for realist study

First, the CMO heuristic implies a reductionist worldview and has limitations in capturing the interrelationships among the generative mechanisms and the complex interaction between context and mechanisms (Hinds & Dickson, 2021). Admittedly, this thesis trying to understand the phenomena of healthcare providers' use of knowledge from social media in its entirety was vast, which led me to reduce the phenomena into four interconnected and progressive outcomes (ie, products, accessibility, engagement, and knowledge use). During this stage, I may have missed the non-linear relationships between these four outcomes and other key outcomes. For each outcome I reported, due to the analytic complexity of using CMO configuration to capture multilevel contextual influences, I reduced the contexts into different

dimensions (eg, content developers, recipients, social media platforms) and identified the activating factors from each dimension, which may have neglected the synergistic or antagonistic effects among these factors. Therefore, the CMO heuristic may have limitations in capturing the interactive contexts and generative mechanisms of complex social programs.

Second, the CMO heuristic is sometimes difficult to distinguish between overdetermination and underdetermination in terms of causation, or from a mathematical logic perspective, whether the context is a "necessary" or "sufficient" condition for the mechanism, which can be noted from the different wording choices that have been used to describe context-mechanism relations, eg, "triggering", "shaping", "enabling", "activating", "supporting", "facilitating" (Greenhalgh & Manzano, 2021). Such ambiguity led to many struggles when I develop the CMO configurations. For example, in one CMO generated from the qualitative study, the fulfillment of recipients' information needs and message credibility as two contextual factors work together to activate the mechanism of the perceived value of social media messages. In this case, the two factors are considered the necessary conditions for activating the mechanism. In another CMO however, I identified that either developers' reputation, endorsement by reputable people or organizations, or electronic word of mouth is sufficient to drive recipients to access social media messages. In this case, the contexts are considered sufficient conditions. Furthermore, the CMO heuristic seems to imply a binary judgment on the context-mechanism relationship (ie, if something, then something) rather than a degree of tendency, which further complicates its position on causation.

Third, the CMO heuristic blurs the boundary between context and mechanism, and conflates the social structure and human agency in driving social change (Hinds & Dickson, 2021; Porter, 2015a, 2015b). Even in one single social program, the operationalization of context and mechanism is challenging and sometimes a matter of choice. The reason is that the intervention complexity (ie, multiple components), contextual complexity (ie, in a dynamic multidimensional and open environment), and causal pathway complexity (ie, complicated/multiple causal pathways) of social programs make the roles and functions of particular components dynamic and evolving, rather than static (Guise et al., 2017). For example, the perceived credibility of social media message in my thesis can function as a context (eg, activating the mechanism of the perceived value of messages), a mechanism (eg, generating the outcome of engagement), and an outcome (eg, generated by the mechanism of social influence from content developers' reputation). Therefore, I developed rules about the level of outcomes and key mechanisms to focus on. Such confusion is in part because the definition of mechanism from scientific realism (ie, human response towards resources (Dalkin et al., 2015; Van Belle et al., 2016)) oscillates between determinism and voluntarism, and makes it difficult to disentangle the specific properties and power of social structure and human agency and their reciprocal influence (Hinds & Dickson, 2021; Porter, 2015a).

6.4.1.2 Alternative approaches to remedy limitations of current realist studies

The first alternative I suggest to address the limitations identified above is to integrate realist methods with complexity and system science methods (Hinds & Dickson, 2021; Koorts et al., 2021; Kwamie et al., 2014; Renmans et al., 2017). The integration of complexity and system

thinking with realism has been advocated from a philosophical level (Mingers, 2011, 2014; Williams, 2020). In practice, for social media to enable knowledge use, there might be multiple sometimes complicated causal pathways, rather than a singular one. The working mechanisms for knowledge translation do not work in isolation, but with potential synergistic effects or feedback loops. Contexts also operate dynamically. It may serve as an activating context in a causal configuration meanwhile an outcome caused by a previous causal configuration (Jagosh et al., 2015). Therefore the integration of complexity and system thinking with realism allows researchers to think about social media working mechanisms and the activating contexts in a holistic and relational way. From the methodological level, Hatt (2009) drew on the critical realist ontology to justify the use of causal loop diagrams in realist studies. He argued that this approach enables an understanding of the dynamic processes of change in complex systems and moves away from the non-reciprocal causal model towards multilateral causal feedback loops. This approach has been well-described (Renmans et al., 2020) and used in many fields, such as the understanding of implementation mechanisms of a performance-based financing intervention (Renmans et al., 2017) and the scaling up of interventions in general (Koorts et al., 2021). In addition to the causal-loop diagram analytic strategy, social network analysis (Ranmuthugala et al., 2011) and qualitative comparative analysis (Befani et al., 2007; Renmans, 2022) have also been integrated into realist evaluation studies to capture the interactions among program elements, and the configurational impacts of multiple contexts towards mechanisms, and multiple mechanisms towards outcomes.

The second alternative is to draw on the morphogenetic approach to conduct realist studies (Porter, 2015a). The morphogenetic approach developed by Archer (1995, 2013) is

based upon the premise of analytical dualism whereby differentiation is made between structure and agency. Porter (2015a) argues for a "Contextual Mechanisms + Programme Mechanisms+ Agency = Outcome" equation, which could help understand the mechanisms embedded in the extant social structure, identify the mechanisms embedded in interventions, and examine how agents interpret and respond to these mechanisms (see Table 6.1). This approach has been successfully used to understand the generative mechanisms of social programs (Davenport, 2020)

Table 6.1 The morphogenetic approach for realist study (Archer, 1995, 2013; Porter, 2015a)

Time →
Structural conditioning (contextual mechanisms) Social interaction (development of program intervention) Structural elaboration (contextual mechanisms + program mechanisms) Social interaction (interpretation and behavioural outcomes)

6.4.2 Healthcare providers' social media use for collective action in the COVID-19 pandemic

One dimension of social media use by healthcare providers that is not covered in my thesis but is well-manifested in the pandemic is its political use for collection action, or from a knowledge translation perspective, persuasive knowledge use (Graham et al., 2006; Straus et al., 2013).

