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Corrigenda and Addenda

Addendum to the Acknowledgments: Comparison of Intercom and Megaphone Hashtags Using Four Years of Tweets From the Top 44 Schools of Nursing: Thematic Analysis

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Related Article:

Correction of: https://nursing.jmir.org/2021/2/e25114

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In "Comparison of Intercom and Megaphone Hashtags Using Four Years of Tweets From the Top 44 Schools of Nursing: Thematic Analysis" (JMIR Nursing 2021;4(2):e25114 doi: 10.2196/25114), the author noted one error.

In the originally published paper, the Acknowledgments section contained the following line about the source of funds for the 2016-2018 Twitter data:

> *The September 29, 2016, to February 22, 2018, Twitter data for this project were purchased with funds provided by the George Washington University School of Nursing's Center for Health Policy and Media Engagement.*

To increase clarity regarding the amount and original sources of funding provided for the purchase of data, this has been corrected to:

> *The September 29, 2016, to February 22, 2018, Twitter data for this project were purchased by the George Washington University School of Nursing's Center for Health Policy and Media Engagement for $1000 with funds received from the Gordon and Betty Moore Foundation, Robert Wood Johnson Foundation, Beatrice Renfield Foundation, Sigma Theta Tau International, American Association of Critical-Care Nurses, Donald and Barbara Jonas Foundation, National League for Nursing, OnCourse Learning, American Association of Colleges of Nursing, American Organization of Nurse Executives, and Wolters Kluwer Health. No funding was provided for this study beyond the $1000 used for the purchase of data.*

The correction will appear in the online version of the paper on the JMIR website on April 29, 2021, together with the publication of this correction notice. Because this was made after submission to PubMed, PubMed Central, and other full-text repositories, the corrected article has also been resubmitted to those repositories.

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Original Paper

Comparison of Intercom and Megaphone Hashtags Using Four Years of Tweets From the Top 44 Schools of Nursing: Thematic Analysis

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Abstract

Background: When this study began in 2018, I sought to determine the extent to which the top 50 schools of nursing were using hashtags that could attract attention from journalists on Twitter. In December 2020, the timeframe was expanded to encompass 2 more years of data, and an analysis was conducted of the types of hashtags used.

Objective: The study attempted to answer the following question: to what extent are top-ranked schools of nursing using hashtags that could attract attention from journalists, policy makers, and the public on Twitter?

Methods: In February 2018, 47 of the top 50 schools of nursing had public Twitter accounts. The most recent 3200 tweets were extracted from each account and analyzed. There were 31,762 tweets in the time period covered (September 29, 2016, through February 22, 2018). After 13,429 retweets were excluded, 18,333 tweets remained. In December 2020, 44 of the original 47 schools of nursing still had public Twitter accounts under the same name used in the first phase of the study. Three accounts that were no longer active were removed from the 2016-2018 data set, resulting in 16,939 tweets from 44 schools of nursing. The Twitter data for the 44 schools of nursing were obtained for the time period covered in the second phase of the study (February 23, 2018, through December 13, 2020), and the most recent 3200 tweets were extracted from each of the accounts. On excluding retweets, there were 40,368 tweets in the 2018-2020 data set. The 2016-2018 data set containing 16,939 tweets was merged with the 2018-2020 data set containing 40,368 tweets, resulting in 57,307 tweets in the 2016-2020 data set.

Results: Each hashtag used 100 times or more in the 2016-2020 data set was categorized as one of the following seven types: nursing, school, conference or tweet chat, health, illness/disease/condition, population, and something else. These types were then broken down into the following two categories: intercom hashtags and megaphone hashtags. Approximately 83% of the time, schools of nursing used intercom hashtags (inward-facing hashtags focused on in-group discussion within and about the profession). Schools of nursing rarely used outward-facing megaphone hashtags. There was no discernible shift in the way that schools of nursing used hashtags after the publication of *The Woodhull Study Revisited*.

Conclusions: Top schools of nursing use hashtags more like intercoms to communicate with other nurses rather than megaphones to invite attention from journalists, policy makers, and the public. If schools of nursing want the media to showcase their faculty members as experts, they need to increase their use of megaphone hashtags to connect the work of their faculty with topics of interest to the public.

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KEYWORDS

Twitter; hashtag; nurses; media; intercom hashtag; megaphone hashtag

Introduction

Twitter is a microblogging website where users can post "tweets" (brief messages, images, and videos) to share with "followers" (people who have chosen to follow their Twitter account). Hashtags are words or phrases (without spaces) that are preceded by a pound sign (#) [1]. Hashtags first came into use on Twitter in 2007 when a user named Chris Messina put forward a proposal for "…improving contextualization, content filtering, and exploratory serendipity within Twitter" [2]. In his proposal, Messina wrote that his primary interest was "simply having a better eavesdropping experience on Twitter" [2]. In 2018, hashtags were widely used on Twitter to make tweets easy to find for other Twitter users interested in a given topic.

When the landmark *Woodhull Study on Nursing and the Media* was published in 1998, the voices and faces of nurses were found to be largely absent from news stories [3]. Mary Chaffee wrote that "[t]his lack of visibility limits nursing's ability to communicate important health information, impedes nursing's ability to define its role and contributions in the health care delivery system, and restricts nursing's ability to advocate for health policy" [4]. Because Twitter was not launched until 8 years after the Woodhull Study was conducted, the researchers obviously could not look at Twitter data in their analysis. Shattell and Darmoc argue that nurses should consider using Twitter to make their "practical, real-life knowledge or…research findings or insights on current issues… available for the public" and to "harness attention from some more traditional media sources" [5]. While there is an abundance of research regarding the use of hashtags by health care professionals on Twitter [6-10], little is known about the ways in which schools of nursing used Twitter to invite attention from and engagement with journalists, policy makers, and the general public in the 2 years before *The Woodhull Study Revisited* was published in September 2018 and the 2 years after its publication. This study seeks to fill this gap.

When this study began in 2018 as a last-minute addition to *The Woodhull Study Revisited*, I sought to determine the extent to which the top 50 schools of nursing were using hashtags that could attract/invite attention from journalists on Twitter [11]. Preliminary findings using 2016-2018 data were intriguing but were not published with the rest of the results of *The Woodhull Study Revisited* [12]. In December 2020, the timeframe was expanded to encompass 2 more years of data so that before and after *Woodhull Study Revisited* analyses could be conducted. In addition, the scope was expanded to include an in-depth analysis of the types of hashtags used by schools of nursing. The resulting study is a comprehensive analysis of 4 years of tweets from the top 44 schools of nursing in the United States.

Methods have been described in detail using plain language so that researchers can easily replicate the study without needing specialized knowledge in natural language processing or machine learning. Democratizing Twitter analysis requires greater transparency regarding the methods used. As such, each table in this manuscript illustrates a step in the data analysis process that would otherwise be opaque to readers if the step was simply described in the narrative.

Methods

Research Question

The study sought to answer the following question: to what extent are top-ranked schools of nursing using hashtags that could attract/invite attention from journalists, policy makers, and the general public on Twitter? Below is a detailed description of the methods used for sampling, data collection, and data analysis.

Sampling

When this study began in February 2018, the sample of nursing schools was drawn from US News and World Report's 2017 list of the top nursing schools with master's degree programs. Fifty of the highest-ranked schools were selected from this list, with numerical rankings ranging from 1st to 48th (with several ties). The US News and World Report rankings were used as a mechanism for identifying the schools of nursing to include in this study with the knowledge that the rankings do not necessarily mean that the schools included at the top of the list are inherently "better" than the schools ranked lower. The decision to include the 50 highest-ranked schools of nursing in the sample was based on the fact that the US News and World Report rankings are the primary way that members of the media can quickly identify top schools of nursing nationally. The US News and World Report gets 7 million unique visitors to the education rankings and information webpages each month (US News and World Report, 2018).

In February 2018, of US News and World Report's 50 top schools of nursing, two schools did not have a Twitter account and one school had a locked private Twitter account that was inaccessible to anyone other than those who were given permission by the school to follow the account. Thus, the school of nursing with the locked Twitter account and the two schools without a Twitter account were excluded from the 2016-2018 data set. The three schools omitted from the 2016-2018 data set are indicated in Table 1. In December 2020, when the second phase of this study was conducted, 44 of the original 47 schools of nursing still had public Twitter accounts under the same name used in the 2016-2018 data set. The three schools that no longer had a public Twitter account under the same name in 2020 are indicated in Table 1 and were omitted from both the 2016-2018 and 2018-2020 data sets for the sake of consistency.

Table 1. Sample composition.

2017 US News & World Report Rank	Name of the university	Name of the school of nursing	Official school Twitter account in February 2018	Account status in December 2020
#1	Duke University	School of Nursing	@DukeU_NrsngSchl	Active
#2	Johns Hopkins University	School of Nursing	@JHUNursing	Active
#3	University of Pennsylvania	Penn Nursing Science	@PennNursing	Active
#4	Emory University	Nell Hodgson Woodruff School of Nursing	@EmoryNursing	Active
#5	Ohio State University	College of Nursing	@osunursing	Active
#6 Tie	University of Washington	School of Nursing	@UWSoN	Active
#6 Tie	Yale University	School of Nursing	@YaleNursing	Active
#8 Tie[a]	Columbia University	School of Nursing	@CU_Nursing	Inactive
#8 Tie	University of Pittsburgh	School of Nursing	@UPittNursing	Active
#10	University of Maryland–Baltimore	School of Nursing	@MarylandNursing	Active
#11 Tie	Case Western Reserve University	Frances Payne Bolton School of Nursing	@fpbnursing	Active
#11 Tie	University of Michigan–Ann Arbor	School of Nursing	@UMichNursing	Active
#13 Tie	New York University (Meyers)	Rory Myers College of Nursing	@NYUNursing	Active
#13 Tie	University of Alabama–Birmingham	School of Nursing	@UABSON	Active
#15 Tie	University of California Los Angeles	School of Nursing	@UCLANursing	Active
#15 Tie	Vanderbilt University	School of Nursing	@VanderbiltNurse	Active
#17	University of North Carolina–Chapel Hill	School of Nursing	@UNCSON	Active
#18	Rush University	College of Nursing	@RushUNursing	Active
#19	University of Virginia	School of Nursing	@UVASON	Active
#20 Tie	Pennsylvania State University–University Park	College of Nursing	@PSUNursing	Active
#20 Tie	Rutgers University–Newark	School of Nursing	@RU_Nursing	Active
#20 Tie	University of Illinois–Chicago	College of Nursing	@UICnursing	Active
#23 Tie[a]	University of Iowa	College of Nursing	@UICollegeofNurs	Inactive
#23 Tie	University of Texas–Austin	School of Nursing	@LonghornNursing	Active
#23 Tie[b]	University of Texas Health Science Center–Houston	Cizik School of Nursing	No Twitter account found	N/A[c]
#26 Tie[b]	Medical University of South Carolina	College of Nursing	@MUSC_CON Locked account	N/A
#26 Tie	University of Colorado Anschutz Medical Campus	College of Nursing	@NursingCU	Active
#28 Tie	Georgetown University	School of Nursing and Health Studies	@GtownNHS	Active
#28 Tie	Indiana University-Purdue University–Indianapolis	School of Nursing	@IUSONIndy	Active
#28 Tie[b]	University of San Diego	Hahn School of Nursing and Health Science	No Twitter account found	N/A
#31 Tie	Arizona State University	College of Nursing and Health Innovation	@asunursing	Active
#31 Tie	Boston College	Connell School of Nursing	@BC_CSON	Active
#31 Tie	The Catholic University of America	School of Nursing	@CUANursing	Active

2017 US News & World Report Rank	Name of the university	Name of the school of nursing	Official school Twitter account in February 2018	Account status in December 2020
#31 Tie	George Washington University	School of Nursing	@GWNursing	Active
#31 Tie	University of Utah	College of Nursing	@uofunursing	Active
#36 Tie	Oregon Health and Science University	School of Nursing	@OHSUNursing	Active
#36 Tie	University of Rochester	School of Nursing	@UofRSON	Active
#38 Tie	University of Cincinnati	College of Nursing	@UCnursing	Active
#38 Tie	University of Miami	School of Nursing and Health Studies	@UMiamiNursing	Active
#38 Tie	University of Missouri	Sinclair School of Nursing	@MizzouNursing	Active
#41 Tie[a]	University of Arizona	College of Nursing	@UACON	Inactive
#41 Tie	Washington State University	College of Nursing	@WSUNursing	Active
#43 Tie	University of Connecticut	School of Nursing	@UConnNursing	Active
#43 Tie	University of Missouri–Kansas City	School of Nursing and Health Studies	@UMKCSoNHS	Active
#45 Tie	Florida Atlantic University (Lynn)	Christine E. Lynn College of Nursing	@faunursing	Active
#45 Tie	University of Massachusetts–Amherst	College of Nursing	@UMAnursing	Active
#48 Tie	University of Alabama	Capstone College of Nursing	@uaccn	Active
#48 Tie	University of Tennessee–Knoxville	College of Nursing	@utknursing	Active
#48 Tie	Virginia Commonwealth University	School of Nursing	@VCUNursing	Active
#48 Tie	Wayne State University	College of Nursing	@WSUCoN	Active

[a]Schools that no longer had a public Twitter account under the same name in 2020.

