MR. SHAUN HANCOCK (Orcid ID : 0000-0002-2015-2752)

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Corresponding author mail-id :dominique.cadilhac@monash.edu

Running Head:

Nurses' Role in Implementing Telemedicine

Title:

Nurses' Role in Implementing and Sustaining Acute Telemedicine: A Mixed-Methods, Pre-Post Design Using an Extended Technology Acceptance Model

Authors:

Kathleen Bagot, PhD, BBSci(Hons), BSci[1], Natasha Moloczij, MHlthSc, BA(Psych)[2], Lauren Arthurson, MHSM, BSpPath[3], Casey Hair, NN, GradCert[4], Shaun Hancock, BPsychSc(Hons)[5], Christopher Bladin, PhD, MBBS, FRACP[6], Dominique A. Cadilhac, PhD, MPH, BN(post-reg), RN(Div 1)[7]

Author information:

Research Fellow, Public Health: Stroke Division, The Florey Institute of Neuroscience & Mental Health, Melbourne University, Melbourne, Australia
Program Manager-Nurse-led Research, Victorian Comprehensive Cancer Centre, xxx,xxx
Stroke Coordinator & Allied Health Manager, Inpatient Rehabilitation, Echuca Regional Hospital, XXX,XXX
VST Site Coordinator, Ballarat Health Service, XXX,XXX

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Research Officer, Public Health: Stroke Division, The Florey Institute of Neuroscience & Mental Health, Melbourne University, Melbourne, Australia
Director, Stroke Services, Ambulance Victoria, xxx,xxx
XXX, Translational Public Health and Evaluation, Division Stroke and Ageing Research, School of Clinical Science, Monash University, Clayton, VIC, Australia

Correspondence
Dr. Dominique A. Cadilhac, Translational Public Health and Evaluation, Division Stroke and Ageing Research, School of Clinical Science, Monash University, 27-31 Wright Street, Clayton VIC 3168, Australia

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Implementation, nurses, stroke, sustainability, telemedicine

Heading level 2:

Abstract

Purpose: Technology-based systems like telemedicine are frequently being implemented into healthcare settings, impacting clinician practices. Little is known about factors influencing acute telemedicine uptake, if factors differ across time, or between nurses and non-nurses.
Design: A mixed-methods, pre-post design with implementation of a new acute stroke telemedicine service.
Methods: A survey based on an extended Technology Acceptance Model (TAM) was administered to clinicians involved in acute stroke care at 16 regional hospitals (2014–2017). Open-ended questions postimplementation (at 6 months) included strengths of the program and areas to improve. Subsequently, a secondary analysis of nurses' semistructured interviews at the first telemedicine site (2010–2011) was completed to provide greater explanatory detail.
Findings: Surveys were completed by nurses (preimplementation *n* = 77, postimplementation n = 92) and non-nurses (pre *n* = 90, post *n* = 44). Preimplementation, perceived usefulness was the only significant

predictor of intending to use telemedicine for nurses, while perceived ease of use and social influence were significant for non-nurses. Postimplementation, perceived usefulness was significant for both groups, as was facilitating conditions for nurses. Specific examples aligned to TAM categories from our detailed interviews (*n* = 11 nurses) included perceived usefulness (improved clinical support and patient care), perceived ease of use (technical, clinical aspects), facilitating conditions (setting, education, confidence), and social influence (working relationships).

Conclusions: Important factors for acute stroke telemedicine varied between nurses and non-nurses, and changed after implementation. The benefits of telemedicine should be emphasized to nurses. Preimplementation, more non-nurses wanted systems to be easy. Support in clinical, technical, and relationship aspects of telemedicine consultations is required.

Clinical Relevance: Nurses are influential in implementing acute telemedicine, which is complex, with clinical and technical aspects entwined. Evidence-based implementation strategies must be tailored over time, and between nurses and non-nurses, to ensure initial uptake and ongoing use.

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Body of article:

The evidence-based practice of delivering health care when remote from patients (telemedicine) is being implemented internationally for acute conditions (Audebert, Schenkel, Heuschmann, Bogdahn, & Haberl, 2006; Meyer et al., 2008) and chronic conditions (Brewster, Mountain, Wessels, Kelly, & Hawley, 2014; Franc et al., 2011; Klonoff, 2009). Settings range from home-based health monitoring (Browning, Tullai-McGuinness, Madigan, & Struk, 2009) to rural emergency departments (EDs) for noncritical emergency conditions (du Toit, Malau-Aduli, Vangaveti, Sabesan, & Ray, 2017) and emergency conditions (Ward, Jaana, & Natafgi, 2015). These new healthcare delivery models require system-wide change,

disrupting clinicians' work practices, including for nursing staff (Rouleau et al., 2017; Sensmeier, 2012).