Right after my research proposal was approved, COVID-19 swept across the globe and became a global pandemic. Cities were locked down; people were practicing physical distance; social media became more pervasively used. Among its different usage purposes, social media has become the arena for healthcare providers to advocate and demand change. Different kinds of social movements have been initiated on social media, such as the global level

#WearingMasks and #CovidIsAirborne social media campaign, and the local level #Caremongering initiative (Seow et al., 2021). This political dimension of social media use was also manifested in the qualitative study where one healthcare provider described the local impact of the #CovidIsAirborne social media campaign. By using social media collectively, healthcare providers can: 1) prioritize and initiate policy discussions, 2) increase policymakers' awareness, and 3) influence policy formulation and policy adoption (Bou-Karroum et al., 2017). Recently, the Registered Nurses' Association of Ontario and Healthcare Excellence Canada developed the social movement action framework for knowledge uptake and sustainability (Grinspun et al., 2022). This framework describes a people-led, grassroots approach to change in response to an urgent shared concern or strong desire for change. In such social movements, social media plays an irreplaceable role in building networks and promoting collective action and public visibility. The political dimension of social media use by healthcare providers encompasses a more complex chain of mechanisms that requires further interdisciplinary investigation.

6.5 Implications for nursing

Drawing on the findings of this thesis, I suggest several implications for 1) content developers in nursing, 2) nursing practice, and 3) nursing policymaking. While all the implications here are for the nursing discipline, they are also applicable to many other health professionals.

6.5.1 Implications for content developers in nursing

More and more nursing educators, researchers, and practitioners have become content developers with the aim of supporting professional practice and increasing social influence. Based on the findings of this study, I propose eight implications for nursing content developers who wish to facilitate not only knowledge sharing but also knowledge use.

These implications are to 1) assess the readiness for starting a social media initiative. It might seem easy and simple for individuals to open a social media account and post healthcare content, however, a fast, frugal, and "hope-the-change-happens" approach may not be an effective or sustainable way to impact population-level health outcomes (Elliott et al., 2020). Based on the consolidated SMILE framework 1.0, investment of resources and team expertise are essential for social media initiatives to thrive. Therefore, the initial assessment of readiness is necessary. Some probing questions may be considered during this stage: is there an explicit topic to be covered; do you have the team, time, resources, and expertise to develop the social media content and monitor the operation? 2) Take a well-planned approach to developing social media messages. Content developers should recognize target users' needs and their context, and prepare teams and resources to develop credible and actionable social media messages in a user-friendly format. 3) Pre-assess the potential implementation barriers to inform the behaviour change techniques to be used in the social media message. 4) Use different online (eg, influencer endorsement) and in-person (eg, approaching hospitals and professional organizations) strategies to increase message accessibility and engagement. 5) Actively offer guidance and feedback, promote interaction, and provide additional learning resources associated with social media messages when necessary. 6) Evaluate the impact of the social media initiatives by collecting multiple sources of data to inform the adjustment of social

media strategy. 7) Build an online community of practice with a solid group of participants with similar interests and goals to support knowledge sharing and learning. 8) Build a long-term vision for the social media initiative and keep it active and sustained.

6.5.2 Implications for nursing practice

Social media is a double-edged sword for nursing practice. On the one hand, it promotes professional networking, collaboration, and development (Farsi, 2021). On the other hand, it may mislead clinical practice and impact patient outcomes due to spreading misinformation (Cook et al., 2018; Suarez-Lledo & Alvarez-Galvez, 2021; Wang et al., 2019). Therefore, the judicious use of social media is critical. Based on the consolidated SMILE framework 1.0, nurses can use social media to inform clinical practice by 1) using social media platforms that are specialized for and widely accepted by peer healthcare providers; 2) following social media accounts that are relevant and authoritative with good reputation; 3) timely storing the social media content that is informative for clinical practice; 4) actively asking questions pertaining to the social media content and its potential implementation; and 5) building networks and joining an online community of practice with whom you have the same interests and goals.

6.5.3 Implications for nursing policymaking

In the realist review, I identified that healthcare organizations play a moderator role in nurses' use of social media to inform clinical practice. Although the use of social media has been reported to improve collaboration, coordination, and cooperation among health providers, it is still underused within healthcare organizations with the lack of institutional support, lack of guidelines, and an " old-school mentality" as the barriers (Campbell et al., 2016; Hughes et al.,

2009; Naeem & Ozuem, 2021; Scantlebury et al., 2017). Therefore, implementation strategies are needed if healthcare organizations want to promote the wise use of social media by nurses and other healthcare providers. On the one hand, healthcare organizations (and the healthcare regulatory organizations) should develop guidelines and regulations on healthcare providers' professional, ethical, and legal use of social media, for example: how to keep patient confidentiality, maintain appropriate relations with patients online, and manage conflicts of interest. On the other hand, healthcare organizations should provide training and resources for healthcare providers on content development or on using social media to timely access relevant and trustworthy healthcare evidence.

6.6 Implications for future research

Based on the findings of this thesis, I propose implications for future research that can further enhance our understanding of how social media can support healthcare providers' knowledge use from five aspects: 1) closed social media platforms (ie, relationality-driven approach); 2) open social media platforms (ie, rationality-driven approach); 3) the rationality-relationality integrated approach to facilitating knowledge use; and 4) the political dimension of social media in driving practice change.