[b]Schools omitted from the 2016-2018 data set.

[c]N/A: not applicable.

Data Collection

Data collection was conducted twice during this study. In February 2018, a list of the top 50 schools of nursing was matched with publicly accessible Twitter accounts and then a data request was submitted to Export Tweet for the most recent 3200 tweets from each of the top-ranked schools of nursing. Because schools of nursing tweet with varying frequency, the past 3200 tweets for any given school of nursing covered a wide array of time frames. At one end of the spectrum, there were five schools of nursing, including Vanderbilt University, Johns Hopkins University, University of Michigan–Ann Arbor, Boston College, and University of Pennsylvania, for whom the oldest tweet in the data set was from 2016. At the other end of the spectrum, there were five schools of nursing, including University of Virginia, Yale University, Case Western Reserve University, University of Utah, and University of North Carolina–Chapel Hill, for whom the oldest tweet was from early 2009. Table 2 lists the oldest tweet in the data set from each school, with schools of nursing listed in order of their oldest tweet in the data set.

Table 2. Oldest tweets in the 2016-2018 data set.

Name of the university	Official school Twitter account	Date of the oldest tweet in the 2016-2018 data set
University of Virginia	@UVASON	March 02, 2009
Yale University	@YaleNursing	March 10, 2009
Case Western Reserve University	@fpbnursing	March 12, 2009
University of Utah	@uofunursing	May 5, 2009
University of North Carolina–Chapel Hill	@UNCSON	May 7, 2009
University of California Los Angeles	@UCLANursing	August 7, 2009
New York University (Meyers)	@NYUNursing	October 27, 2009
University of Missouri–Kansas City	@UMKCSoNHS	December 07, 2009
University of Illinois–Chicago	@UICnursing	January 4, 2010
Arizona State University	@asunursing	January 19, 2010
Washington State University	@WSUNursing	January 29, 2010
Florida Atlantic University (Lynn)	@faunursing	April 22, 2010
University of Miami	@UMiamiNursing	April 30, 2010
George Washington University	@GWNursing	September 29, 2010
University of Alabama–Birmingham	@UABSON	May 12, 2011
Wayne State University	@WSUCoN	June 21, 2011
Indiana University-Purdue University–Indianapolis	@IUSONIndy	July 13, 2011
University of Washington	@UWSoN	July 26, 2011
Emory University	@EmoryNursing	February 10, 2012
Oregon Health and Science University	@OHSUNursing	February 18, 2012
Georgetown University	@GtownNHS	March 12, 2012
Ohio State University	@osunursing	April 12, 2012
University of Alabama	@uaccn	April 24, 2012
Duke University	@DukeU_NrsngSchl	May 11, 2012
University of Massachusetts–Amherst	@UMAnursing	June 12, 2012
University of Tennessee–Knoxville	@utknursing	July 17, 2012
Rush University	@RushUNursing	July 27, 2012
University of Maryland–Baltimore	@MarylandNursing	August 10, 2012
University of Missouri	@MizzouNursing	May 13, 2013
University of Rochester	@UofRSON	October 28, 2013
University of Colorado Anschutz Medical Campus	@NursingCU	February 28, 2014
University of Pittsburgh	@UPittNursing	March 18, 2014
Rutgers University–Newark	@RU_Nursing	April 30, 2014
University of Cincinnati	@UCnursing	June 17, 2014
Pennsylvania State University–University Park	@PSUNursing	October 23, 2014
University of Connecticut	@UConnNursing	November 30, 2014
Virginia Commonwealth University	@VCUNursing	January 27, 2015
University of Texas–Austin	@LonghornNursing	April 9, 2015
The Catholic University of America	@CUANursing	April 10, 2015
University of Pennsylvania	@PennNursing	March 24, 2016
Boston College	@BC_CSON	April 7, 2016

Name of the university	Official school Twitter account	Date of the oldest tweet in the 2016-2018 data set
University of Michigan–Ann Arbor	@UMichNursing	June 16, 2016
Johns Hopkins University	@JHUNursing	July 22, 2016
Vanderbilt University	@VanderbiltNurse	September 29, 2016

Table 2 was used to determine the most recent "oldest tweet" date in the 2016-2018 data set. The @VanderbiltNurse Twitter account had the most recent "oldest tweet" (September 29, 2016), so September 29, 2016, was selected as the start date for the analysis. This meant that the time period to be covered in the 2016-2018 data set would be September 29, 2016, through February 22, 2018. Tweets with dates older than September 29, 2016, were filtered out from the data set, resulting in 16,939 tweets for the 2016-2018 data set. Table 3 describes the composition of the final 2016-2018 data set, with schools listed in alphabetical order by Twitter account name.

Table 3. Composition of the 2016-2018 data set.

Name of the university	Official school Twitter account	Number of tweets
Arizona State University	@asunursing	430
Boston College	@BC_CSON	138
The Catholic University of America	@CUANursing	7
Duke University	@DukeU_NrsngSchl	415
Emory University	@EmoryNursing	437
Florida Atlantic University (Lynn)	@faunursing	303
Case Western Reserve University	@fpbnursing	159
Georgetown University	@GtownNHS	257
George Washington University	@GWNursing	883
Indiana University-Purdue University–Indianapolis	@IUSONIndy	251
Johns Hopkins University	@JHUNursing	1992
University of Texas–Austin	@LonghornNursing	545
University of Maryland–Baltimore	@MarylandNursing	738
University of Missouri	@MizzouNursing	49
University of Colorado Anschutz Medical Campus	@NursingCU	206
New York University (Meyers)	@NYUNursing	184
Oregon Health and Science University	@OHSUNursing	312
Ohio State University	@osunursing	949
University of Pennsylvania	@PennNursing	1342
Pennsylvania State University–University Park	@PSUNursing	94
Rutgers University–Newark	@RU_Nursing	88
Rush University	@RushUNursing	191
University of Alabama–Birmingham	@UABSON	390
University of Alabama	@uaccn	166
University of California–Los Angeles	@UCLANursing	99
University of Cincinnati	@UCnursing	318
University of Connecticut	@UConnNursing	20
University of Illinois–Chicago	@UICnursing	124
University of Massachusetts–Amherst	@UMAnursing	38
University of Miami	@UMiamiNursing	39
University of Michigan–Ann Arbor	@UMichNursing	942
University of Missouri–Kansas City	@UMKCSoNHS	31
University of North Carolina–Chapel Hill	@UNCSON	80
University of Rochester	@UofRSON	587
University of Utah	@uofunursing	138
University of Pittsburgh	@UPittNursing	179
University of Tennessee–Knoxville	@utknursing	208
University of Virginia	@UVASON	120
University of Washington	@UWSoN	152
Vanderbilt University	@VanderbiltNurse	2692
Virginia Commonwealth University	@VCUNursing	107
Wayne State University	@WSUCoN	42

Name of the university	Official school Twitter account	Number of tweets
Washington State University	@WSUNursing	265
Yale University	@YaleNursing	232

During phase two of the study, a data request was submitted to Vicinitas for all tweets from February 23, 2018, through December 13, 2020, from the 44 still-active Twitter accounts. Tweets prior to February 23, 2018, were deleted from the data set. Table 4 lists the oldest tweet in the 2018-2020 data set from each school, along with the number of tweets per school.

Table 4. Oldest tweet and total tweets from each school in the 2018-2020 data set.

Name of the university	Official school Twitter account	Oldest tweet date	Total number of tweets
University of Virginia	@UVASON	February 28, 2018	914
Yale University	@YaleNursing	February 23, 2018	550
Case Western Reserve University	@fpbnursing	February 23, 2018	701
University of Utah	@uofunursing	February 23, 2018	707
University of North Carolina–Chapel Hill	@UNCSON	February 23, 2018	396
University of California–Los Angeles	@UCLANursing	February 28, 2018	446
New York University (Meyers)	@NYUNursing	February 23, 2018	655
University of Missouri–Kansas City	@UMKCSoNHS	March 1, 2018	105
University of Illinois–Chicago	@UICnursing	February 27, 2018	523
Arizona State University	@asunursing	February 23, 2018	1943
Washington State University	@WSUNursing	February 23, 2018	504
Florida Atlantic University (Lynn)	@faunursing	February 23, 2018	565
University of Miami	@UMiamiNursing	February 27, 2018	445
George Washington University	@GWNursing	February 23, 2018	2056
University of Alabama–Birmingham	@UABSON	February 28, 2018	990
Wayne State University	@WSUCoN	February 27, 2018	141
Indiana University-Purdue University–Indianapolis	@IUSONIndy	February 25, 2018	445
University of Washington	@UWSoN	February 23, 2018	822
Emory University	@EmoryNursing	February 23, 2018	859
Oregon Health and Science University	@OHSUNursing	February 23, 2018	375
Georgetown University	@GtownNHS	February 23, 2018	961
Ohio State University	@osunursing	February 23, 2018	1927
University of Alabama	@uaccn	March 1, 2018	210
Duke University	@DukeU_NrsngSchl	February 23, 2018	900
University of Massachusetts–Amherst	@UMAnursing	April 27, 2018	53
University of Tennessee–Knoxville	@utknursing	February 23, 2018	577
Rush University	@RushUNursing	March 1, 2018	334
University of Maryland–Baltimore	@MarylandNursing	February 26, 2018	1348
University of Missouri	@MizzouNursing	February 26, 2018	258
University of Rochester	@UofRSON	February 23, 2018	558
University of Colorado Anschutz Medical Campus	@NursingCU	February 23, 2018	595
University of Pittsburgh	@UPittNursing	February 23, 2018	400
Rutgers University–Newark	@RU_Nursing	February 27, 2018	462
University of Cincinnati	@UCnursing	February 24, 2018	509
Pennsylvania State University–University Park	@PSUNursing	February 23, 2018	600
University of Connecticut	@UConnNursing	February 27, 2018	136
Virginia Commonwealth University	@VCUNursing	February 26, 2018	240
University of Texas–Austin	@LonghornNursing	February 25, 2018	795
The Catholic University of America	@CUANursing	March 9, 2018	1
University of Pennsylvania	@PennNursing	February 23, 2018	2357
Boston College	@BC_CSON	February 23, 2018	281
University of Michigan–Ann Arbor	@UMichNursing	February 23, 2018	1435

Name of the university	Official school Twitter account	Oldest tweet date	Total number of tweets
Johns Hopkins University	@JHUNursing	February 23, 2018	6570
Vanderbilt University	@VanderbiltNurse	February 23, 2018	4719

After cleaning the data, the 2016-2018 and 2018-2020 data sets were merged into a single data set containing 57,307 tweets. Table 5 describes the composition of the new 2016-2020 data set, with schools listed in alphabetical order by Twitter account name.

In December 2020, the original list of 47 schools of nursing was matched with publicly accessible Twitter accounts. Of the original 47 schools of nursing, 44 still had public Twitter accounts under the same name used in the first part of the study. The three Twitter accounts that were no longer active (@UICollegeofNurs, @UACON, and @CU_Nursing) were removed from the original data set, resulting in a data set containing 16,939 tweets from 44 top-ranked schools of nursing. The most recent 3200 tweets from each of the Twitter accounts were extracted and analyzed. Excluding retweets, there were 40,368 tweets for the time period covered (February 23, 2018, through December 13, 2020). These 40,368 tweets were added to the data set, resulting in a data set containing 57,307 tweets from September 29, 2016, through December 13, 2020.

Table 5. Composition of the final 2016-2020 data set.