Benefits of telemedicine include improving workforce disparities in regional areas, providing access to specialists for patients and clinicians (resulting in local capacity building), and reducing hospital transfer or travel costs for families (Schwamm et al., 2009). Even if technical, financial, and legal requirements are met (Ward et al., 2015), clinicians' acceptance of the telemedicine model is fundamental to success (Ward, Stevens, Brentnall, & Briddon, 2008). Early acceptance can influence initial use (du Toit et al., 2017) and long-term use (Wade, Eliott, & Hiller, 2014). Importantly, preimplementation perceptions of a new innovation in primary healthcare settings can influence uptake in clinical practice up to 2 years postimplementation (Carlfjord & Festin, 2015). While postimplementation satisfaction has been evaluated, the understanding of clinician perspectives is limited (Brewster et al., 2014), which may explain the inconsistent uptake of telemedicine (Armfield, Edirippulige, Bradford, & Smith, 2014).

Interdisciplinary care requires different health professionals adapting their practice to incorporate telemedicine as part of their everyday practices. In particular, nurses within EDs can have an important role in the use of telemedicine (Grady, 2014) because, as first-line responders in patient assessment and management, they act as gatekeepers to its use at their site (Brewster et al., 2014; Whitten & Mackert, 2005). Available reviews specific to nurses and telemedicine contain research dominated by chronic conditions or nonacute settings (Koivunen & Saranto, 2018; Penny, Bradford, & Langbecker, 2018) or a single time-point (Ward et al., 2015), or results do not distinguish between the experiences of nurses from other healthcare professionals (Strudwick, 2015).

Understanding whether different healthcare professional groups have different perceptions of acute telemedicine specifically, and whether perceptions vary after experiencing a new acute telemedicine service, would support implementation strategies. Stroke is a time-critical condition, with greater opportunities to treat patients within the first few hours of symptom onset to reduce the chance of disability or death, but specialist support for clinical decision making is required (Bladin &

Cadilhac, 2014). Telemedicine for acute stroke, the innovation or intervention to be implemented, is being established for equitable access to specialist doctors for acute care treatment decisions.

The aims of the current study were to (a) identify the factors that predicted intentions to use an acute stroke telemedicine service, pre- and postimplementation for nurses and non-nurses; and (b) identify postimplementation strengths and required improvements by nurses and non-nurses across 16 sites. A third aim was to provide greater explanatory detail of nurses' perspectives of acute telemedicine pre- and postimplementation from the first acute stroke telemedicine site.

Heading level 1:

Methods

Heading level 2:

Study Design and Context

A sequential, mixed-methods approach using a pre-post design was used to evaluate the implementation of the Victorian Stroke Telemedicine (VST) Program (Bladin et al., 2015; Cadilhac, Moloczij, et al., 2014). The VST Program was designed to support clinicians in 16 regional hospitals to have access to metropolitan-based neurologists at any day and time. The patient target group comprised those presenting to the regional ED within 4.5 hr of suspected stroke symptom onset. Telemedicine consultations were undertaken with secure, two-way audio-video conferencing using a mobile telemedicine cart located in each hospital ED. Regional sites determined who would initiate consultations, and included consultants, physicians, registrars, or nurses. Consultant neurologists liaised in real-time and reviewed computerized tomography scans of the brain, required for the clinical assessment and diagnosis of stroke.

Core implementation components included multistage evaluation of barriers and facilitators to incorporating telemedicine into the acute stroke clinical pathway, education and training sessions including mock consults, with iterative audit and feedback on changes in clinical processes disseminated. Organizational and leadership implementation

drivers included clinical champions, site leads, and incorporation into local governance policies and practices via adapted clinical protocols. Facilitation was essential to VST Program implementation, conducted by a part-time site co-ordinator for approximately 18 months of initial operation. This role was fulfilled typically by a local nurse recruited from within each site, and this role was supported by an interdisciplinary project team based at the Florey Institute in Melbourne (Cadilhac, Moloczij, et al., 2014).