6.6.1 For closed social media platforms (ie, relationality-driven approach)

In the realist review, I identified that the relationality-driven social media use model relies heavily on using closed social media platforms. This was an unexpected finding. In the following qualitative study, I only consolidated the rationality-driven model that uses open social media platforms. In future research, both systematic and realist reviews specifically

targeting closed social media platforms would be necessary to understand their effectiveness and mechanisms for knowledge translation with healthcare providers. In addition, realist evaluation studies with closed platform developers and users would further enhance our understanding of the mechanisms.

6.6.2 For open social media platforms (ie, rationality-driven approach)

Although in the qualitative study (ie, the third phase of the thesis), I consolidated the program theory for open social media platforms, two main limitations exist: 1) the interview participants were primarily from China; 2) both the content developer and healthcare providers have their limitations in providing information through individual interviews (details see chapter 5-5.5 strengths and limitations). Therefore, focus group qualitative studies with content developers and healthcare providers who have more diverse characteristics would be more informative for our understanding of this topic (Manzano, 2022). Within the focus group, participants can mutually guide each other through interaction and build collective knowledge on how we can make the best of social media for healthcare providers' knowledge use. Second, digital ethnography research, allowing researchers to immerse themselves in the virtual field and observe how real-world influential social media initiatives operate, would further enhance our understanding of healthcare providers' engagement and use of knowledge on social media. Third, evaluation studies of social media initiatives that draw on the consolidated SMILE framework 1.0 would significantly optimize our theoretical understanding of this complex practice. Last, a systematic review of the behaviour change techniques that have been used in

social media interventions for healthcare providers would largely inform our understanding of the behaviour change mechanisms.

6.6.3 For the rationality-relationality integrated approach to facilitating knowledge use

In the realist review, I propose that the rationality and relationality integrated approach might accelerate the knowledge use by healthcare providers. Future empirical studies are necessary to explore how to integrate these two approaches and investigate their synergistic effect.

6.6.4 The political dimension of social media in driving practice change

The primary focus of this thesis is healthcare providers' individual-level conceptual and instrumental knowledge use in that social media is inherently a grassroots approach that has a direct impact at the individual level. However, social media is also a powerful catalyst for collective identity and collective action in terms of public concerns, which in turn impact individual-level behaviour. In future research, it would be interesting to draw on the knowledge from sociology and political science to understand the causal mechanisms of how social media mobilizes and engages change agents to make a collective impact on healthcare practice change.

6.7 Conclusions

Drawing on the tenets of scientific realism and the CMO heuristic, I developed a consolidated program theory of how social media supports healthcare providers' knowledge use in clinical practice. I identified two causal explanations for healthcare provider' use of

knowledge from social media: the rationality-driven approach that primarily use open social media platforms and the relationality-driven approach that primarily uses closed social media platforms. These two approaches can be situated in a dynamic continuum with one side being primarily rationality-driven and the other primarily relationality-driven. It is my hypothesis that when content developers consider both the rational and relational dimensions to create social media interventions, they are likely to accelerate knowledge use.

Social media has distinctive advantages for promoting the use of knowledge by healthcare providers. However, as a complex virtual process, it bears inherent limitations and uncertainty for knowledge translation. Based on the findings of the thesis, I offer several implications for nursing practice and future research directions.

6.8 References

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Appendix

Appendix 1: Search strategy for the realist review in MEDLINE

1. Social Media/
2. Social networking/or online social networking/
3. Communications media/
4. blogging/
5. Webcast/
6. (Facebook or blog* or microblog* or podcast* or twitter or tweet* or YouTube or Myspace or Tumblr or Pinterest or Instagram or weibo or WeChat or Wecom or QQ or Qzone or TikToK or Wiki* or Vimeo or Flickr or Kik or Reddit* or Whatsapp*).tw
7. ("social adj3 media" or "Social adj3 network*").tw
8. "user generated content".tw
9. ((virtual or online) adj3 (world* or communit* or network*)). tw
10. ("Web 2.0*" or "Web 2*").tw
11. (LinkedIn or "linked in").tw
12. ("hash tag*" or hashtag*).tw
13. (Vlog or "video blog" or "video log").tw
14. ("Six degrees" or sixdegrees).tw
15. "Patientslikeme".tw
16. (Crowdsourc* or "Crowd sourc*").tw
17. ("new media" or "We media").tw.
18. Or/1-17
19. exp Health Personnel/
20. ((health* or medical or paramedical or hospital or operating-room or psychiatric or pharmac*) adj2 (personnel or provider* or professional* or practitioner* or worker* or aide* or assistant* or staff or officer* or specialist* or consultant*)).ti,ab,kw
21. (nurs* or midwife or midwives).ti,ab,kw
22. (Physician* or Clinician* or doctor* or "general practitioner*" or resident*).ti,ab,kw
23. (an?esthesia assistant* or an?esthetist* or an?esthesiologist* or dieti* or nutritionist* or therapist* or physiotherapist* or psychotherapist* or pharmacist* or dentist* or dental staff or audiologist* or case manager* or allergist* or anesthesiologist* or cardiologist* or dermatologist* or endocrinologist* or gastroenterologist* or geriatrician* or gyn?ecologist or nephrologist* or neurologist* or oncologist* or ophthalmologist* or otolaryngologist* or pathologist* or pediatrician* or physiatrist* or psychologist* or pulmonologist* or radiologist* or rheumatologist* or surgeon* or urologist* or optometrist* or hospitalist* or paramedic* or "health educator*" or "social worker*" or "welfare worker*").ti,ab,kw
24. Or/19-23
25. Guideline adherence/
26. exp Evidence-based practice/
27. exp Diffusion of innovation/