Name of the university	Official school Twitter account	Number of tweets in the 2016-2018 data set	Number of tweets in the 2018-2020 data set	Total number of tweets in the 2016-2020 data set
Arizona State University	@asunursing	430	1943	2373
Boston College	@BC_CSON	138	281	419
The Catholic University of America	@CUANursing	7	701	708
Duke University	@DukeU_NrsngSchl	415	900	1315
Emory University	@EmoryNursing	437	859	1296
Florida Atlantic University (Lynn)	@faunursing	303	565	868
Case Western Reserve University	@fpbnursing	159	2056	2215
Georgetown University	@GtownNHS	257	961	1218
George Washington University	@GWNursing	883	445	1328
Indiana University-Purdue University–Indianapolis	@IUSONIndy	251	6570	6821
Johns Hopkins University	@JHUNursing	1992	655	2647
University of Texas–Austin	@LonghornNursing	545	1927	2472
University of Maryland–Baltimore	@MarylandNursing	738	375	1113
University of Missouri	@MizzouNursing	49	600	649
University of Colorado Anschutz Medical Campus	@NursingCU	206	334	540
New York University (Meyers)	@NYUNursing	184	462	646
Oregon Health and Science University	@OHSUNursing	312	1	313
Ohio State University	@osunursing	949	210	1159
University of Pennsylvania	@PennNursing	1342	990	2332
Pennsylvania State University–University Park	@PSUNursing	94	446	540
Rutgers University–Newark	@RU_Nursing	88	509	597
Rush University	@RushUNursing	191	595	786
University of Alabama–Birmingham	@UABSON	390	136	526
University of Alabama	@uaccn	166	523	689
University of California–Los Angeles	@UCLANursing	99	1348	1447
University of Cincinnati	@UCnursing	318	53	371
University of Connecticut	@UConnNursing	20	445	465
University of Illinois–Chicago	@UICnursing	124	1435	1559
University of Massachusetts–Amherst	@UMAnursing	38	258	296
University of Miami	@UMiamiNursing	39	105	144
University of Michigan–Ann Arbor	@UMichNursing	942	396	1338
University of Missouri–Kansas City	@UMKCSoNHS	31	2357	2388
University of North Carolina–Chapel Hill	@UNCSON	80	400	480
University of Rochester	@UofRSON	587	558	1145
University of Utah	@uofunursing	138	577	715
University of Pittsburgh	@UPittNursing	179	795	974
University of Tennessee–Knoxville	@utknursing	208	707	915
University of Virginia	@UVASON	120	914	1034
University of Washington	@UWSoN	152	822	974
Vanderbilt University	@VanderbiltNurse	2692	4719	7411
Virginia Commonwealth University	@VCUNursing	107	240	347

Name of the university	Official school Twitter account	Number of tweets in the 2016-2018 data set	Number of tweets in the 2018-2020 data set	Total number of tweets in the 2016-2020 data set
Wayne State University	@WSUCoN	42	504	546
Washington State University	@WSUNursing	265	141	406
Yale University	@YaleNursing	232	550	782

Data Analysis

The analyses in this study were conducted using R version 4.0.3 (Bunny-Wunnies Freak Out), R Studio Version 1.3.1093, and Microsoft Excel for Mac Version 16.43. The following are the steps taken to generate a list of the most frequently used hashtags in the 2016-2020 data set, along with the number of times each hashtag appeared. Initially, the Excel file was uploaded to R software. The R Markdown package was installed, and the elements of Van Horn and Beveridge coding were used [13]. The text strings in the data set were cleaned. The character encoding in tweets was homogenized to remove the strings of nonsense characters indicating the presence of emojis in the source tweets. This converted character encoding to Unicode UTF-8. Thereafter, capitalization in tweets was removed by turning everything into lowercase. Subsequently, extra whitespace and URLs were removed from the tweets. Once the text strings were cleaned, the hashtags present in the data set were identified and a list of the hashtags from most to least frequently used was generated. The data frame generated in R was exported to Excel, with hashtags listed in one column and their frequency in another. The corresponding script in R has been provided in Multimedia Appendix 1 so that readers can replicate the analysis.

Because there was interest in detecting changes in the use of hashtags by schools of nursing after the results of *The Woodhull Study Revisited* were published in Fall 2018, the steps described above were repeated to split the 2016-2018 data set into two parts. The first covered September 29, 2016, through September 27, 2018 (the day that *The Woodhull Study Revisited* was published in the *Journal of Nursing Scholarship*), and the second covered September 28, 2018, through December 13, 2020. The same process outlined previously was used to analyze the data and generate frequency tables for the hashtags used during each time period of interest.

Results

There were 6866 different hashtags used in the 2016-2020 data set. All hashtags that had been used 100 times or more across the entire corpus of tweets in the data set were identified, and these 71 hashtags were characterized as being those with the highest frequency of use by the schools of nursing in the study. These 71 hashtags were used a total of 26,243 times in the 2016-2020 data set, as detailed in Table 6. Among the 6866 different hashtags appearing in the 2016-2020 data set, 3774 were used only once and 6178 were used 10 or fewer times.

Table 6. Hashtags used 100 times or more in the 2016-2020 data set.

Hashtag	Number of times used
#nursing	3259
#pennnursing	1980
#healthcare	1265
#gwu	1192
#nurses	991
#covid19	895
#umson	887
#nurse	857
#jhson	606
#conhi	587
#nursingschool	565
#dnp	535
#vandygram	452
#nursesweek	451
#emorynursing	444
#bsn	442
#canenurse	419
#uabson	374
#npslead	372
#msn	358
#umichnursing	353
#tbt	348
#pennnursinginnovation	347
#volnurse	335
#simulation	287
#fpbnursing	279
#phd	260
#runursing	247
#gocougs	245
#raisehigh	232
#research	230
#icymi	226
#np	218
#cunursing	215
#vusn	215
#health	210
#hiv	205
#mentalhealth	204
#buckeyenurses	200
#nursepractitioner	199
#virginia	196
#yearofthenurse	185

Hashtag	Number of times used
#wegotthis	173
#veterans	170
#buckeyenurse	169
#nashville	164
#gohopnurse	161
#fau	160
#innovation	156
#amrchat	154
#uic	150
#npweek	149
#icowhi16	144
#jhuson	143
#givingtuesday	141
#meninnursing	136
#cwru	132
#huskynurses	132
#prerequisites	125
#globalhealth	122
#ahcj19	118
#bestgradschools	115
#nyu	115
#huskynurse	112
#opioid	111
#nursingstudent	109
#nurseleader	107
#nursingresearch	103
#nationalnursesweek	102
#umich	102
#uofunursing	101

When the data set was divided into two parts to detect changes in the use of hashtags by schools of nursing after the results of *The Woodhull Study Revisited* were published, the findings were similar to those of the analysis of the data set as a whole. There were 27 hashtags that had been used 100 times or more in the September 29, 2016, to September 27, 2018, data set. Among the 3307 different hashtags appearing in this data set, 1806 (54.6%) were used only once and 3028 (91.6%) were used 10 or fewer times. In comparison, there were 47 hashtags that had been used 100 times or more in the September 28, 2018, to December 13, 2020, data set. Among the 4812 different hashtags appearing in this data set, 2716 (56.4%) were used only once and 4350 (90.4%) were used 10 or fewer times. Tables 7 and 8 provide details on the hashtags used 100 times or more during each time period.

Table 7. Hashtags used 100 times or more before *The Woodhull Study Revisited*.

Top hashtags (September 29, 2016-September 27, 2018)	Number of times used
#nursing	1671
#pennnursing	1017
#gwu	671
#umson	530
#healthcare	516
#nurses	507
#nurse	409
#jhson	402
#conhi	393
#emorynursing	252
#nursingschool	243
#bsn	232
#nursesweek	227
#tbt	205
#buckeyenurses	177
#dnp	164
#volnurse	156
#amrchat	154
#icowhi16	144
#jhuson	143
#research	136
#buckeyenurse	133
#health	128
#canenurse	111
#wegotthis	109
#cunursing	106
#virginia	104

Table 8. Hashtags used 100 times or more after *The Woodhull Study Revisited*.

Top hashtags (September 28, 2018-December 13, 2020)	Number of times used
#nursing	1588
#pennnursing	963
#covid19	895
#healthcare	749
#gwu	521
#nurses	483
#vandygram	449
#nurse	448
#dnp	371
#umson	357
#umichnursing	353
#npslead	350
#nursingschool	322
#uabson	313
#canenurse	308
#msn	275
#pennnursinginnovation	264
#simulation	229
#raisehigh	228
#nursesweek	224
#bsn	210
#phd	205
#jhson	204
#conhi	194
#emorynursing	192
#yearofthenurse	185
#fpbnursing	182
#volnurse	179
#runursing	177
#vusn	171
#gocougs	163
#gohopnurse	161
#nashville	161
#mentalhealth	151
#tbt	143
#np	141
#fau	132
#icymi	129
#nursepractitioner	128
#meninnursing	127
#ahcj19	118
#hiv	115

Top hashtags (September 28, 2018-December 13, 2020)	Number of times used
#npweek	112
#cunursing	109
#cwru	104
#veterans	102
#uofunursing	101

Typology of Frequently Used Hashtags

Using Excel, a thematic analysis was conducted of the hashtags that were used 100 times or more in the 2016-2020 data set. Collectively, the 71 hashtags were used a total of 26,243 times. To conduct the thematic analysis, the list of 71 frequently used hashtags was considered and similarities were assessed. As similarities were identified, the hashtags were grouped into categories, and this process of coding (and recoding) hashtags was continued until there were six categories that explained the vast majority of the hashtags. A seventh category was added to capture the assortment of hashtags that did not lend themselves to categorization. The following seven types of hashtags emerged during the process of thematic analysis: (1) Nursing, hashtags about nurses, nursing, nursing degrees, nursing licenses, etc; (2) Schools, hashtags about universities, schools, colleges, mascots, or locations; (3) Illness/disease/condition, hashtags about illnesses, diseases, conditions, or awareness day/month; (4) Population, hashtags about populations that nurses serve; (5) Health, hashtags about health care, health, global health, etc; (6) Conference or tweet chat, hashtags about conferences or specific Twitter chats for health care professionals; (7) Something else, hashtags that did not fit into one of the other six categories. Table 9 lists the hashtags contained in each of the seven categories.

Table 9. Hashtag typology of the 2016-2020 data set.

Category	Description of the category	Hashtags	Number of times used
Nursing	About nurses, nursing, nursing degrees, nursing licenses, etc	#bsn, #dnp, #meninnursing, #msn, #nationalnursesweek, #np, #npslead, #npweek, #nurse, #nurseleader, #nursepractitioner, #nurses, #nursesweek, #nursing, #nursingresearch, #nursingschool, #nursingstudent, #phd, #prerequisites, #simulation, and #yearofthenurse	9810
Schools	About universities, schools, colleges, mascots, or locations	#bestgradschools, #buckeyenurse, #buckeyenurses, #canenurse, #cunursing, #cwru, #emorynursing, #fau, #fpbnursing, #gocougs, #gohopnurse, #gwu, #huskynurse, #huskynurses, #jhson, #jhuson, #nashville, #nyu, #pennnursing, #pennnursinginnovation, #raisehigh, #runursing, #uabson, #uic, #umich, #umichnursing, #umson, #uofunursing, #vandygram, #virginia, #volnurse, and #vusn	10,974
Illness/disease/condition	About illnesses, diseases, conditions, or awareness day/month	#covid19, #hiv, and #opioid	1211
Population	About populations that nurses serve	#veterans	170
Health	About health care, health, global health, etc	#globalhealth, #health, #healthcare, and #mentalhealth	1801
Conference or tweet chat	About conferences or specific Twitter chats for health care professionals	#ahcj19, #amrchat, #conhi, and #icowhi16	1003
Something else	Hashtags that did not fit into one of the other six categories	#givingtuesday, #icymi, #innovation, #research, #tbt, and #wegotthis	1274

For the purposes of this study, the seven types of hashtags were considered to be either inward facing (“intercom hashtags”) or outward facing (“megaphone hashtags”). Intercom hashtags were those intended to invite attention from/interaction with nurses, members of the university/school community, or attendees at a nursing conference or Twitter chat. Megaphone hashtags were those intended to invite attention from/interaction with people such as journalists, policymakers, and the general public.

The intercom hashtag types were as follows: nursing (hashtags about nurses, nursing, nursing degrees, nursing licenses, etc); schools (hashtags about universities, schools, colleges, mascots, or locations); and conference or tweet chat (hashtags about conferences or specific Twitter chats for health care professionals). The megaphone hashtag types were as follows: illness/disease/condition (hashtags about illnesses, diseases, conditions, or awareness day/month); population (hashtags about populations that nurses serve); health (hashtags about

health care, health, global health, etc); and something else (hashtags that did not fit into one of the other six categories).

The vast majority of the 71 hashtags that were used 100 times or more in the 2016-2020 data set can be categorized as intercom hashtags (inward-facing hashtags focused on in-group discussion within and about the profession). Collectively, nursing hashtags (n=9810, 37.4%), school hashtags (n=10,974, 41.8%), and conference or tweet chat hashtags (n=1003, 3.8%) comprised 83.0% (n=21,787) of the 26,243 times that the 71 frequently used hashtags occurred in the data set.

In contrast, few of the 71 hashtags that were used 100 times or more in the 2016-2020 data set can be categorized as megaphone hashtags. Collectively, health hashtags (n=1801, 6.9%), illness/disease/condition hashtags (n=1211, 4.6%), and population hashtags (n=170, 0.7%) comprised 12.1% (n=3182) of the 26,243 times that the 71 frequently used hashtags occurred in the data set. When the "something else" hashtags (5%) were added, the total of megaphone hashtags was approximately 18% of the 26,243 times that the 71 frequently used hashtags occurred in the data set.