An action research model was used, with preimplementation evaluation results used to design site-specific strategies, supporting a tailored implementation approach for each site (Cadilhac, Moloczij, et al., 2014). Clinical improvements from the pilot (Bladin et al., 2015) and details of scaling from a pilot site to 16 implementation sites have been previously reported (Bagot et al., 2017; Cadilhac, Moloczij, et al., 2014). Establishment of the VST pilot study (2010–2011) and subsequently the VST Program (2013–2017) into 16 sites occurred over 8 years. Each hospital had data collected at similar time points from the commencement of their program. Contextual changes included stroke care improvements such as the introduction of endovascular clot retrieval treatment in 2015, which expanded the use of the VST Program. Telemedicine consultations were tracked by program governance systems. The project was approved by each participating regional hospital's human research ethics committee. The research presented here was undertaken in two phases.

Heading level 2:

Phase 1: Survey of Nurses and Other Clinical Staff From the 16 VST Sites (2014–2017)

Heading level 3:

Participants and procedure. All clinicians involved in the management of patients with acute stroke at participating hospitals were invited to complete a questionnaire. These included clinicians within the ED and radiology department, as well as members of the stroke service or ward where the majority of patients with acute stroke were managed (as applicable to each site). A participant information and consent form and paper-based surveys were administered by the site co-ordinators prior to

the telemedicine service being implemented, usually after education sessions, and then approximately 6 months after the service was implemented. Surveys were completed anonymously and returned to the research team for analysis. Data collection for this survey was undertaken between 2014 and 2017 (staggered rollout to 16 sites).

Heading level 3:

Measure. A 24-item survey based on an extended Technology Acceptance Model (TAM; Davis, 1989; Holden & Karsh, 2010; Hu, Chau, Sheng, & Tam, 1999; Parra et al., 2012) was used. The TAM is one of the most commonly used frameworks (Holden & Karsh, 2010; Strudwick, 2015) for understanding acceptance of technology in varying contexts (e.g., business, health care, etc.). The survey was developed from available measures (Health and Safety Executive (n.d.); Purvis, Moss, Denisenko, Bladin, & Cadilhac, 2014), augmented with three items identified during the pilot, and where relevant, items were adapted for stroke telemedicine (Table S1). Items measured included intentions to use (*n* = 4 items), perceived usefulness (*n* = 6 items), and perceived ease of use (*n* = 4 items) were extended by social influence (*n* = 5 items), facilitating conditions (n = 5 items), teamwork and staff (*n* = 6 items), and organizational change (*n* = 5 items). Participants indicated their level of agreement with each item on a Likert-type scale (1 = *strongly disagree*, 7 = *strongly agree*, except for teamwork and organizational change [1 = *strongly disagree*, 5 = *strongly agree*]); scores were averaged within each construct, with higher scores reflecting stronger agreement. Demographics of sex, age, education, years in role, department, and professional group (e.g., nurse, physician, etc.) were captured. Open-ended questions requested strengths and areas to improve telemedicine postimplementation.

Heading level 3:

Analysis. Occupational responses were dichotomized: nurses and non-nurses. Analyses were undertaken using SPSS software (version 25; IBM Corp., Armonk, NY, USA), and assumptions were met. Chi-square tests were used to compare pre- and postimplementation groups' demographics to establish that similar groups participated pre- and postimplementation.

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Prior to analysis, Cronbach's alpha revealed strong internal consistency with all values > .8 for each of the extended TAM constructs. To determine change in the extended TAM variables across time and occupation groups, two-way (time: preimplementation and postimplementation; occupation: nurses and non-nurses) analyses of variance were conducted. Omega squared (ω^2) is reported, with 0.01/0.06/0.14 indicating a small-medium-large effect size, respectively (Skidmore & Thompson, 2013). Correlations were conducted between occupation, years in role, and the extended TAM constructs. Sample size requirements for regressions met the 10 cases per predictor (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). Open-ended questions were subjected to directed content analysis (Hsieh & Shannon, 2005), with coding undertaken based on the broad categories of the TAM framework (i.e., a deductive approach), using Excel software (version 16; Microsoft Corp., Redmond, WA, USA). This approach supported identifying the number of occurrences reported among the total sample of respondents. As the sample sizes varied, the proportion of responses by category and subcategory within the TAM is reported. Two authors (K.B., PhD psychology, female; S.H., honors psychology, male) independently identified responses within perceived usefulness, perceived ease of use, social influence, and facilitating conditions. K.B. and S.H. discussed and harmonized categories and subcategories; all authors reviewed the final results.

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Heading level 2:

Phase 2: Secondary Analysis of Semistructured Interviews From the First Stroke Telemedicine Site (2010–2011)

Heading level 3:

Setting. Interviews were undertaken at the first site of the VST Program. This site was a large hospital in regional Victoria, approximately 200 km from Melbourne, Australia. The site did not have a neurologist on staff, and in 2009 received approximately 375 stroke and transient ischemic attack ED presentations (Morley, 2009).