28. Translational medical research/
29. ("Guideline adherence" or "institutional adherence" or "policy compliance" or "protocol compliance").tw
30. (knowledge adj2 (application or broke* or creation or diffus* or disseminat* or exchang* or implement* or management or mobili* or translat* or transfer* or uptak* or utili*)).tw
31. (evidence* adj2 (exchang* or translat* or transfer* or diffus* or disseminat* or exchang* or implement* or management or mobil* or uptak* or utili*)).tw
32. (KT adj2 (application or broke* or diffus* or disseminat* or decision* or exchang* or implement* or intervent* or mobili* or plan* or policy or policies or strateg* or translat* or transfer* or uptak* or utili*)).tw
33. (research* adj2 (diffus* or disseminat* or exchang* or transfer* or translation* or application or implement* or mobil* or transfer* or uptak* or utili*)).tw
34. ("research findings into action" or "research to action" or "research into action" or "evidence to action" or "evidence to practice" or "evidence into practice" or "best practice*" or "Know do gap" or "evidence practice gap" or "knowledge practice gap").tw
35. (("evidence base*" or "evidence inform*") adj2 (decision* or plan* or polic* or practice or action* or medicine or nursing)).tw
36. ("diffusion of innovation*" or "innovation diffusion" or "organizational change*" or "organizational innovation*").tw
37. ("translational medicine" or "translational research").tw
38. ("implementation science" or "implementation research" or "implementation stud*").tw
39. ((behavio?r or organi?ational) adj2 change*).tw
40. Or/25-39
41. 18 AND 24 AND 40

Appendix 2: The relevance rating criteria for the realist review

The overall criterion is based on the question: how much can this study contribute to our understanding of healthcare providers' use of social media to influence their practice change?

1. High relevance:
    a. Directly answer the research question: how healthcare providers use (or fail to use) social media to influence their practice change; Or
    b. Interventional studies that aim to use social media to influence healthcare providers' practice change; Or
    c. Studies that investigate the determinants of using social media to influence healthcare providers' practice change; Or
    d. Studies that investigate the effectiveness of implementation strategies in promoting healthcare providers to use social media for practice change; Or
    e. Studies that investigate or provide rich information on the relationship between healthcare providers' use of social media and practice change.
2. Medium relevance:
    a. Studies that investigate the determinants of using social media platforms or sharing knowledge through social media by healthcare providers; Or
    b. Studies that use social media to influence healthcare providers' use of technology or conduct clinical research; Or
    c. Studies that investigate the acceptability, appropriateness and implementation of social media interventions, and its impact on healthcare providers conceptual knowledge use, but with no investigation or outcomes on healthcare providers' practice change; Or
    d. Studies that provide some information on the relationship between social media and healthcare providers' practice change.
3. Low relevance:
    a. Studies that investigate the impact of social media messages on recipients' visits, engagement (ie, likes, retweets, comments etc.) with social media messages; Or
    b. Studies that investigate the characteristics of social media messages, or their models of deliveries for promoting recipients' visits, engagement with social media messages; Or
    c. Studies that provide a little information on the relationship between social media and healthcare providers' practice change; Or
    d. Studies that can not be excluded based on the eligibility criteria.

Appendix 3: University of Ottawa Ethics Board Approval for the qualitative study

17/05/2021

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

CERTIFICAT D'APPROBATION ÉTHIQUE | CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-04-21-6774
Titre du projet / Project Title	Understanding how healthcare providers use social media to influence knowledge use in clinical practice: a realist qualitative study
Type de projet / Project Type	Thèse de doctorat / Doctoral thesis
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	17/05/2021
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	16/05/2022

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Junqiang ZHAO	École des sciences infirmières / School of Nursing	Chercheur Principal / Principal Investigator
Wendy GIFFORD	École des sciences infirmières / School of Nursing	Superviseur / Supervisor

Conditions spéciales ou commentaires / Special conditions or comments

Appendix 4: Recruitment poster for the qualitative study (English and Chinese)

Understanding how social media influence healthcare providers' knowledge use in clinical practice and decision making

Who are we looking for?

- Are you a **healthcare provider**?
- Have you followed any **social media** account which disseminates synthesized healthcare evidence(eg: research findings from systematic reviews or guidelines)
- Have you **used any of the evidence** on the social media in your clinical practice?

IF ALL YES, YOU ARE THE ONE WE ARE LOOKING FOR!

Purpose & procedures of the study

- Purpose: to understand how social media influence healthcare providers' knowledge use in clinical practice and decision making.

- Procedures:
  1. Contact the team
  2. Sign consent form
  3. A 40-60 mins interview

We will talk about

- Your recent experience in applying the healthcare evidence in clinical practice;

- When and under what circumstances do you think social media will influence healthcare providers use the evidence in clinical practice

uOttawa

Contact us for further information

Junqiang Zhao, PhD candidate
Email:
School of Nursing, Faculty of Health Science, University of Ottawa

University of Ottawa ethics approval number: H-04-21-6774

【社交媒体如何影响临床医务人员的证据应用】

我们需要您！

- 您是临床医务人员吗?
- 您是否在临床实践中使用过在社交媒体上（如微信，微博，抖音，知乎等）传播的健康相关的科研证据?

如果上述问题您的答案都是肯定的，您就是我们要找的那位!