When the data set was divided into two parts to detect changes in the use of hashtags by schools of nursing after the results of *The Woodhull Study Revisited* were published, the findings were similar to those of the analysis of the data set as a whole, with one notable exception. Prior to the publication of *The Woodhull Study Revisited* on September 27, 2018, none of the hashtags that were used 100 times or more pertained to an illness, disease, or condition. In the 2 years after the publication of *The Woodhull Study Revisited*, 7% of the frequently used hashtags pertained to an illness, disease, or condition. Further analysis revealed that this shift was attributable to the use of the following two hashtags: #covid19 (n=895) and #hiv (n=115).

Missed Opportunities for Tweeting About Trending Topics

Of the 6866 different hashtags appearing in the 2016-2020 data set, 6178 were used 10 times or less. These seldom-used hashtags included a number of hashtags that were widely used on Twitter during the time period covered by this study. Table 10 contains a list of some of these hashtags along with the number of times each hashtag was used in the 2016-2020 data set.

Table 10. Missed opportunities to use hashtags of public interest.

Topic and hashtag	Number of times used in the 2016-2020 data set
Racism, racial bias, and racial justice	
#racism	10
#blacklivesmatter	9
#antiracism	6
#blm	6
#bias	3
#implicitbias	1
#racialbias	1
#unconsciousbias	1
#systemicracism	1
#racialjustice	1
Sexism, sexual harassment, and rape	
#sexualharassment	2
#rape	2
#sexism	1
#timesuphealthcare	1
Politics	
#electionday	9
#vote	8
#election2020	2
#election	2
#trump	2
#election2016	1
#presidentialdebate2020	1
LGBTQ[a]+ health	
#lgbtqhealth	2
#homophobia	1
#heterosexism	1
#transhealth	1
Cancer	
#lungcancer	8
#pancreaticcancer	3
#colorectalcancer	3
#ovariancancer	2
#skincancer	1
#pediatriccancer	1
#livercancer	1
#childhoodcancer	1
Other diseases and conditions	
#kidneydisease	6
#hepatitis	2
#arthritis	2

Topic and hashtag	Number of times used in the 2016-2020 data set
#hearingloss	2
#parkinsons	1
#als	1
Sexual health	
#sexualhealth	7
#sexuality	1
#abortion	1
#condom	0
#birthcontrol	0
#familyplanning	0
End of life	
#death	6
#grief	2
#advancedirective	1
#livingwill	1
#dying	0

[a]LGBTQ: lesbian, gay, bisexual, transgender, gender non-conforming, queer and/or questioning.

Discussion

Although the top 44 schools of nursing have an active social media presence on Twitter, collectively, their use of hashtags functions more like an intercom to communicate with other nurses rather than a megaphone to invite attention from and dialogue with journalists, policy makers, and the general public. Because intercom hashtags are both inward facing and overused, they are of minimal use when it comes to drawing attention from and interacting with people outside of nursing. If schools of nursing want the media to showcase the voices of their faculty members as experts, schools of nursing need to be more strategic in their use of hashtags on Twitter. In order to accomplish this, schools of nursing need to increase their use of megaphone hashtags to connect the work of their faculty and students with topics and events of interest to the general public. For example, when topics like #guncontrol are trending, schools of nursing could tweet about the work their faculty members are doing in violence prevention.

On Twitter, schools of nursing have a unique opportunity to amplify the voices of their faculty members on health-related topics of widespread public interest like the impact of systemic racism on health, gun violence, and access to care, among others. If schools of nursing continue to use mostly intercom hashtags on Twitter, they will have squandered a powerful opportunity to share their expertise beyond the boundaries of the discipline.

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Conflicts of Interest

None declared.

Multimedia Appendix 1
R script for generating the data frame of the most frequently used hashtags in the data set.
[DOCX File , 14 KB - nursing_v4i2e25114_app1.docx]

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Original Paper

Academic Electronic Health Records in Undergraduate Nursing Education: Mixed Methods Pilot Study

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Abstract

Background: Teaching students about electronic health records presents challenges for most nursing programs, primarily because of the limited training opportunities within clinical practice settings. A simulated electronic health record is an experiential, learner-centered strategy that enables students to acquire and apply the informatics knowledge needed for working with electronic records in a safe learning environment before the students have encounters with real patients.

Objective: The aim of this study is to provide a preliminary evaluation of the Lippincott DocuCare simulated electronic health record and determine the feasibility issues associated with its implementation.

Methods: We used one-group pretest-posttest, surveys, and focus group interviews with students and instructors to pilot the DocuCare simulated electronic health record within an undergraduate nursing program in Western Canada. Volunteering students worked through 4 case scenarios during a 1-month pilot. Self-reported informatics knowledge and attitudes toward the electronic health record, accuracy of computerized documentation, satisfaction, and students' and educators' experiences were examined. Demographic and general information regarding informatics learning was also collected.

Results: Although 23 students participated in this study, only 13 completed surveys were included in the analysis. Almost two-thirds of the students indicated their overall understanding of nursing informatics as being fair or inadequate. The two-tailed paired samples *t* test used to evaluate the impact of DocuCare on students' self-reported informatics knowledge and attitudes toward the electronic health record revealed a statistically significant difference in the mean score of knowledge before and after using DocuCare (before: mean 2.95, SD 0.58; after: mean 3.83, SD 0.39; t_{12}=5.80, two-tailed; P<.001). There was no statistically significant difference in the mean scores of attitudes toward the electronic health record before and after using DocuCare (before: mean 3.75, SD 0.40; after: mean 3.70, SD 0.34; t_{12}=0.39, two-tailed; P=.70). Students' documentation scores varied from somewhat accurate to completely accurate; however, performance improved for the majority of students as they progressed from case scenarios 1 to 4. Both the faculty and students were highly satisfied with DocuCare and highly recommended its integration. Focus groups with 7 students and 3 educators revealed multiple themes. The participants shared suggestions regarding the DocuCare product customization and strategies for potential integration in undergraduate nursing programs.

Conclusions: This study demonstrated the feasibility and suitability of the DocuCare program as a tool to enhance students' learning about informatics and computerized documentation in electronic health records. Recommendations will be made to academic leadership in undergraduate programs on the basis of this study. Furthermore, a controlled evaluation study will be conducted in the future.

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KEYWORDS

academic electronic health record; Lippincott DocuCare; simulation; nursing informatics education

Introduction

Background

Electronic health records (EHRs) are an essential component of modern-day digitally connected health care. An EHR is a secure and integrated digital health technology that houses patients' information and encounters with the health system. EHRs help improve access to health services, enhance the quality and safety of care, and increase the efficiency of the health system [1]. As the largest group of care providers, nurses are increasingly using digital health tools across practice settings [2,3]. Therefore, nursing schools must provide theoretical and technical knowledge related to these health information systems for nursing students [4,5]. This is particularly important given the growing concerns regarding the lack of preparedness in using health information systems among graduating students once they join the workplace [6-10]. However, teaching students about EHRs presents challenges for most schools of nursing, primarily because of the limited EHR training opportunities within practice settings and the complexity of educating a large number of students in busy and often complex clinical environments [5,11-13].

Simulated EHRs for academic purposes have been proposed as an innovative pedagogy to promote the acquisition of theoretical knowledge of informatics and the skills needed to use EHRs in a safe environment before encounters with real patients [14-25]. Incorporating these learning experiences within undergraduate nursing education expands the realm of effective teaching and learning practice, fulfills accreditation requirements, and ensures graduates have the required entry-to-practice competencies in nursing informatics upon exiting the program so that they are better prepared for practice in today's digitally rich health care environment [3,26-28]. A simulated EHR is a learner-centered pedagogy grounded in a constructivist approach of experiential learning where learners are actively involved in the process of knowledge construction and reflective learning as opposed to passively receiving information [15,29,30]. Using case scenarios that mimic real-world clinical practice enables the students to learn how to use EHRs for care delivery, eg, identifying and interpreting patient data such as verifying medication accuracy, in a supervised environment before clinical encounters with real patients; thus, it improves learning outcomes and can contribute to promoting patient safety [20,30-36].

Simulated EHRs resemble electronic patient records used in practice settings [22,37]. A number of products are available for nurse educators to choose from including open-source EHR or electronic medical record (EMR) and vendor-operated EHR or EMR platforms [38]. Examples of open-source platforms include OpenEMR, WorldVistA, and OSCAREMR. Vendor-operated platforms are available through health information system technology vendors such as Cerner. These also are offered through publishing companies such as Lippincott DocuCare by Wolters Kluwer, EHR Tutor by Assessment Technologies Institute, SimChart by Elsevier, and NEEHR Perfect, now known as ehr^{go}, by Archetype Innovations. Although these products have similar platforms, they vary in cost and functionality [38].

Research suggests that integrating simulated EHRs in prelicensure nursing education is beneficial to students' learning and development of important educational outcomes [20,30,34]. Simulated EHRs help improve students' critical thinking [18] and their ability to navigate EHRs and understand informatics concepts such as data management [19,39,40]. Other researchers found that simulated EHRs help enhance students' skills in electronic documentation [24,41,42] and aid in the development of positive attitudes and perspectives about electronic records [43,44]. The integration of simulated EHRs also enhances students' confidence and self-efficacy in using electronic records [23,44-46] and increases informatics knowledge and competency [16,40,47]. Despite these benefits, factors such as cost and faculty expertise continue to be major challenges in integrating simulated EHRs in nursing education [18,34,48,49].

At our university, curricular revisions presented an ideal opportunity to explore the integration of a simulated EHR within undergraduate nursing programs to expose students to health information technologies used in practice and to acquire the required entry-to-practice informatics competencies. This direction was enforced further by the introduction of Connect Care, a new EMR, in our health system. Although our students will have the opportunity to complete a user-training program before their clinical practicum in units that transitioned to Connect Care, these students have no previous exposure to hands-on practice with electronic records within their laboratory or simulation education, which is a gap in our curriculum. To support students' learning and application of informatics knowledge that is currently taught in theory courses and the computerized documentation introduced in the new curriculum across all clinical courses, we reviewed a number of simulated EHR solutions considering the benefits and value in meeting the students' and program's needs [16,18,37,38]. We opted for the Lippincott DocuCare simulated EHR because it is user friendly and is aligned with the V-Sim resources currently used in our simulation laboratory. In addition, the cost of DocuCare for an individual student's web access at US $100 for 12 months (negotiable when based on an institutional purchase plan) provided additional support for choosing this product over others. The next step of our evaluation was to obtain feedback from students and faculty on the suitability of this product for integration into our programs.

Research Questions

This pilot study aimed to provide a preliminary evaluation of the Lippincott DocuCare program and to determine the feasibility issues associated with its implementation. The following research questions were examined:

1. Is there a significant difference in the mean scores of self-reported informatics knowledge and attitudes toward the EHR before and after using DocuCare?
2. What is the accuracy of students' electronic documentation?
3. Are students satisfied with using DocuCare as a learning tool?
4. How do students and educators describe their experiences using DocuCare as a learning tool to improve computerized documentation and overall informatics competency?

Methods

Design and Sample

In this mixed method pilot study, a quasi-experimental one-group pretest-posttest design using short surveys was used to answer research questions 1 to 3, which were relevant to students' learning and satisfaction with DocuCare. Focus group interviews with students and educators were used to answer research question 4 [50]. A convenience sample from third- and fourth-year nursing students enrolled in undergraduate nursing programs in the Faculty of Nursing was invited to participate in this study because, at this level of education, they would have had some exposure to clinical practice and would have accumulated sufficient theoretical knowledge. Nursing educators involved in laboratory and clinical teaching within the undergraduate programs were also invited to participate.

Study Procedures

Students were recruited through an announcement supplemented with an information sheet on the e-class site, inviting students registered in a number of third- and fourth-year courses to express interest in participating by contacting the researchers. A list of interested participants was then compiled, and the volunteering students were enrolled in the study on a first-come first-serve basis.

Interested student participants were contacted via email and asked to complete a survey (pretest), as described later, and to indicate their availability for attending an in-person orientation session to have a practice demo, using a scavenger hunt exercise, on how to use DocuCare. Two dates were provided with the option for an evening and weekend meeting time to accommodate students' schedules. At the same time, a total of 50 access codes were requested from DocuCare for use by students and educators in this study at no cost. Students who completed the pretest survey were then contacted and given the unique DocuCare access codes. As only a few students were able to attend the in-person orientation, a supplementary written guide with step-by-step directions and URL links to DocuCare publisher training videos on how to use the program was provided as a reference when they used DocuCare on their own.