Heading level 3:

Participants and procedure. The data used for this phase of the current study were derived from a larger qualitative study at this single site. Clinicians involved in the care of patients with acute stroke (purposive sampling) were invited to be interviewed at three time points: preimplementation and two postimplementation interviews (after the 6-month pilot phase and after a further 12-month implementation phase). Telephone and face-to-face interviews were conducted using a semistructured interview schedule. Questions were designed to explore factors (e.g., barriers, facilitators, experience) associated with the implementation and sustainability of telemedicine at this site. Interviews were recorded, transcribed verbatim, and then analyzed using inductive thematic methods, including two researchers verifying coding.

In-depth interviews were not conducted in subsequent hospitals joining the VST Program as the publicity of the program and available information about the telemedicine service would have influenced the knowledge of the project, impacting on clinician perspectives. Furthermore, given the action-research model for the VST project, whereby changes to the protocol were made, the interview data from the first hospital provides the purest perspectives when introducing a new acute stroke telemedicine service, and therefore is of most relevance to the current study. Further information about the full VST project using these data has been previously published (Bagot, Cadilhac, Vu, Moss, & Bladin, 2015; Bagot et al., 2018; Moloczij et al., 2015).

Heading level 3:

Analysis. To provide greater explanatory detail specifically into nurses' perspectives from Phase 1 of the current study, a secondary analysis of interview transcripts obtained only from the nurses was conducted. Post-pilot and post-12-month interview data were combined to provide a single postimplementation period. Descriptive analysis was undertaken to identify common patterns and important categories (Ritchie, Spencer, & O'Conner, 2003) using a deductive approach, with coding guided by the constructs within the TAM framework (Holden & Karsh, 2010; King & He, 2006). One author (K.B.) reviewed transcripts identifying text within

the a priori constructs of perceived usefulness, perceived ease of use, social influence and facilitating conditions. Initial categories were generated and subsequently grouped into categories and subcategories. K.B. and the research lead (D.C., an experienced health services researcher and former nurse, female) reviewed and discussed the initial framework. Results were refined, harmonizing subcategories and reviewed by all authors. Qualitative analysis software (NVivo v9; QSR International, Melbourne, Victoria, Australia) was used and illustrative quotations are provided.

Heading level 1:

Results

Overall, 360 telemedicine consultations were conducted within the first 6 months across all sites. There were a median of 17.5 (Q1 = 13.5, Q3 = 31.75) consultations per site.

Heading level 2:

Phase 1: Results From the Survey Administered Pre- and Postimplementation in 16 Sites

Heading level 3:

Respondent characteristics. Demographics (Table S2) were similar between pre- and postimplementation for all participants (pre *n* = 167; post *n* = 136), and then by nurse (pre *n* = 77; post *n* = 92) and non-nurse (pre *n* = 90; post *n* = 44) groups, except that fewer postimplementation group nurses were 18 to 34 years of age, and more were 35 to 49 years of age compared to preimplementation. Non-nurses comprised physicians (*n* = 13 pre; *n* = 5 post), general practitioners (*n* = 5 pre; *n* = 0 post), medical registrars (*n* = 16 pre; *n* = 14 post), medical interns (junior to registrars; *n* = 20 pre; *n* = 6 post), managers (*n* = 12 pre; *n* = 9 post), and other (*n* = 24 pre; *n* = 0 post). Compared to non-nurses, nurses had been in their roles longer (mean/*SD* years 9.30/7.72 vs. 3.71/5.13 years; $p < .001$), were more likely to be employed part-time ($p < .001$), and comprised fewer medical ($p = .005$) and more female ($p < .001$) team

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members, both preimplementation (reported here) and postimplementation.

Heading level 3:

Changes over time for nurses and non-nurses. Mean scores for the extended TAM domains (Table S3) were moderate to high (above the midpoint on the response scale) for both nurses and non-nurses, and compared to preimplementation, all postimplementation scores increased significantly (with typically large effect sizes). Nurses reported significantly greater intentions to use telemedicine than non-nurses, but with a small effect size (ω^2 = .019).