研究目的：

了解临床医务人员如何利用社交媒体上的健康相关证据影响临床决策和实践。

研究程序：

1. 通过如下邮箱联系我们
2. 签署知情同意书
3. 40-60分钟的访谈

访谈内容：

- 您最近在临床实践中应用社交媒体中健康相关证据的经历；
- 您认为社交媒体在什么情况下可能促进临床医务人员的证据应用。

uOttawa

联系我们：

赵俊强，博士研究生
加拿大渥太华大学健康学院

感谢您的支持!

渥太华大学伦理审查编号：H-04-21-6774

Appendix 5: Participant informed consent form for the qualitative study (English and Chinese)

Consent Form

Title of the study: Understanding how healthcare providers use social media to influence knowledge use in clinical practice: a realist-informed qualitative study

Name of researcher*

Junqiang Zhao* PhD(c)

School of Nursing, Faculty of Health Science, University of Ottawa

Telephone: XXX

E-mail: XXX

Name of thesis supervisor*

Wendy Gifford* PhD

Associate Professor, School of Nursing, Faculty of Health Science

University of Ottawa

Telephone: XXX

E-mail: XXX

Invitation to Participate: Social media has been used extensively worldwide to communicate health-related information. Despite its popularity, many researchers and organizational decision-makers upload research findings onto social media platforms without deliberately planning how to facilitate the use of findings by the social media recipients in policy, programs, or practice. Large theoretical gaps exist in understanding how social media interventions impact healthcare practices. **The purpose of the study is to consolidate a program theory on how, and under what circumstances social media works as a knowledge translation strategy for healthcare providers' clinical practice**. You are being invited to participate in this PhD research because of your expertise in social media development or valuable experience in using social media to inform clinical practice.

Voluntary Participation: This is a qualitative study. Your participation will essentially consist of one 40-60 minutes interview to explore your perspectives on how, and under what circumstances social media works to inform healthcare providers' clinical practice. The interview will be scheduled at a date and time convenient to you and will be conducted virtually. Please note that the interview will be audio recorded. Once the analysis of your interview is completed and synthesized with the other data, I will share findings with you by email for feedback, clarity, and confirmation. It will be up to you whether to further respond. I will wait for two weeks for your response before finalizing the research findings. Your participation is voluntary. You have the right to refuse to participate in this study. If you decide to participate,

you may still choose to withdraw from the study at any time without any negative consequences. If you choose to withdraw, your data will be removed from the dataset.

Benefits: You may not experience any direct benefits from participating in the interview. However, your participation in this study will advance our understanding of how social media works to inform healthcare providers' clinical practice. We will develop a program theory based on the research findings. This theory can be used to guide social media intervention development and explain the factors influencing the use of evidence on social media.

Confidentiality and anonymity: you are assured by the researcher that the information you share will remain strictly confidential. No identifying information will ever be shared with your employer, nor anyone affiliated with your employer. Participants in the interviews will be assigned an alphanumeric code in the format: P01 (participant 1). This code will only be linked to the participant's personal information in the Master List. The Master List will be an encrypted excel file stored on a password-protected device. Only the PI Junqiang Zhao and the supervisor Dr. Wendy Gifford will have access to the master list. Your name and any other information that may identify you will be removed from any printed records, publications, or presentations.

Conservation of data: Any paper records will be stored in a locked research office at the Centre for Research on Health and Nursing at the University of Ottawa Roger Guidon Hall (1118- 451 Smyth Road). All electronic data will be stored in a file on the University of Ottawa's secured network of the thesis supervisor (Dr. Gifford) after the completion of the thesis research in September 2022. The data will be conserved for five years. After five years, if the data is chosen to be destroyed, it will be destroyed beyond recovery.

Acceptance: you, *(Name of participant),* agree to participate in the above research conducted by Mr. Junqiang Zhao at the School of Nursing, Faculty of Health Science, University of Ottawa, under the supervision of Professor Wendy Gifford.

By signing this page, you are confirming the following:

- You have read and understood all the information in this Information and Consent Form.
- You understand the risks and benefits of the study.
- All your questions have been answered to your satisfaction.
- You voluntarily agree to participate in this study and have not been wrongly influenced or coerced.
- You may freely choose to stop your participation at any time and any data collected will not be used any further.
- You should print a copy of the consent form to keep for their personal records

You do not give up your legal rights by signing this form.

If you have any questions about the study, you may contact the researcher or his supervisor.

If you have any questions regarding the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5

Tel.: (+1)(613) 562-5387, Email: ethics@uottawa.ca

Participant signature: Date:

Researcher signature: Date

知情同意书

研究标题：社交媒体如何以及在什么情况下影响临床医务人员的循证临床实践：一项现实主义质性研究

研究员姓名:

赵俊强 博士候选人

渥太华大学健康科学学院护理学院

电话：XXX

邮箱：XXX

导师姓名:

温迪·吉福德 博士 教授

渥太华大学健康科学学院护理学院

电话：XXX

邮箱：XXX

研究背景：社交媒体已经在世界范围内广泛用于传播健康相关信息。尽管它很受欢迎，但许多研究人员和组织决策者将研究结果上传到社交媒体平台上，却没有刻意规划如何促进社交媒体受众在政策、计划或实践中使用研究结果。在理解社交媒体干预如何影响临床实践方面存在巨大的理论差距。这项研究的目的是巩固一个项目理论，即社交媒体如