The pretest-posttest survey included 18 items organized into 3 sections. This survey was administered to students at the beginning of the pilot (pretest) and used again as a posttest at the end of the pilot. Section 1 included 8 questions related to demographic and general information: program, year of study, opportunities for learning about informatics competencies in theory and laboratory training, exposure to electronic documentation in clinical sites, and support resources available to students when learning about computerized documentation. Section 2 included 5 Likert-type scale items (strongly disagree to strongly agree) that measured self-reported informatics knowledge using the entry-to-practice informatics competency indicators relevant to documentation and data management. These indicators have been validated in another study (Cronbach α=.93) [51]. Section 3 included 5 Likert-type scale items (strongly disagree to strongly agree) that measured nurses' attitudes and dispositions toward the EHRs (Cronbach α=.77) [52]. A high score on this scale indicates a positive disposition, and a low score indicates a negative disposition. Research Electronic Data Capture (REDCap; Vanderbilt University) software was used to administer the data collection tools [53].

During the pilot, which was conducted over approximately 1 month, the participating students were asked to work on 4 patient case scenarios within the DocuCare platform, 1 scenario per week, or as their schedule permitted. Each case scenario required 1 to 2 hours on average, during which time the students needed to find information required for care planning, electronically document the care provided, and submit their completed work to the instructor for assessment. A standardized answer key for each scenario and a marking rubric, developed for the purpose of this study, were used to enhance objectivity and consistency in marking students' submissions in DocuCare. For each case scenario, the students' submissions were marked against the rubric using a rating scale from 1 to 4 (1=inaccurate, 2=somewhat accurate, 3=fairly accurate, and 4=completely accurate). A total score of 16 was tallied for the 4 case scenarios for each student. Students' previous documentation skills were not tested at baseline. Owing to their workload, laboratory educators were not available to participate in marking students' submissions. Instead, a master's-level graduate student was hired to assist with the project. The graduate student marked the students' submissions, provided feedback, tracked the students' progress, and responded to questions they had during the pilot. These marks were not included in academic grades. The case scenarios used in this pilot were identified from the Lippincott VR-Sim library and adapted slightly to balance the difficulty level, that is, simple-to-complex concepts. Each scenario was also mapped to relevant entry-to-practice informatics competency indicators as they applied to the focus of the scenario [27].

A few days after completion of the 1-month pilot, the students were asked to complete the posttest survey and a satisfaction survey and to express interest in participating in semistructured focus group interviews to share their experiences. Two focus groups were scheduled to accommodate students' schedules. The satisfaction survey included 15 items measured on a rating scale from 1 to 5 (1 being very dissatisfied and 5 being very satisfied). Some of these survey items were related to ease of use and user experience that, with permission, were slightly adapted from the DocuCare vendor product satisfaction survey. The remaining items related to perceptions of the impact on learning were added by the researchers. This survey was integrated as a complementary measure in case students were not able to participate in interviews because of their workload.

For nurse educators, a poster invitation was sent to recruit interested participants. Those who expressed interest in participating were offered a training webinar along with access to DocuCare and the same scenarios that students used for them to try out the product over a 2-week period and share their perspectives. Educators were also asked to express interest in participating in a focus group interview.

Each focus group interview lasted between 60 and 90 minutes. The interviewers (second and third authors) facilitated all discussions in English using an interview guide. Field notes were taken and used, where required, to assist with reflecting

on the data during analysis. The discussions were audio-recorded and transcribed verbatim.

Data Analysis

Data from completed surveys were included in the analysis, and incomplete surveys were excluded. Using IBM SPSS Statistics version 25.0, descriptive statistics, including frequencies, means, and SDs, were used to summarize and describe the data. A two-tailed paired *t* test using a difference score (posttest and pretest) was applied to test the null hypothesis: there was no statistically significant difference in students' self-reported informatics knowledge and attitudes toward EHR mean scores before and after using the DocuCare program for 1 month (H0: M1−M2=0). For the qualitative interview data, the third author (UDW) compared all transcriptions and audio recordings to ensure the trustworthiness of the data. All transcripts were imported into the NVivo 11 data management software (QSR International Pty Ltd) and the data were coded and analyzed inductively. All authors discussed and defined emergent codes and themes to ensure intercoder reliability. The final codes and themes were refined until a consensus about the interpretations or coding frameworks was reached. Data were stored, managed, accessed, and analyzed within a secure SharePoint drive.

Ethical Considerations

This study was approved by the institutional review and ethics board. Participation was voluntary, and students were assured that their participation had no impact on their academic performance. Each participant received an information sheet detailing the study procedures, benefits, and risks. Surveys were completed by implied covert action (ie, completion and submission of surveys). Written informed consent was obtained from all participants before the focus group sessions. Each interview began with an explanation of the purpose and procedures of the interview and assurance that the discussion would remain confidential.

Results

Characteristics of Participants and General Information on Informatics Learning

Although 23 students participated in this pilot study, the results are reported based on an analysis of 13 completed pretest-posttest surveys. This decision was made because of missing data between the pre- and posttest surveys. Most of these respondents represented 2 large undergraduate nursing programs: the Collaborative Program (n=7 students; 5 were third-year and 2 were second-year students) and the After-Degree Program (n=5; all were in their second year of study). Only one third-year student was from the honors program. There was no representation from first-year After-Degree students or those in the bilingual program.

Students (n=13) described their overall understanding of the concept of nursing informatics and its relevance to their future practice as moderate (4/13, 31%), fair (6/13, 46%), or inadequate (3/13, 23%). The majority indicated receiving specific learning about informatics competencies expected of registered nurses in Canada: information and knowledge management (12/13, 92%) and professional and regulatory accountability (13/13, 100%), but fewer reported on the competency pertinent to the use of digital health technology in clinical practice (10/13, 77%). With regard to learning about computerized documentation in EHRs during undergraduate education, 54% (7/13) of respondents indicated yes, whereas 46% (6/13) of them indicated no. Regarding permissions for students in the clinical setting, 54% (7/13) indicated they were permitted to view patient information with instructor or preceptor supervision. For permissions related to electronic documentation, almost two-third of the students (9/13, 69%) indicated that most clinical placement sites they went to did not use electronic documentation, whereas 23% (3/13) indicated yes and 8% (1/13) indicated sometimes.

Self-reported Knowledge in Informatics and Attitudes Toward EHRs

Table 1 provides an overview of the mean difference scores for the pre- and posttest surveys. The two-tailed paired samples *t* test to evaluate the impact of DocuCare on students' self-reported informatics knowledge and attitudes toward the EHR revealed a statistically significant difference in the mean score of knowledge before (mean 2.95, SD 0.58) and after using DocuCare (mean 3.83, SD 0.39; t_{12}=5.80, two-tailed; *P*<.001). The mean score was −0.88 (SD 0.54) with a 95% CI ranging from −1.21 to −0.55. The eta-squared statistic (0.74) indicated a large effect size. Therefore, the null hypothesis was rejected. However, there was no statistically significant difference in the mean scores of attitudes toward the EHR before (mean 3.75, SD 0.40) and after using DocuCare (mean 3.70, SD 0.34; t_{12}=0.39, two-tailed; *P*=.70). The mean score was 0.05 (SD 0.43), with a 95% CI ranging from −0.21 to 0.30. Therefore, we failed to reject the null hypothesis, that is, there was no statistically significant difference in students' self-reported informatics attitudes toward the EHR mean scores before and after using the DocuCare program.

Table 1. Self-reported informatics knowledge and attitudes toward electronic health records before and after using DocuCare (N=13).

Items	Pretest, mean (SD)	Posttest, mean (SD)	Difference score	*P* value
Informatics knowledge: I have...				
A good knowledge to critically evaluate data and information from a variety of credible sources (including experts, clinical applications, databases, practice guidelines, relevant websites, etc) to inform the delivery of nursing care.	4 (0.577)	4.15 (0.555)	−0.154	.16
A good knowledge of the various components of the EHR[a] such as results reporting, clinical documentation, electronic medication administration, etc).	2.62 (1.044)	3.77 (0.439)	−1.154	.003
A good knowledge related to documenting important nursing and patient data using standardized nursing languages, such as the International Classification for Nursing Practice, ie, nursing diagnosis and interventions to support clinical decision-making and nursing practice improvement.	2.85 (0.987)	3.54 (0.877)	−0.692	.08
A good knowledge related to gathering and retrieving relevant health care and patient data from the EHR.	2.77 (1.092)	3.92 (0.494)	−1.154	.001
A good knowledge related to documenting health care and patient data into the EHR.	2.54 (1.198)	3.77 (0.439)	−1.231	.004
Attitudes toward EHRs				
Use of EHRs are more of a help than a hindrance to patient care	3.85 (1.214)	3.62 (1.121)	0.231	.68
Use of computerized charting has helped to improve documentation of the clinical record	3.92 (0.760)	4 (0.913)	−0.077	.78
EHRs pose less threat to the patient's privacy than do paper records.	3.23 (0.599)	3.08 (0.954)	0.154	.44
Computerized charting has decreased the workload of nurses and other personnel.	3.62 (0.768)	3.54 (0.660)	0.077	.58
In time, the use of EHRs will lead to improved patient care	4.15 (0.376)	4.31 (0.480)	−0.154	.16

[a]EHR: electronic health record.

Accuracy of Students' Electronic Documentation

For most students, their scores improved as they progressed from case scenarios 1 to 4, with more practice and ongoing feedback. Of the 13 students, 9 completed the 4 case scenarios. The lowest total score obtained by these students was 11 of 16, whereas the highest score was 15.

Students' Satisfaction With the DocuCare Learning Experience

Of the 13 student participants, 12 (92%) completed the satisfaction survey at the end of the pilot. Only 42% (5/12) of these students attended the in-person orientation. Of these 5 students, 3 (60%) were satisfied with this session. Regarding the frequency of accessing DocuCare during the pilot, 58% (7/12) of students indicated accessing the program once a week, 25% (3/12) accessed it multiple times each week, and 17% (2/12) accessed it once a day or multiple times each day. Most students (11/12, 92%) were satisfied to very satisfied with the ability to access DocuCare at any time and from anywhere, the ease of use when submitting completed learning activities for assessment, and the ability to learn at their own pace. In addition, students were satisfied to very satisfied with the DocuCare layout (8/12, 67%) and reported that they encountered no technical glitches when using DocuCare (7/12, 58%).

With regard to learning, two-thirds of the students (9/12, 75%) were satisfied to very satisfied that DocuCare provided a realistic learning experience about computerized charting in EHRs because, in principle, it was similar to the electronic health or patient records used in the clinical setting. It also helped increase their confidence in gathering relevant patient information to inform clinical judgment and nursing care planning for the assigned case scenarios used in this pilot study and care planning in general. The majority of the students (11/12, 92%) were also satisfied to very satisfied that DocuCare increased their critical thinking and clinical judgment abilities and their overall confidence in applying computerized charting in a real clinical setting (10/12, 83%). Overall, 92% (11/12) of students were satisfied to very satisfied that using DocuCare enabled them to progressively enhance their informatics competencies and recommended using it for students' learning about computerized charting in undergraduate nursing programs.

In their responses to an open-ended question at the end of the satisfaction survey that asked what was helpful and what could be improved, the students provided some insights. One student indicated:

> *It could've been better if I attended the orientation session prior to the study as the program was hard to use in the beginning. However, the program allowed me to find the areas which I need to improve on such as critical thinking skills and judgement. I think it will be helpful/beneficial to students if the DocuCare program becomes part of the school curriculum.*

Another student asserted that DocuCare was user friendly:

> *it was nice and simple to follow through with the steps, and the feedback was really helpful as well.*

Another student added:

definitely getting that feedback..., that did help me increase my confidence in what I could do on this system, so I thought that was helpful in that sense.

Focus Group Interviews With Students and Faculty

A total of 7 students participated in focus groups, one interview had 4 students whereas the other had 3 students. A total of 7 educators attended the DocuCare webinar and tested the product; however, only 3 educators expressed an interest and participated in the focus group interview. Participants described their experiences using DocuCare as a learning tool to improve computerized documentation and overall informatics competency. Overall, 5 themes emerged, which were as follows: (1) current challenges related to documentation, (2) motivating factors for embracing computerized charting as an educational tool, (3) educators' and students' experiences with DocuCare, (4) educators' and students' suggestions for improving DocuCare, and (5) recommendations for integrating DocuCare in undergraduate nursing curricula.