Heading level 3:

Predictors of nurses' and non-nurses' intentions to use telemedicine. When compared to preimplementation, correlations were stronger between intention to use telemedicine and each domain at postimplementation (Table S4). The years in role was not associated with intentions to use telemedicine, and was therefore excluded from further analysis. For the total sample (Table 1), preimplementation intentions to use telemedicine were predicted by perceived usefulness, perceived ease of use, social influence, and occupation [pre $F(7, 142) = 11.44$, $p < .001$; adjusted $R^2 = .38$], but only perceived usefulness was significant postimplementation [post $F(7, 120) = 37.83$, $p < .001$; adjusted $R^2 = .67$]. Teamwork and organizational change did not predict intentions (pre- or postimplementation), and as results did not change when these variables were excluded, they were dropped from further analyses. Occupation was a significant predictor, so we examined predictors separately by nurses and non-nurses (Table 2).

Preimplementation, nurses' intentions to use telemedicine [$n = 69$, $F(4, 64) = 21.39$, $p < .001$; adjusted $R^2 = .55$] was predicted by perceived usefulness, while non-nurses' intentions [$n = 87$, $F(4, 82) = 11.9$, $p < .001$; adjusted $R^2 = .37$] were predicted by perceived ease of use and social influence. Predictors changed postimplementation; perceived usefulness and facilitating conditions were significant predictors for nurses [$n = 90$, $F(4, 89) = 46.71$, $p < .001$; adjusted $R^2 = .67$], while perceived usefulness only was significant for non-nurses [$n = 43$, $F(4, 38) = 26.49$, $p < .001$; adjusted $R^2 = .71$].

Most of the strengths identified within the open-ended responses (Table S5) were in perceived usefulness (>60% of responses), including improved clinical access and support, and improved patient care, followed by perceived ease of use of telemedicine (approximately 25% of responses). Most responses for the areas for improvement (Table S6) were within facilitating conditions, particularly more education and training required, and within perceived ease of use, including reducing technology issues. Nurses and non-nurses similarly identified strengths, but nurses more frequently identified that education or training was required postimplementation (36% of nurses' responses, 14% of non-nurses' responses).

Heading level 2:

Phase 2: Results From the Qualitative Interviews Conducted at the First VST Site

Heading level 3:

Sample characteristics. There were 11 nurses (10 female; median age 32 years, Q1 = 30, Q3 = 44) interviewed (8 face-to-face, 3 by phone): *n* = 5 preimplementation, *n* = 3 post-6-month pilot and *n* = 3 post-12-month. Nursing role experience was median 10 years (Q1 = 5, Q3 = 22), with *n* = 3/5 having had previous telemedicine experience prior to VST implementation.

Heading level 3:

Nurses' perspectives of implementing a new telemedicine service. Although the summary of responses are allocated to a single TAM domain (Table 3), categories and subcategories were multifaceted or inter-related. For example, comments on technology included needing training in the technology (facilitating condition), but if technology fails, then this detracts from using telemedicine (perceived ease of use), and confidence in using the technology (category confidence, subcategory technical) was dependent on having sufficient training (category education, subcategory technical).

Categories identified within perceived usefulness typically were

enablers to using telemedicine, including improved clinician access and support and improved patient care, and that telemedicine had a range of uses (e.g., education, support to other sites, or other conditions):

Inset quote:

> Knowing that we're doing the right thing or knowing if there's are any extra specific things that we need to be doing for these patients . . . knowing whether to transfer or not. . . . That's always something we kick around for hours and hours and hours and then decide later on to transfer, whereas having these guys' opinion straight up, . . . you get a definitive answer and definitive care for the patient a lot quicker than what we did beforehand. (Nurse 32, 5 years' nursing experience, postimplementation)

Perceived ease of use categories typically were potential barriers to telemedicine, including that the technology had to be easy to use. Technology issues were particularly identified as detracting from the benefits of telemedicine and therefore very important to address, including having a back-up plan. Perceptions of extra workload due to the extra step were also referenced:

Inset quotes:

> Just the frustration of it not being able to, it's just always been that it didn't, like one end wasn't working so you couldn't turn it on and see, so that was frustrating. But, as I say when it does work, brilliant. (Nurse 9, 25 years' nursing experience, preimplementation)

> How has it impacted on my workload? I think it's added another step to the process but in the absence of local expertise that's a necessary step. (Nurse 25, 3 years' nursing experience, postimplementation)

Categories within facilitating conditions included the importance of the setting and profile of the program. There were multiple references to the ED and staff being busy, thereby impacting on the capacity for

receiving training, and even having the opportunity to think about using telemedicine. Multiple comments related to having enough confidence or trust in the technology to work and the education to ensure knowing when to initiate and how to use it. Comments indicated that nurses' roles could include technical or clinical aspects:

Inset quotes:

> I hate saying that busyness is an excuse but often it is because if you want to train people how to use it quickly, you've got to give them time to have a look at it . . . that's how I learnt, tell me 10 times and it eventually sinks in. That's how a lot of ED people think. (Nurse 2, 22 years' nursing experience, postimplementation)

> I came in and turned the screen on and ran away again . . . and then I think I might have come in and helped set up the thrombolytic as well because yeah, just people don't do it very often so it's just that reassurance that this is the process. . . . (Nurse 25, 3 years' nursing experience, postimplementation)

Categories within social influence involved the various professional working relationships. Nurses often commented on "influential others" to be involved in using the telemedicine service, including other local doctors or medical registrars and the telemedicine neurologists:

Inset quotes:

> Nurses I've found are willing to give anything a go, and "let's try out that telemedicine thing," whereas the doctors we get a lot of resistance from. . . . (Nurse 32, 5 years' nursing experience, postimplementation)

> Because it was a really complicated case, so it was good getting their feedback and knowing what sort of tests and sort of things we need to look for and do for this patient. (Nurse 32, 5 years' nursing experience, postimplementation)

Heading level 1:

Discussion

To our knowledge, this is the first study to identify influential differences between nurses and other non-nurse clinicians, and changes with the implementation and experience of acute stroke telemedicine. Treatment of acute stroke is complex, and the decision to treat patients needs to be considered against the risk for harm from adverse consequences of bleeding (Emberson et al., 2014). Therefore, uptake of thrombolysis has been slow, particularly among hospitals without access to specialist support. We found the majority of nurses and non-nurses had the intention to use telemedicine for acute stroke prior to implementation, and this was strengthened within the first 6 months of the VST Program. Similarly, strong endorsements have been previously reported for a telemonitoring service by nurses and doctors combined (Gagnon, Orruno, Asua, Abdeljelil, & Emparanza, 2012), but support may not be maintained over time (Lemon et al., 2018). Setting (e.g., acute vs. chronic), context (i.e., stroke vs. other conditions), evaluation time periods (e.g., pre- and post- or only postimplementation), and service utilization (e.g., high vs. low frequency of use) differences between studies may impact findings.

Heading level 2:

Important Factors Differed for Nurses and Non-nurses, and They Changed Over Time

Different factors were important in predicting nurses and non-nurses' use of telemedicine; nurses may be more task focused, and therefore usefulness is a priority, while non-nurses may have other role influences such as deciding to treat or not. However, results for nurses and non-nurses were more aligned after experiencing telemedicine. Consistent with our findings, perceived usefulness of telemedicine services has previously been identified as a major factor explaining intentions to its use by nurses in critical care units prior to implementation (Kowitlawakul, 2011). The main theme for the usefulness of

telemedicine was the impact on patient care, including specifics such as seeing the patient (Penny et al., 2018) and reducing patient transfers (Koivunen & Saranto, 2018). Ease of use was important for non-nurses' intentions to use telemedicine, but only prior to implementation. Similar to our acute setting results, perceptions such as that telemedicine may be time consuming or may lead to increased workload, or that users may experience technical problems such as system failures and poor image or sound quality, are amongst the most cited barriers to using telemedicine services in chronic settings (Koivunen & Saranto, 2018; Penny et al., 2018). Non-nurses in our study may have more readily identified barriers than nurses (c.f., early and late adopters; Rogers, 2003) or considered telemedicine more disruptive to their practice than nurses (Schwamm, 2018).

Alongside the perceived usefulness of the service, facilitating conditions was important for nurses' intentions to use telemedicine postimplementation. Aspects of facilitating conditions identified within our acute pilot setting interviews have previously been identified within chronic conditions: ongoing support is required, including technical support, training, and confidence in being on camera (Koivunen & Saranto, 2018; Penny et al., 2018).

Social influence was identified as important for non-nurses prior to the telemedicine service being available, but not postimplementation. Our results do not allow us to identify which people the non-nurses were referring to; however, in preimplementation interviews, some nurses did indicate that they could facilitate the engagement of the telemedicine service for doctors and medical registrars (e.g., knowing when to call, location of the teledoc, etc.). Consistent staff support of telemedicine was a suggested improvement postimplementation. Nurses were acting as boundary spanners (personnel who link internal networks with external resources; Williams, 2002) across the different health professionals involved in the telemedicine service. This liaison is critical as physician involvement is influential to quality improvement success (Kaplan et al., 2010). Further, peer support and superiors have been reported to influence clinical guideline implementation (Francke, Smit, de Veer, & Mistiaen, 2008). With some physicians indicating that contacting external specialists or treatment offered is not required

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(Kwan, Hand, & Sandercock, 2004), nurses' facilitation can support patients getting access to specialists and gold standard treatments such as stroke thrombolysis (Emberson et al., 2014), which may be controversial to some (Australasian College for Emergency Medicine, 2014).