何以及在什么情况下影响临床医务人员的循证临床实践。由于您在社交媒体开发方面的专业知识或使用社交媒体为临床实践提供信息的宝贵经验，您被邀请参加本博士研究。

自愿参与：这是一项质性研究。您的参与主要包括一次 40-60 分钟的访谈，探讨您对社交媒体如何以及在何种情况下影响临床医务人员循证临床实践的看法。访谈将安排在您方便的日期和时间，在线进行。请注意，访谈将被录音。一旦您的访谈分析完成并与其他数据进行综合，我将通过电子邮件与您分享研究结果，以获得反馈、澄清和确认。是否作出进一步回应将取决于你。在最终确定研究结果之前，我将等待两周，等待您的答复。你的参与是自愿的。您有权在任何时候拒绝参与本研究而不会产生任何负面后果。如果您中途选择退出研究，您的数据将从数据集中删除。

益处：参加访谈可能不会给你带来任何直接好处。然而，您的参与将促进我们对社交媒体如何促进临床医务人员循证临床实践的理解。我们将根据研究结果制定一个项目理论。该理论可用于指导社交媒体干预策略的开发，并解释影响社交媒体证据使用的因素。

保密性和匿名性：研究人员向您保证您的信息将严格保密。不会与您的雇主或任何与您的雇主有关联的人共享任何身份信息。访谈参与者将被分配一个字母数字代码，格式为：P01（参与者 1）。此代码将仅链接到主列表中参与者的个人信息。主列表将是一个加密的 excel 文件，存储在受密码保护的设备上。只有研究负责人赵俊强及其导师温迪·吉福德博士可以访问主列表。您的姓名和任何其他可能识别您的信息将从任何打印记录、出版物或演示文稿中删除。

数据保存：任何文件记录都将存储在渥太华大学卫生研究中心的锁定研究办公室（451 史密斯路，罗杰格顿霍尔 1118 办公室）。2022 年 9 月完成论文研究后，所有的电子数据将被存储在渥太华大学的论文主管（吉福德博士）的安全网络中。这些数据将保存五年。五年后，如果选择销毁数据，数据将无法恢复。

通过签署此页面，您确认了以下内容：

- 您已阅读并理解本信息和同意书中的所有信息。
- 您了解研究的风险和好处。
- 您的所有问题都得到了满意的回答。

- 您自愿同意参与本研究，且未受到错误影响或胁迫。
- 您可以随时自由选择停止参与，所收集的任何数据将不会被进一步使用。
- 您可以打印一份同意书副本，以供其个人记录。
- 您不会因为签署本表格而放弃您的合法权利。

如果您对研究有任何疑问，可以联系研究人员或其导师。

如果您对本研究的道德操守有任何疑问，您可以联系渥太华大学伦理办公室渥太华坎伯兰街 550 号塔巴雷特堂 154 室（K1N 6N5）。

电话：（+1）（613）562-5387

电子邮件：ethics@uottawa.ca

参与者签名：　　日期：

研究人员签名：　　日期：

Appendix 6: Interview guide for the qualitative study (English and Chinese)

Interview guide for content developers (English version)

Introduction

Thank you for agreeing to participate in this interview. Before we start, I would like to share with you the purpose of this interview. My PhD research intends to answer the question: how and under what circumstances can social media influence healthcare providers' evidence-informed clinical practice? Because of your expertise in this field, I want to gain some insights from you on this topic. Please feel free to say anything that you think is relevant. The interview will last for 40-60 minutes.

Can I have your consent to record this interview?

Do you have any questions before we start?

Interview Questions

1. Do you think it is possible to use social media to influence healthcare providers' practice change? Why/Why not?
2. What are the lessons you have learned in developing social media content?
3. What factors promote people to apply the evidence on social media to clinical practice (or why fail to apply/do not want to apply)?
4. What key characteristics of the social media (virtual), healthcare providers (individual), organization or system do you suggest are likely to influence the use of evidence on social media in practice?
5. Are there any other important outcomes that result from reviewing evidence on social media?
6. This is how we think social media might work for healthcare providers' evidence-informed clinical practice based on our review of the literature. Does it make sense to you based on your experience? Why or why not? [*I will show the interviewee a model diagram and elaborate the content of this model to the interviewee using plain language*]
7. How do you think this model can be optimized to make it clearer and more accurate to what happens in practice?
8. Are there any other aspects that you think are relevant and crucial for our understanding of how social media is used by healthcare providers to inform their clinical practice?

Thank you so much for sharing with me your standpoints on this topic. We will share our research findings with you after we finish the data analysis.

社交媒体开发人员访谈提纲 （中文版）

简介

您好！感谢您同意参加本次访谈。在我们开始之前，我想和您分享一下这次访谈的目的：社交媒体如何以及在什么情况下影响临床医务人员的循证临床实践。由于你在这个领域的专业知识，我想从你那里获得一些关于这个话题的见解。我们的访谈大概会持续 40-60 分钟。

在我们开始访谈之前您有什么问题吗？

您同意我对这次访谈进行录音吗？

访谈问题

1. 您觉得社交媒体上的健康相关证据可能改变临床医务人员的临床实践吗？为什么？
2. 您在社交媒体内容开发方面有哪些经验教训？
3. 您觉得在什么情况下临床医务人员会在临床实践中使用社交媒体上的证据？
4. 如果临床医务人员要使用社交媒体上的证据，您认为有哪些关键因素可能会促进证据应用？（我们常规的证据应用，研究证据已经在那里了，这个是社交媒体上的研究证据，您觉得有差异吗）
    a. 社交媒体
    b. 临床医务人员
    c. 组织或系统
5. 对您来说，社交媒体上的健康相关证据会给临床医务人员带来哪些正面的或者负面的影响？
6. 我们根据文献回顾提出了一个初步的理论框架 [我将向受访者展示一个模型图，并用通俗易懂的语言向受访者阐述该模型的内容]。您认为这样一个理论模型合理吗？为什么？
7. 您觉得在哪些方面需要进一步优化？
8. 针对社交媒体影响临床医务人员的证据应用，您认为还有哪些非常重要的方面吗？

非常感谢您与我分享您在这个话题上的观点。我们将在完成数据分析后与您分享我们的研究结果

Interview guide for healthcare providers (English version)

Introduction

Thank you for agreeing to participate in this interview. Before we start, I would like to share with you the purpose of this interview. My PhD research intends to answer the question: how and under what circumstances can social media influence healthcare providers' evidence-informed clinical practice? Because of your expertise in this field, I want to gain some insights from you on this topic. Please feel free to say anything that you think is relevant. The interview will last for 40-60 minutes.