Theme 1: Current Challenges Related to Documentation

Reflecting on teaching and learning experiences in clinical practicum sites and acknowledging that they may become more complicated with the ongoing Connect Care implementation, the participating educators and students agreed that a number of challenges related to documentation currently exist in clinical and laboratory learning. This first theme, *current challenges related to documentation*, comprised 6 categories, 4 of which were exclusively from educators' perspectives: students' level of experience, stressful clinical settings, student-instructor ratios, and limited laboratory training hours. The following excerpt illustrates educators' concerns about students' level of experience and student-instructor ratios:

For some of them, they've never been in the hospital, so it's a really, you know, unfamiliar environment, and it is really high stakes. They're real people involved. You know, and so their stress levels are already really high...I think...if you have eight students and one instructor to do some of that stuff on the fly, like with labs we have to do sometimes, is incredibly stressful for the instructor and really stressful for the students. [Educator 3]

A number of educators also underlined the limitations in laboratory training hours and in teaching about documentation and informatics as obstacles they currently encounter in clinical practice:

we have two-hour labs now—we don't always have a lot of time for them to sit down and do a narrative charting of what they just did [Educator 2]

In addition, educators felt that the stressful clinical setting compounded the challenges faced by students when learning about documentation:

you get in front of the computer...it is the time factor...they get their two minutes on there, because everybody else is lined up for them, right...and when they get into a hurry, mistakes get made...they're charting on the wrong person and everything, getting everybody stressed out...and I just find even with the long paper charting, the entry "I received into care, blah blah blah, found sitting, breathing normally,"...they've got this whole thing memorized, so they're not even critically thinking about that. [Educator 1]

Similarly, students shared their views on the challenges encountered with learning about documentation, both in theory and in a clinical setting. The limited teaching on documentation and informatics was perceived as a substantial challenge:

I do remember having a couple classes maybe where they taught us about charting in first year—which, I mean, it felt really awkward to do it, but I think—they did kind of tell us the basics. But yeah, I feel it's just kind of an awkward process of learning how to do it properly [Student 1]

Students also mentioned their stressful experiences of learning through trial and error in clinical sites:

...going through this program one of the biggest struggles that I've had was documentation, period. Whether it was on paper or in—that's one thing that I felt could 've been addressed a little bit more...my very first clinical, I had no idea. Like, not a clue. So, I'm just copying from what my nurse that was buddying me, what they did—I mean, it may have been right, it might've been wrong, but that's the tool that I had at that time. As time has gone on, I've kind of figured out different ways to do things. [Student 2]

Theme 2: Motivating Factors for Embracing Computerized Charting as an Educational Tool

Participants' reflection on informatics and DocuCare as a simulated record assisted in creating the second theme: *motivating factors for embracing computerized charting as an educational tool*. This theme included 3 categories: ideal timing, fostering exposure, and learning opportunity.

Participants acknowledged the need to prioritize the introduction of EHRs during their nursing education. They felt that their time in school was the ideal time to learn about EHRs because of their availability and openness and the school's propitious learning environment. According to one student:

I think that informatics in general is like, a whole concept, a language, a culture, a mindset—and you have to learn how to use that...I think it's very important. If we're using these kinds of systems, I think this is the perfect time to teach that. It's a time when we're not as worried about maybe—other job or political ramifications—we're here at school to learn and to be educated, and to prepare for that setting. So, I think this is a captive audience who wants to learn, and that means it's a perfect time. And if we are here for two to four years, that's enough time that we can go and ask more questions about it, and kind of say what we want to see better or worse, whereas in—afterwards, time sometimes goes a little bit faster. So, I think the fact that we're here and we're learning about the job—this is in part—a huge

aspect of the job, and it's a perfect time to do it. [Student 2]

Educators followed up by emphasizing that fostering *hands-on* experience in simulated electronic records is vitally important for the development of documentation competencies and for building confidence in using clinical information systems in clinical settings:

This will just open their eyes to a bit of what they can expect...documentation...it's so different than, you know, they write essays. But charting is not like that...it's like a new language almost for them, right...it's such a looming thing you know at the beginning for them that I think the more that they can kind of get exposed to it and see it and get familiar with in ways that sort of—you know, the more we can kind of tie as many pieces together as we can early on...you know, the better. [Educator 3]

Similarly, students shared important insights into how fostering exposure with hands-on practice opportunities with simulated records may help provide a standardized approach to refine documentation skills, alleviate anxiety, and enhance overall readiness for clinical practice:

So, I felt very disorganized going to clinical, even though I was trying to follow that paper, and I know it's somewhat charting by exception, but—I think with DocuCare it will definitely help me organize my thoughts better—kind of understand the assessments and questions they would ask, and to use that to develop other like, nursing diagnoses. And how to interpret other kind of orders that are put in place better...I would say it [DocuCare] definitely gave me a bit of perspective of what using digital health resources means, like in terms of navigation, in terms of like—all those little details and like, the potential value of it. [Student 3]

Several of the participants highlighted that there were valuable learning opportunities, especially those regarding the refinement of documentation skills and enhancing their critical thinking. One student stated the following:

The learning was multifaceted for me—it did bring up that systems analysis part, like—what would be the challenges of implementing this? What would be the challenges of me using this as a clinician on the floor? What are the challenges, how do they affect the patient? I don't understand why wouldn't try to teach the exact programs that we're trying to implement in the hospital so that there's a lot more confidence when you're graduating nurses. I'd like to know how to do it, like—have a computer that you'll have on a unit in the lab, so that you'll have a chance to see what it feels like to document. [Student 1]

Furthermore, participants agreed that the learning opportunities offered while using DocuCare would be transferable to different EHR systems. This transferability would occur in a learning juxtaposition of facts and theories being formed during school with DocuCare and the new systems and processes they encounter when they become clinicians, which may result in augmenting or restructuring the former. One educator certified the following:

I work on so many different units, and every chart is set up a little bit differently, and things are found in slightly different places...I guess going from DocuCare to Connect Care, there might be a little bit of an adjustment if they're slightly different, but really once they're on Connect Care and familiar with where everything is, it'll be the same no matter where they go, which'll be great. [The systems] are both different, but I think—it's similar enough...we teach our students critical thinking, that sort of thing—like I actually was really impressed with how easy I found this. And I think because—even though they're not exactly the same, they're similar enough. [Educator 3]

Students corroborated educators' views regarding learning opportunities and the transferability of knowledge, where simulated learning with DocuCare may help address gaps and inconsistencies relevant to the limited opportunities for learning about clinical informatics systems. This was evident for students who had opportunities to receive Connect Care training before the pilot. They were able to compare similarities and differences and think about how these systems can be used in a complementary way to address gaps in students' learning. As a student explained:

I did start off with Connect Care before I started the DocuCare so, in some sense, I could see where I'm navigating, but likewise I've never done orders and stuff on Connect Care—I just know the basic assessments and stuff. And like, I do see differences—Connect Care is more advanced with its formatting, navigating through tabs and the information they portray, but I think DocuCare is a great kind of preliminary health record for students to learn if they can't have access to Connect Care yet—because Connect Care is very limited in locations, and as they slowly roll it out, whereas DocuCare is a—kind of a good simulation to get comfortable with, you know, the electronic health record. [Student 2]

Theme 3: Educators' and Students' Experiences With DocuCare

During the focus group interviews, participants described their experiences with DocuCare. On the basis of the accounts that emerged, we attempted to understand the experiences with DocuCare for both students and educators. This third theme is divided into 4 categories: ease of use, provision of feedback to students, well-integrated layout, and tools to provide safer care.

Although educators did not complete a satisfaction survey, they shared important insights through the focus group interviews. Educators described DocuCare as easy to use and having many features that can facilitate engagement with learners:

I think it was pretty easy to go in and find the tabs, and then you'd find something else the next time you

> *went in that you missed last time, so—it was just a matter of spending that time doing it, right?* [Educator 1]

Educators also mentioned the DocuCare feature for providing feedback to students on their submissions was seamless and efficient, thus promoting learning and positive interactions with students. As an educator indicated:

> *I thought it was kind of easy because you could just go in there and say, Okay, incomplete assessment, now please resubmit...It was non-offensive, supportive, which is sort of what we do, and then there's a box to add your comments* [Educator 1]

Educators also found that the layout of tabs within DocuCare was well integrated and presented a comprehensive view of the clinical information that students need to document, and it included a review of the care provided. According to one educator:

> *Well, definitely the tabs. I did like that you had your flow sheets; you had your assessment...you look at it...and it's there. You don't have to go fishing around, it's a click. The layout, the dropdown menus—I mean everything about it is very familiar, I didn't have a hard time navigating it.* [Educator 2]

Students also stated that DocuCare reinforced the provision of safer care. According to them, safer care was linked to improvements in communication, efficiency, evidence-based practice, and humanization of care. One student noted:

> *The doctor's writing is really confusing, and I think if you were to consolidate all of that onto electronic charting, it'd be a lot easier to follow, like, the story of how they've been doing up until like the point that you're now taking over...In some situations, it [DocuCare] does condense the information down and get you more focused on what's important, what's necessary—and as well for multiple people, it kind of makes everybody on the same field. So, somebody might write something or explain something in a completely different way, but this way—it's all uniform almost. So, it's harder for me to get like, a full picture of the patient, whereas with the DocuCare it was actually—once I figured out where to go—it was pretty easy to see, Okay, this is how they were on their last shift, because it's just typing and everything comes out really clear, because it's electronic. So that I actually found it really easy in terms of finding like, past information.* [Student 2]

Theme 4: Educators' and Students' Suggestions for Improving DocuCare

Many responses were assigned to the theme *suggestions for improving DocuCare*. This theme, which is concerned with suggestions for improvement, is divided into 3 categories: warning signs, search functions, and indexing patient information. Educators suggested that it might be beneficial to have a warning sign within DocuCare, allowing users to know when the data chart is incomplete. Educators clarified that they (students):

> *always forget something when they do an assessment...it would be kind of nice if it glowed or something—it wouldn't let you carry on unless you complete it* [Educator 1]

Conversely, students felt that having a search function in DocuCare would make it more user friendly and easier to navigate. One student explained:

> *In this world we all know that there's so much information, it's changing all the time, and it could be found anywhere. If I would've had a search bar where I could have typed in "urticaria," that would've brought up which sections are those in...it was very inefficient for me to spend an hour trying to look for something. So, if there's a tool that allows me to search for it quick, then—I think that would be super helpful.* [Student 1]

Other students suggested adding a sidebar indexing patients' most important and recent information would enhance access to the most relevant information needed when providing care within DocuCare. This indexing function is actually similar to what is typically seen in clinical sites. According to one student:

> *With Connect Care they have the patient's information consistently on the side. You can easily access the main information that you're reporting, like, what's their weight and diet, what's coming up for them...so you can view everything, and even vital signs. So, where DocuCare is very fragmented in different tabs, Connect Care has it in like an actual flow sheet, so where you know, you just read, scroll, and you can add it in at the same time.* [Student 3]

Theme 5: Recommendations for Integrating DocuCare in Undergraduate Curricula

This theme comprised recommendations for integrating DocuCare in the undergraduate nursing curricula. Specifically, it included 4 categories: better orientation and support, more exposure and frequency, scheduling DocuCare in the curriculum and integrating it within courses, and flexibility of delivery with a focus on learning, not grading.

Both educators and students agreed that the introduction of DocuCare in the undergraduate curricula should start with an orientation for both educators and students on the system usage coupled with ongoing technical and human support. According to one student:

> *It'll be even good to just have like, one video example with like, the computer videos of a teacher or instructor just going through one basic assessment, or one case scenario, so students can visualize and see—This is how it [kind of] should be done.* [Student 3]

Educators, conversely, found that the orientation session provided to them was sufficient:

> *I found the webinar actually really helpful. After I watched that I was like, "Ah, piece of cake!" You know—It was not intimidating at all!* [Educator 2]

However, educators felt that:

> *a designated tech support person would be good* [Educator 2]

and:

> *having access, like—on [our] time, because setting things up...so, if there's a way that we could have sort of continuous access to it, that would be—I think better* [Educator 3]

Educators and students also agreed that incorporating DocuCare in the education of nursing students should be systematic, with more frequent exposure. They suggested that exposing students to it in the simulation laboratory and, where possible, in clinical settings would allow adequate opportunities for students to develop proficiency and integration with their overall repertoire of clinical skills. One student pointed out:

> *Yeah, and I mean even still at the end of all the cases that I did—I still think I wasn't, I still would've wanted a little bit more practice. If that was my method of documentation on the floor, I would definitely want more than what I got in the cases that I did...I think that it would be beneficial to do it throughout the program, not just a one-time thing, and kind of starting it off slow or starting it off smaller, and then growing the pieces bigger so that you are constantly exposed to it and constantly practicing through it.* [Student 2]

Students and educators differed in their views about the timing of introducing DocuCare in the curriculum and integration with other courses. For students, starting early in their program would be most useful; however, they believed that having some foundational knowledge in nursing first would be more appropriate. According to one student:

> *I think—maybe at the end of first year, but more in second year, because I think for me, like figuring out how to do the assessments first—instead of having like—learning to do the assessments, and then learning to use DocuCare—I think I want be more comfortable with actually what I'm doing before I try putting in...[Student 1]*

Conversely, educators felt:

> *it would be really valuable, that first year in health assessment, if we can give them time* [Educator 2]

Finally, educators and students provided important insights on how DocuCare learning could be incorporated despite challenges with content-heavy curricula and busy students' schedules. Flexible delivery, with a focus on learning not grading, was highlighted. Students highly supported the use of self-directed learning via online modules that can be incorporated into the laboratory or e-class platform without imposing a grading system. According to a student:

> *I could even see it as an e-class module...and with the no marks thing. I think it'd be good if simulation lab had an opportunity to like—you go in, here's your patient, here's your thing. But I think it'd be great if there was an option—almost like a little certificate kind of thing. You could come at your own time, here are the times and dates, we have the operator here, here's a case scenario, we need you to come in maybe with yourself or with a partner, or even as a clinical group.* [Student 3]

Conversely, educators felt the need to engage students in this learning and to monitor their progress down the road:

> *You have to make them accountable in some way...you just put pass or fail.* [Educator 3]

Discussion

Principal Findings

The purpose of this pilot study was to determine feasibility issues and evaluate the suitability of DocuCare from the perspectives of students and educators, as a tool for supporting students' acquisition of informatics competency and to enhance their readiness for future practice in digital health environments. The use of DocuCare in this study contributed to improving students' knowledge about informatics and accuracy of electronic documentation, congruent with findings from previous research [16,19,24,40-42,47]. There was no change in attitudes toward EHRs. On the basis of the findings from focus group interviews with students, this could be explained by the fact that students already had positive attitudes toward this technology, as demonstrated in their responses. In our study, educators agreed that *hands-on* learning opportunities through simulated electronic records were vitally important for the application of knowledge, development of critical thinking and documentation competencies, and building confidence in using clinical information systems in practice settings. Similarly, students were overwhelmingly satisfied to very satisfied with DocuCare and highly recommended using it in undergraduate nursing programs. They indicated that opportunities for electronic documentation will not only strengthen their communication skills but also enhance their critical thinking skills and their understanding of informatics concepts. It could ease their transition to using advanced technology in the work setting, which is congruent with findings from previous research [11,47].