Heading level 2:

Multifaceted Factors to Be Addressed for Implementation and Acceptance of Telemedicine

We have identified that there are multiple similarities between telemedicine used for chronic and acute conditions. However, through the pilot site interviews, the busyness of the ED and the ED staff may require specific strategies to engage clinicians, including formal and informal training sessions. Our findings from the qualitative interviews with nurses at the first VST site provided evidence that acute telemedicine implementation and use included technical (e.g., teledoc logistics, troubleshooting for others), clinical (e.g., use of thrombolysis drug), and multidisciplinary or interprofessional (e.g., emergency and neurology specialists, local and remote clinicians) aspects of consultations. Significant telestroke implementation roles for nurses have previously been reported (e.g., clinical roles: clinical coordinator and nurse practitioner; project roles: program manager or research coordinator; Kiernan & Demaerschalk, 2010).

We identified variation in nurses' confidence in the clinical, technical, and relationship aspects of telemedicine, and that these are all important for uptake and use at 6 months. More confidence with telemedicine is associated with more clinical experience (Eley, Fallon, Soar, Buikstra, & Hegney, 2008). When implementing telemedicine, access to implementation team members and other support (e.g., IT), with both formal and informal (e.g., impromptu) training and education sessions, are required. For the telemedicine intervention to be usable, these sessions should account for schedules of clinicians working in busy, acute settings. Further, improvements in videoconference technology can reduce technical issues, improve reliability, and support ongoing use. Nurse-specific competencies for telehealth (van Houwelingen, Moerman,

Ettema, Kort, & Ten Cate, 2016), and specific pre-post implementation strategies have been previously identified (Bagot et al., 2018). Tailoring strategies to nurses and non-nurses separately and adapting strategies postimplementation are required for success.

Heading level 1:

Strengths, Limitations, and Guidance for Future Research

The strengths of this study include using an established theory, our mixed-method approach, with large samples pre- and postimplementation of a new acute stroke telemedicine service. Despite the strengths of the study, a number of limitations need to be considered. The acute stroke telemedicine service was a synchronous and noncompulsory service; sites determined if, and when, to initiate an acute telemedicine consultation. Results may vary from services that are asynchronous, and not voluntary. For the survey component undertaken in Phase 1, the major limitation was the prediction of self-reported intentions to use telemedicine, rather than actual use data. Moreover, the staggered approach to implementation at the hospitals and regular promotion of the positive impacts of VST throughout the study period may have influenced results from respondents joining the program later. However, intentions are the strongest predictor of behavior (Godin, Bélanger-Gravel, Eccles, & Grimshaw, 2008), and telemedicine consultations were undertaken by each site within the first 6 months, and continue to be used (Bagot et al., 2018). Differences in results between nurses and non-nurses may have been due to nurses having more experience in their role (approximately 8 years to less than approximately 2 years). This variation would be associated with confidence levels (Eley et al., 2008). Future work could consider the Interactive Socio-Technical Analysis (Harrison, Koppel, & Bar-Lev, 2007) to capture interactions between individuals (e.g., nurses and non-nurses), and between individuals and the technology. For the qualitative component, interviews of nurses were limited to one site approximately 8 years ago while the telemedicine program was being established. Our research design did not include undertaking additional semistructured interviews at each new site to join the VST program, and we may not have captured all relevant themes or subthemes. However, anecdotal evidence

suggests similar comments were made during implementation of more recent sites. Future work may consider an interpretative phenomenological approach (Smith & Osborn, 2008) to provide an in-depth understanding of nurses and non-nurses' experiences. Research across different conditions and settings (e.g., acute, chronic, etc.) would contribute to understanding technology implementation in healthcare.

Heading level 1:

Conclusions

Implementation of innovations such as telemedicine services for complex, time-critical conditions like stroke is multi-faceted, and the use of evidence-based strategies must be tailored to ensure system level and individual uptake. Prior to implementation, the potential usefulness of telemedicine should be emphasized to nursing groups, and the ease of use and important others' support of telemedicine should be emphasized to other clinicians to facilitate intentions to use telemedicine. To maintain use after implementation, telemedicine should be identified as useful (such as beneficial to patient care) to all clinicians involved, and facilitating conditions (such as education or training to build confidence) should be provided to support nurses. Training and support are required for both clinical and technical aspects to ensure clinicians are confident in using the equipment and engaging with clinicians remotely in time-sensitive settings.