Can I have your consent to record this interview?

Do you have any questions before we start?

Interview Questions

1. Can you share with me one of your recent experiences in applying healthcare evidence on social media into clinical practice?
2. What are the lessons you have learned during the process of applying evidence from social media into practice?
3. What factors promote you to apply the evidence from social media to clinical practice (or why fail to apply/do not want to apply)?
4. What key characteristics of the social media (virtual), healthcare providers (individual), organization or system do you suggest are likely to influence the use of evidence on social media in practice?
5. Are there any other important outcomes that result from reviewing evidence on social media?
6. This is how we think social media might work for healthcare providers' evidence-informed clinical decision-making based on our review of the literature. Does it make sense to you based on your experience? Why or why not? [*I will show the interviewee a model diagram and elaborate the content of this model to the interviewee using plain language*]
7. How do you think this model can be optimized to make it clearer and more accurate to what happens in practice?
8. Are there any other aspects that you think are relevant and crucial for our understanding of how social media is used by healthcare providers to inform their clinical practice?

Thank you so much for sharing with me your standpoint on this topic. We will share our research findings with you after we finish the data analysis.

临床医务人员访谈提纲 （中文版）

简介

您好！感谢您同意参加本次访谈。在我们开始之前，我想和您分享一下这次访谈的目的：社交媒体如何以及在什么情况下影响临床医务人员的循证临床实践。由于你在这个领域的专业知识，我想从你那里获得一些关于这个话题的见解。我们的访谈大概会持续 40-60 分钟。

在我们开始访谈之前您有什么问题吗？

您同意我对这次访谈进行录音吗？

访谈提纲

1. 您能和我分享一下您最近一次（或者比较典型的一次）将社交媒体上的健康相关的证据应用于临床实践的经历吗？
2. 是什么样的原因让您决定将社交媒体的证据应用于临床实践？
3. 您认为有哪些关键因素可能会影响社交媒体上的科研证据在临床的应用？
    a. 社交媒体
    b. 临床医务人员
    c. 组织或系统
4. 在将来自社交媒体的证据应用于实践的过程中，有哪些经验教训？
5. 对您来说，浏览社交媒体上的健康相关证据会给您带来哪些正面的或者负面的影响？
6. 我们根据文献回顾提出了一个初步的理论框架 [我将向受访者展示一个模型图，并用通俗易懂的语言向受访者阐述该模型的内容]。您认为这样一个理论模型合理吗？为什么？
7. 您觉得在哪些方面需要进一步优化？
8. 针对社交媒体如何影响临床医务人员的证据应用，您认为还有哪些非常重要的方面吗？

非常感谢您与我分享您在这个话题上的观点。我们将在完成数据分析后与您分享我们的研究结果。

Appendix 7: Comparison of the original and consolidated CMO configurations

<table>
<tr><th colspan="2">Original version developed in the realist review</th><th colspan="2">Consolidated version through the qualitative study</th></tr>
<tr><td colspan="4">Outcome 1: Social media products— content developers generate social media products relevant to target populations
• CMO-C1 confirmed CMO-1.</td></tr>
<tr><td>CMO-1: Content developers invest in social media initiatives</td><td>When content developers receive training or guidance on social media use in healthcare, invest resources and build a multidisciplinary collaborative team for social media initiatives (C), they are more likely to increase capabilities and capacities (M) to develop, maintain and promote social media products that are relevant to target populations (O).</td><td>CMO-C1: Content Developers invest in social media initiatives</td><td>When content developers invest resources, have content and social media expertise, and involve end-users as team members (C), they have increased capabilities and capacities (M) to develop, maintain and promote social media products to target populations (O).</td></tr>
<tr><td colspan="4">Outcome 2: Accessibility— target populations are able to access the social media products
• CMO-C2 was a new proposition;
• CMO-C3 refined CMO-3;
• CMO-2 was disconfirmed in the qualitative study, thus not presented in the consolidated version.</td></tr>
<tr><td rowspan="2">CMO-2: Healthcare organizations support social media use</td><td rowspan="2">When healthcare organizations support the use of social media as a valid source of evidence (C), healthcare providers are likely to feel more comfortable and confident (M) in accessing information from social media, and developing an improved attitude toward using social media for professional purposes (O).</td><td>CMO-C2: Content developers choose a specialized and widely accepted social media with search and navigation functions</td><td>When content developers edit and post their product on social media platforms that are specialized for and widely accepted by peer healthcare providers and preferably have advanced search and navigation functions (C), platform users fulfill their individualized information needs (M), and access relevant information promptly (O).</td></tr>
<tr><td>CMO-C3: Content developers' reputation, influencer endorsement, and/or positive (electronic) word-of-mouth</td><td>When content developers have a high reputation in the field, or the social media product is endorsed by reputable people or organizations, or it receives positive (electronic) word-of-mouth (C), target audiences perceive the message as credible and be socially influenced (M) to access and engage with the product (O).</td></tr>
<tr><td colspan="4">Outcome 3: Engagement— target populations engage with the messages on social media by reading, commenting on, and sharing the messages
• CMO-C4 and CMO-C5 refined CMO-3;
• CMO-4 was disconfirmed in the qualitative study, thus not presented in the consolidated version.</td></tr>
<tr><td>CMO-3: Develop and deliver messages</td><td>When content developers involve target healthcare providers to develop concise social media messages and deliver them using multimodal integrated approaches through accredited bodies and/or social media influencers (C), healthcare providers are likely to be more receptive to the messages and perceive them as relevant and trustworthy (M), and as a result, engage with the messages (O).</td><td>CMO-C4: Content developers use marketing strategies to disseminate social media products</td><td>When content developers use online and/or offline marketing strategies to disseminate the social media products to targeted audiences (C), the target audiences pay increased attention to (M), and engage with them (O).</td></tr>
<tr><td>CMO-4: Content developers tailor social media messages</td><td>When social media messages are tailored to address healthcare providers' information needs (C), healthcare providers are likely to perceive the messages as responsive and useful (M), and as a result, engage with the messages (O).</td><td>CMO-C5: Social media message features</td><td>When the social media messages meet recipients' information needs with signs of high credibility and preferably, in a clear and vivid format (C), recipients perceive the messages as valuable for professional development or solving clinical problems (M), and engage with the messages (O).</td></tr>
</table>