The results of this study and other research confirm that students recognize gaps in their informatics preparedness to meet workplace requirements regarding the use of electronic tools to support nurses' work, particularly for data management and electronic charting [5,6,11,16,42]. Uniquely, in our study, students and educators provided suggestions for improving the DocuCare platform. They also shared strategies and recommendations on how DocuCare could be incorporated in strategic ways to augment students' learning about digital health and informatics without creating additional workload or overwhelming the already content-heavy curricula. Students were also quite passionate and willing to take on a self-directed role in embracing this technology to support their education. They recognize that the technological changes taking place in the clinical environment warrant action, but their education was not keeping pace. Although these findings reflect more awareness among student nurses regarding the importance of digital health and informatics in nursing practice, they also assert the need for more work on the part of nursing schools

and nurse educators in creating learning opportunities within the curriculum to enhance students' preparedness for their future nursing roles. Unfortunately, within Canadian prelicensure education, significant gaps still need to be addressed.

In a recent survey of Canadian schools of nursing, fewer than 20% of 360 nurse educators surveyed reported using EHR simulation in conjunction with teaching clinical skills in a simulation laboratory [5]. Congruent with these findings, in another survey conducted by Canada Health Infoway, only 35% of the nurse educators surveyed reported using a training version of an electronic record or clinical information system to support the teaching of nursing skills [2]. In addition, despite the increased utilization of digital health tools in practice, only 6 of 10 nurses surveyed about the use of virtual care reported having adequate knowledge and skills to use these systems [2].

Nagle et al [5] identified that teaching students about the use of EHRs is challenging in practice settings because there are few opportunities for students to access or use fully functional EHR systems in health care facilities. These findings are congruent with our findings and those in the general literature [11,34]. Nagle et al [5] also highlighted the need for an affordable EHR *sandbox* that could be used in simulation laboratories to teach students how to integrate these tools as they learn other clinical skills. They also identified the need for academic administration support for nurse educators as they implemented these tools [5,54]. Simulated EHRs are valuable for students learning about informatics and computerized charting; therefore, removing barriers to integrating them within Canadian nursing education should be a priority [5,20,34,42,54].

Educating future nurses about digital health and informatics is no longer an option but rather a core requirement in modern-day nursing practice [5,34,40,42,54-59]. Although the abrupt transition to remote delivery of education during the COVID-19 pandemic highlighted the current gaps in technology infrastructure and created challenges for higher education institutions worldwide, it also revealed opportunities for embracing technology and virtual simulation. This could be an important opportunity for nursing programs to capitalize on as we navigate more virtual practice across all domains of nursing [60-64].

Limitations

As this was a pilot study and voluntary participation was appreciated, the small sample size and the use of a one-group quasi-experimental design affected the power of the study. Numerous contextual factors may also have influenced students' willingness to participate in the study. The participants' recruitment was interrupted because of the COVID-19 pandemic and the public health guidelines restrictions. Students' academic workload, disruption of clinical placements, stress and feelings of uncertainty related to the COVID-19 pandemic, and the uncertainty regarding the completion of their program and entering the workforce in an evolving global pandemic may have also influenced students' desire to participate in this research. Finally, students who agreed to participate might have been more interested in the topic of the study compared with those who did not participate, which may have resulted in a response bias.

Conclusions

The integration of simulated EHRs within the nursing curriculum has the potential to improve students' knowledge and understanding of informatics and build confidence in using EHRs, including computerized charting. In this pilot study, the opportunity to use DocuCare firsthand enabled our students and educators to provide important insights and recommendations to the curriculum committee on the suitability and value of this educational tool for improving teaching and learning about informatics, computerized documentation, and the use of EHRs. This preliminary evaluation will also inform the planning of a future larger, controlled evaluation study, inviting students and educators from other sites within our collaborative nursing programs in Alberta. Given the paucity of Canadian research on simulated EHRs, the findings of this study may also be useful to other schools of nursing.

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Authors' Contributions

MK was involved in funding acquisition, conceptualization, designing the methodology, investigation, formal analysis, project administration, resources, supervision, and writing, reviewing, and editing the original draft. DJ was involved in investigation and writing the review. UDW was involved in investigation, formal analysis, and writing and editing the review. SA was involved in investigation, formal analysis, and writing and editing the review.

Conflicts of Interest

None declared.

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Abbreviations

EHR: electronic health record
EMR: electronic medical record

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Original Paper

A Digital Mobile Community App for Caregivers in Singapore: Predevelopment and Usability Study

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Abstract

Background: With increasing life expectancy and aging populations, the global prevalence of chronic diseases and the long-term care required for people with comorbidities is rising. This has led to an ever-growing need for caregiving. Previous literature has shown that caregivers face problems of isolation and loneliness. However, many health organizations mainly focus their efforts on in-person community groups that require participants to meet physically. This is not always convenient or accessible for caregivers who are often juggling caring for their care recipient with family and work responsibilities.

Objective: With medical advancements such as the proliferation of mobile phones and internet technology, caregivers may have opportunities for easier access to resources and support. Technological innovations could help empower the caregiving community to seek assistance for improving their quality of life at their convenience. A community network app called Caregivers' Circle was conceptualized in response to the needs of the caregivers on a day-to-day caregiving journey. This paper traces the predevelopment inquiry and technical details of this app to provide a clear understanding of its implementation along with a usability study to gauge user opinion of the app within Singapore.

Methods: A predevelopment survey was conducted to identify specific needs of caregivers and gaps in the currently available web-based community networks. The survey consisted of questions on demographical data, health-related issues of the care recipient, mental and physical health–related issues of the caregiver, digital media use, information seeking, and support. This pre–app development survey was completed by 103 caregivers. Qualitative enquiries were also conducted with caregivers within Singapore to identify issues related to caregiving, support provided, and what caregivers would want from a caregiving mobile app.

Results: From the feedback garnered from the caregivers, the developers were able to identify several caregivers' needs and gaps within the current support networks. This feedback was integrated into the mobile app called Caregivers' Circle upon development. The features of this app include a public *forum* for community discussions, a *marketplace* to buy and sell items, *care groups* to hold private discussions with friends or other users of the app, and a *friends* feature to search and add new caregiving friends.

Conclusions: In general, the caregivers liked the Caregivers' Circle app and were confident that this app could help them have a better quality of life. The Caregivers' Circle app is unique in its integrated approach. The integration of many features that caregivers need on a daily basis into an easy app can save their time as well as help them navigate their life smoothly.

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KEYWORDS

caregiving; technological solution; mobile application; easy communication; caregiver; mobile app; communication; elderly; aging population; internet technology; community network; network

Introduction

With the increase in life expectancy and aging populations, the global prevalence of chronic diseases and the long-term care required for people with comorbidities is expanding. This demographic shift has led to an ever-growing need for caregiving. A caregiver can be defined as "a person who provides direct care (eg, for children, older adults, the chronically ill)" [1]. In this study, a caregiver is defined as a person who provides direct care for individuals (eg, children, adults, older adults) with special needs or mental or physical disability. Although there are facilities such as care homes to provide for those who need assistance, there are many people who informally care for their loved ones. For example, it is estimated that the annual number of informal carer hours provided for people with dementia living at home globally was 82 billion hours in 2015 and this number is expected to increase [2]. Another type of caregivers are parents caring for children with special needs, and they are often the primary or sole caregivers. For instance, autism spectrum disorder was ranked among the 20 leading causes of years lost due to disability globally, with 3.6 million children aged 1-9 years living with this disorder. Autism spectrum disorder is only one of the numerous disabilities and conditions that afflict millions of children and requires long-term care [3].

Several studies have shown that caregivers face problems of isolation and loneliness. For example, Pertl et al [4] found that the high level of burden in dementia caregivers is associated with isolation and loneliness rather than the level of disability or the length of time that they have been taking care of the care recipient. A number of studies have shown that informal caregivers of children with intellectual disability, for example, would self-stigmatize themselves, which was reflected in the reactions to negative public response to the disability, by hiding their issues and withdrawing from social interactions [5,6]. Apart from adapting to the steep learning curve of taking care of patients, caregivers may have to adjust their own lifestyles, which include sacrificing their working hours, personal time, and relationships in order to help the patients. A research studying informal caregivers for the older adults within the United States found that over one-third of the respondents had quit or retired early from their employment to focus on caregiving. Among those who were still working, over half reported that caregiving had affected their work life [7]. Isolation and loneliness have been found to affect emotional and physical well-being and can lead to an increased likelihood of illness and death [8]. These factors, in turn, may also affect the care recipients and the quality of care they receive. Osborne et al [9] found that the poor mental health of caregivers negatively affected the development of their children diagnosed with intellectual disability.

With the current COVID-19 pandemic outbreak, these feelings of isolation have exponentially increased across the world due to the enforcement of social distancing and quarantine both in the general population and, particularly, in people with disabilities and their carers [10]. This has led to an increase in mental health issues and a need for coping strategies to deal with the impact of these social restrictions and the other potentially isolating measures in place to prevent the spread of the pandemic that currently remains prevalent with no foreseeable end.

Within Asia, cultural norms and filial piety often create expectations for family members to become the primary caregivers [11]. Southeast Asia is estimated to house 7.7% of the global total of people with dementia, 98% of whom are living at home, whereas only 55% of patients with dementia live at home in Western Europe. The cultural expectations that care needs be provided within families can lead to increased pressure and stress on carers who feel the need to become the sole carer, regardless of whether they feel capable, leading to an increased likelihood of ill health [2]. Lim et al found that in Singapore, caregivers of patients with cancer had lower quality of life scores than those in Western countries [12]. In 2010, 8.1% of Singaporeans aged 18-69 years stated that they were caregivers to friends or family [13], and this number is steadily increasing. Additionally, social stigma surrounding disability in Asia is much more prevalent. Many parents of children with disabilities or special needs attempt to hide the fact that their child may have special needs. Therefore, it is imperative that support is provided to enhance coping, improve quality of life, and reduce the burden of caregivers. Social support has also been found to reduce caregiver burden both in terms of family members and peers [14,15]. Several studies have reported that working with peers with similar problems enables the caregiver to feel less isolated and lonely. For example, parents of children with autism in China said their peers with similar experiences were less discriminatory and encouraged open discussion, which boosted spirits. The literature also suggests that providing support in the form of education and training can help to reduce this burden [16].

Both globally and within Singapore, several organizations and public health initiatives are focusing on improving caregiver well-being. In 2018, the Singapore Ministry of Health developed a Caregiver Support Action Plan [17] to provide financial support, training, and information for caregivers. Organizations such as the Agency for Integrated Care [18] and the National Council of Social Services [19] also offer assistance. However, many organizations mainly focus on in-person community groups that require participants to take time off to meet in the specified venue. This is not always convenient or accessible for caregivers, who are often juggling caring for their care recipients, in addition to family and work.