Heading level 1:

Acknowledgments

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Please gray-box Clinical Resources

Heading level 1:

Clinical Resources

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- Centre of Research Excellence in Telehealth, University of Queensland Australia. https://cretelehealth.centre.uq.edu.au/
- Victorian Stroke Telemedicine. https://www.vst.org.au/
- World Health Organization. Health and sustainable development: Telehealth. https://www.who.int/sustainable-development/health-sector/strategies/telehealth/en/

Heading level 2:

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Table 1. Characteristics of Participating Nursing Homes and Respondents

Nursing home characteristics (n = 20)	Mean (SD)	n (%)
Number of beds: Long-term care	46.3 (35)	
Time since opening (years)	10.5 (9.5)	
Readiness and capacity (scale 1–5)		
Staffing resources	2.8 (0.89)	
Time resources	2.6 (0.79)	
Perceived willingness of the care workers	3.6 (0.88)	
Care worker characteristics (n = 343)		
Age (years)	38.6 (13.6)	
Gender (female)		296 (89.2)
Registered nurses		61 (18.2)
Licensed practical nurses		94 (28.1)
Nursing aides		180 (53.7)
Years of work experience in nursing care	11.4 (11.1)	

Table 2. Results of the Barrier Items: Proportions of Answers Indicating Moderate or Major Problem by Educational Background

Barrier items	RNs and LPNs	Nursing assistants	All[a]

	n	%	n	%	n	%
Lacking availability of nonpharmacological treatment	141	63.1	36	50.0	184	60.9
Lacking application of nonpharmacological treatment	140	56.4	36	47.2	183	53.6
Reluctance of residents to report pain	141	51.1	35	45.7	184	51.1
Inadequate time to assess pain comprehensively	141	50.4	36	52.8	184	50.5
Insecurity of care workers regarding pain assessment in residents with communication difficulties	142	43.7	37	48.6	187	48.3
Inadequate availability of physicians	138	38.4	35	51.4	180	41.1
Inadequate flow of information among the care workers	141	34.0	34	44.1	182	36.4
Resident reluctance to take pain medication	139	32.4	35	51.4	182	37.4
Inadequate care worker knowledge	142	28.2	35	37.1	179	31.1
Inadequate flow of information between care workers and therapists	140	25.0	33	45.5	179	29.1
Inadequate communication between care workers and physicians	142	26.8	34	41.2	182	29.1
Resident fear of side effects	141	25.5	34	29.4	183	28.5
Family concerns about side effects (n = 185)	141	28.4	36	27.8	185	28.5
Physician reluctance to prescribe	140	29.3	33	27.3	178	28.5
Residents' pain is not taken seriously	143	19.6	38	34.2	189	25.2
Availability of drugs	142	21.8	35	34.3	188	23.8
Slow (nontimely) reaction to residents' pain reports	142	19.7	38	31.6	188	22.5
Lacking PRN prescription for pain medication	141	19.1	36	27.8	185	21.2
Lacking qualification of care workers to administer pain medication (e.g., at night or on weekends)	143	16.1	35	37.1	186	17.9
Nurses' concern about side effects	140	12.9	36	5.6	184	11.4

Note. LPN = licenced practical nurse; PRN = pro re nata; RN = registered nurse.

[a]Eight missing observations for the level of educational background.

Table 3. Summary of Barriers and Facilitators Assigned to COM-B Domains

COM-B domains		Barriers and facilitators
Capability	Psychological	Attitudes towards pain in older people Difficulties to interpret behavior in residents with dementia Need for training of nursing assistants in pain assessment
	Physical	
Opportunity	Social	Joint ward rounds of physicians and nurses ↑
	Physical	Time constraints for the application of nonpharmacological treatment High turnover Limited availability of nonpharmacological options Inadequate availability of physicians Single physician who is responsible for all residents ↑
Motivation	Reflective	Perceived lack of time for pain assessment Little intentions to assess pain comprehensively on a regular base
	Automatic	No established routines regarding pain assessment and application of nonpharmacological treatment

Note. ↑ = increased; COM-B = Capability, Opportunity and Motivation determine Behavior.

Author/s:
Bagot, K; Moloczij, N; Arthurson, L; Hair, C; Hancock, S; Bladin, CF; Cadilhac, DA

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