Outcome 4: Knowledge use— using social media to change levels of knowledge, understanding, attitude (ie, conceptual knowledge use), or the direct application of the knowledge in practice (ie, instrumental knowledge use) • CMO-C6, CMO-C6.1, CMO-C6. 2, CMO-C7, and CMO-C8 confirmed CMO-5, CMO-5.1, CMO-5.2, CMO-6, and CMO-7. • CMO-C6.3 and CMO-C9 refined CMO-5.3 and CMO-8; • CMO-C6.4 and CMO-C10 were new propositions.			
CMO-5: Content developers use triggers to promote message use	When content developers embed different triggers (ie, behaviour change techniques) in the social media messages (C), healthcare providers are likely to engage with the messages (M), and as a result, use the messages in practice conceptually and/or instrumentally (O).	CMO-C6: Content developers use triggers to promote message use	When content developers embed different triggers (ie, behaviour change techniques) in the social media messages (C), healthcare providers experience increased behavioural capabilities, self-efficacy, intention, or awareness (M), and use the messages in practice (O).
CMO-5.1: Content developers promote interaction	When content developers interact with and promote interactions among healthcare providers regarding the messages, and if possible, offer targeted feedback (C), healthcare providers are likely to experience social support (M) to use social media messages (O).	CMO-C6.1: Content developers promote interaction	When content developers actively interact with healthcare providers and promote interactions among healthcare providers regarding the messages, and if possible, offer targeted feedback (C), healthcare providers experience social support (M), and use the messages in practice (O).
CMO-5.2: Content developers use reminders in their social media initiatives	When content developers use reminders or other reinforcement strategies in their social media initiative (C), healthcare providers are likely to have increased awareness of and give more attention to the messages (M), and as a result, sustain engagement with and use of the messages (O).	CMO-C6.2: Content developers use reminders	When content developers use reminder strategies in their social media initiative (C), healthcare providers have increased awareness (M), and use the messages in practice (O).
CMO-5.3: Content developers include behaviour prescription and demonstration	When content developers include behaviour prescription and, in some cases, behaviour demonstration in the messages (C), healthcare providers are likely to have increased capabilities (M) for message use (O).	CMO-C6.3: Content developers include behavior prescription, demonstration, and/or offer learning resources	When content developers prescribe and demonstrate how to perform the behaviours in the social media message, and/or offer additional resources for systematic learning (C), healthcare providers have increased capabilities and self-efficacy (M), and use the message in practice (O).
CMO-6: Healthcare providers' evidence-seeking behaviour	When healthcare providers actively seek for research evidence to inform clinical practice (C), they are likely to value its role and have the intrinsic motivation (M) to find and use the research evidence from social media conceptually and/or instrumentally (O).	CMO-C6.4: Content developers embed clinical cases or patient stories	When content developers embed real clinical cases or patient stories into the social media messages (C), healthcare providers have improved trust in the practice and expectations of implementation outcomes (M), and use the message in practice (O).
CMO-7: Healthcare providers keep vigilant about social media messages	When healthcare providers keep vigilant about social media messages by using professional judgment and crosschecking techniques (C), they are likely to become more confident about the credibility of messages (M), and as a result, may use the messages judiciously (O).	CMO-C7: Healthcare provider' evidence-seeking behavior	When healthcare providers actively seek for research evidence to inform clinical practice (C), they have the intrinsic motivation (M) to find and judiciously use the message on social media in practice (O).
CMO-8: Healthcare organizations promote professional autonomy	When the professional autonomy of staff is lifted in healthcare organizations (C), healthcare providers will be able to function at their full scope of practice (M), and as a result, decide to use or not to use social media messages in their practice (O).	CMO-C8: Healthcare providers critically appraise and verify social media messages	When healthcare providers critically appraise and verify the social media message through various sources (C), they become confident about the credibility of the message (M), and judiciously use the message in practice (O).

		CMO-C9: Behavioural recommendation is within healthcare providers' scope of practice	When the behavioural recommendations in a social media message are within the healthcare provider's scope of practice with few constraints from their working and professional organizations (C), healthcare providers have the capability to exercise professional autonomy (M), and use the message in practice (O).
		CMO-C10: Behavioural recommendation has low implementation complexity	When the behavioural recommendations in a social media message have low implementation complexity at the individual level (C), healthcare providers gain an improved perception of its implementability (M), and use the message in practice (O).