With the proliferation of mobile phones and digital technology, caregivers could have easier access to resources and support. Singapore has a mobile penetration rate of 86%, which is ranked the highest rate in Southeast Asia. Approximately 77% of the nation's population are active social media users, which places Singapore among the top 3 countries globally for social media penetration [20]. Therefore, utilizing opportunities afforded by technology could assist in supporting the caregiving community. A review by Marasinghe et al [21] found that technology can reduce the burden of caregivers by assisting with the functional limitations of the care recipient. Technology-based support can also reduce caregiver burden by providing social support at low cost and accessibility to the caregiver [22]. For example, Damianakis et al [23] found that using a web-based community

support group for caregivers of people with traumatic brain injury was positively received by participants. Piraino et al [24] found that personal web-based networks have the potential to improve family engagement and support by filling communication gaps that other traditional communication methods may not address.

Considering the issues faced by the caregivers and the increase in technology, we developed a community network mobile app for caregivers in Singapore with the aim of providing a space for caregivers to discuss problems, support each other, develop friendships with like-minded individuals, and ask questions to peers facing similar hardships. By creating a platform for caregivers in Singapore, we hope the app can meet the needs of the users through several features, including forums, a marketplace, private chat groups, and friend additions, to ultimately reduce the feelings of isolation and loneliness and provide locally relevant support. In this paper, we provide the technical details of the app development to provide a clear understanding of its implementation along with a usability study to gauge public opinion of the app.

Methods and Results

Pre–App Development Requirements Analysis

To identify the specific needs of caregivers and gaps in the currently available web-based community networks, a predevelopment survey was first distributed to caregivers in Singapore through web-based survey platforms, namely, Qualtrics and Google Forms or through face-to-face interviews. Participants were recruited through caregiving networks such as community centers, caregiving organizations, and special needs schools. Participants were eligible if they were between the ages of 21 years and 70 years. The survey questions were in English and Mandarin, which are the 2 official written languages of Singapore. Questions were based on demographics, health-related issues of the care recipient, mental and physical health–related issues of the caregiver, digital media use, information seeking, and support. Data were downloaded from the survey platforms into Microsoft Excel. For face-to-face interviews, the data were manually entered into Excel. All data were analyzed in SPSS (IBM Corp). A subset of the participants recruited for the quantitative survey also agreed to take part in face-to-face interviews to identify issues related to caregiving, the support currently provided, and what caregivers would require from a caregiving mobile app. Interviews were conducted in either English or Mandarin based on the preference of the participant. Participants consented to be audio-recorded and the interviews were then transcribed verbatim.

Pre–App Development Surveys and Interviews

The pre–app development survey was completed by 103 participants. The demographical data are provided in Table 1. Approximately half (52/103) of the respondents were caring for recipients younger than 18 years, while 23.3% (24/103) were caring for recipients older than 70 years. The results showed that two-thirds of the caregivers felt stressed and lacked support in caring for their care recipient. About 38.8% (40/103) of the participants felt that their health has suffered since becoming a caregiver.

We conducted interviews with 29 participants (Table 1). The interview results supported the quantitative survey and found that many caregivers lack support and feel stressed about their situation.

> *…I think the caregivers' stress is probably something that er, that we all, a lot of us need help in, because most of us feel very alone in that situation.* [Daughter of an 80-year-old patient with dementia]

> *…You're always wondering whether you're doing enough. Um, or that, you know, I'm not doing a good job. Because there are good days and there are bad days, and then on bad days then you think that oh, you know, I am so bad at this.* [Daughter of an 80-year-old patient with dementia]

> *…sometimes it becomes very stressful, when I come home I become very tired, there are small things at home and you still have to handle your responsibility, it becomes very stressful. Talking to a therapist is a luxury, I think in Singapore it's not that common, you go in there's somebody that lets you say and then try to understand what you are feeling and guide your thinking and I think in Singapore my conception is this is very rare.* [Father of a special needs 8-year-old child]

> *…To me the mental health for caregiver is really important, sometimes I need to remind myself, I need to take care of myself in order to take care of my son, but this is hard.* [Mother of a 10-year-old autistic child]

Although several caregivers use web-based forums or communication channels to converse with peers in similar situations, many of the available forums are either global or consist of caregivers in Western countries, several of whom discuss matters related to social services and the available assistance within their countries. This makes it difficult for a Singaporean audience to completely relate to or utilize such recommendations.

> *…sometimes you see parents asking like my child recently started of this medicine, he's behaving this way, does anybody has any ideas. Sometimes they ask about doctors, I am living at this state, do you know any neurologist around there? This can be a localized context where you are asking also. I don't think the doctors in the states are relevant to us.* [Father of an 8-year-old child with intellectual disability discussing in web-based support groups]

In addition, forums that are tailored toward Singapore residents such as Facebook groups often elicit worries about privacy and security owing to the large number of non-caregiving members being able to potentially access the information provided. Many participants also highlighted their difficulty in purchasing or selling items related to their caregiving, such as mobility devices. Although there are platforms that exist where caregivers can sell, give away, or purchase disability-related items, such as "Carousell," these websites are not tailored toward caregivers and sell a multitude of products that can make searching for items daunting and difficult to navigate.

…my daughter, she likes to bite objects, so that time her teacher asked me to purchase the chewing tube, I also don't know where to buy the things sometimes, very difficult to find. [Father of a 10-year-old special needs child]

Table 1. Demographic details of the participants taking part in the pre–app development survey and interviews.

Characteristics	Predevelopment survey (n=103)	Predevelopment interviews (n=29)
Age (years), mean (SD)	49 (10.5)	51 (8.3)
Gender, n (%)		
Male	24 (23.3)	6 (21)
Female	79 (76.7)	23 (79)
Ethnicity, n (%)		
Chinese	78 (75.7)	22 (76)
Malay	9 (8.7)	1 (4)
Indian	6 (5.8)	2 (7)
Other	10 (9.7)	4 (14)
Care recipient disability, n (%)		
Autism	44 (42.7)	10 (35)
Physical disability	28 (28.2)	8 (28)
Intellectual disability (including dementia)	16 (15.5)	5 (17)
Other	15 (14.6)	6 (21)
Care recipient age (years), n (%)[a]		
Child (<18 years)	52 (50.5)	15 (52)
Adult (18-69 years)	20 (19.4)	3 (10)
Older adult (70+ years)	24 (23.3)	11 (38)

[a]Seven values are missing among those who took the survey in this category.

App Development

From the feedback garnered from the caregivers, the developers were able to identify several caregiver's needs and gaps within the current support networks. This feedback was integrated into the mobile app called "Caregivers' Circle" upon development. Features include *caregroups* to hold private discussions with friends or other users in the app, a *marketplace* to buy and sell items, a *friends* feature to search and add new caregiving friends, and a public *forum* for community discussions. These features are shown in Figure 1. The majority of the Singaporeans are Android users (59.7%), with iPhone operating system (iOS) users being the second most popular mobile platform (39.2%) [25]. Therefore, the community network app was developed for use on both Android and iOS platforms to provide broad accessibility across Singapore. Participants who wish to take part in the app functions will be able to download it from either Google Play or iTunes app stores. Within the Android platform, the integrated development environment Android Studio 3.4.1 was used to develop the mobile app using the programming language Core Java. Within the iOS system, the integrated development environment Xcode 10.1 was used to develop the app with the programming language Swift 4.2 and the package manager Cocoa pods. This is a development environment designed by Apple for iOS systems. Cocoa pods assist in the management of libraries organizing the source code that the Xcode tool uses. The backend of Caregivers' Circle used the free script language Personal Home Page: Hypertext Processor 7.2 and Laravel 5.5, which is a web app framework. Upon downloading the app, users will be asked to register with their contact details, who they are caring for, whether they receive assistance in caring for their care recipient, the type of disability they are caring for, and the age of the care recipient. Privacy was a major worry among caregivers within Singapore and therefore, user contact details will be kept hidden and a pseudonym username can be used if they wish to remain anonymous. Profiles can be edited if the user wishes to change any detail (Figure 2). Within their profiles, users can select tabs to view any forum posts they have created or any items they have or wish to sell in the marketplace.

Figure 1. Flowchart of the Caregivers' Circle app functions.

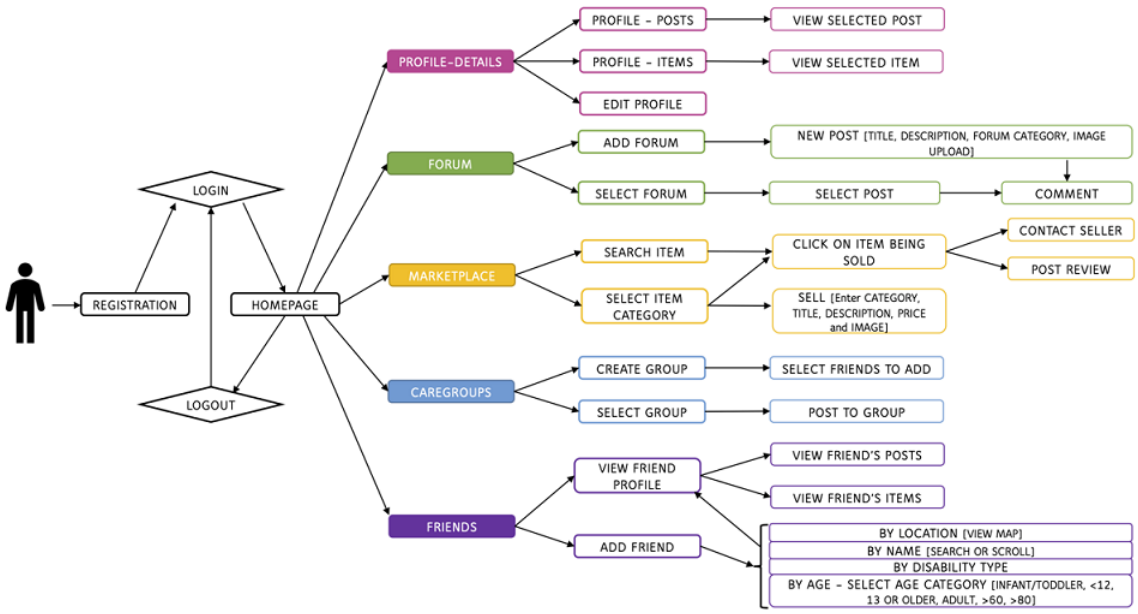
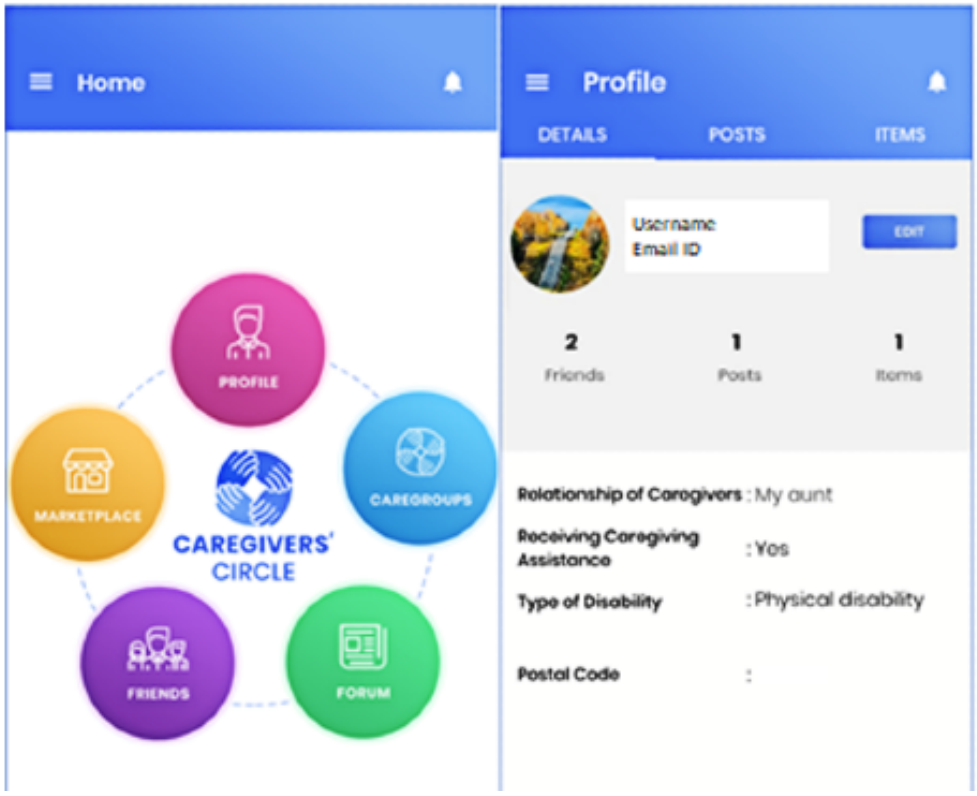


Figure 2. Screenshots depicting Caregivers' Circle home page and profile page.



Forum Feature

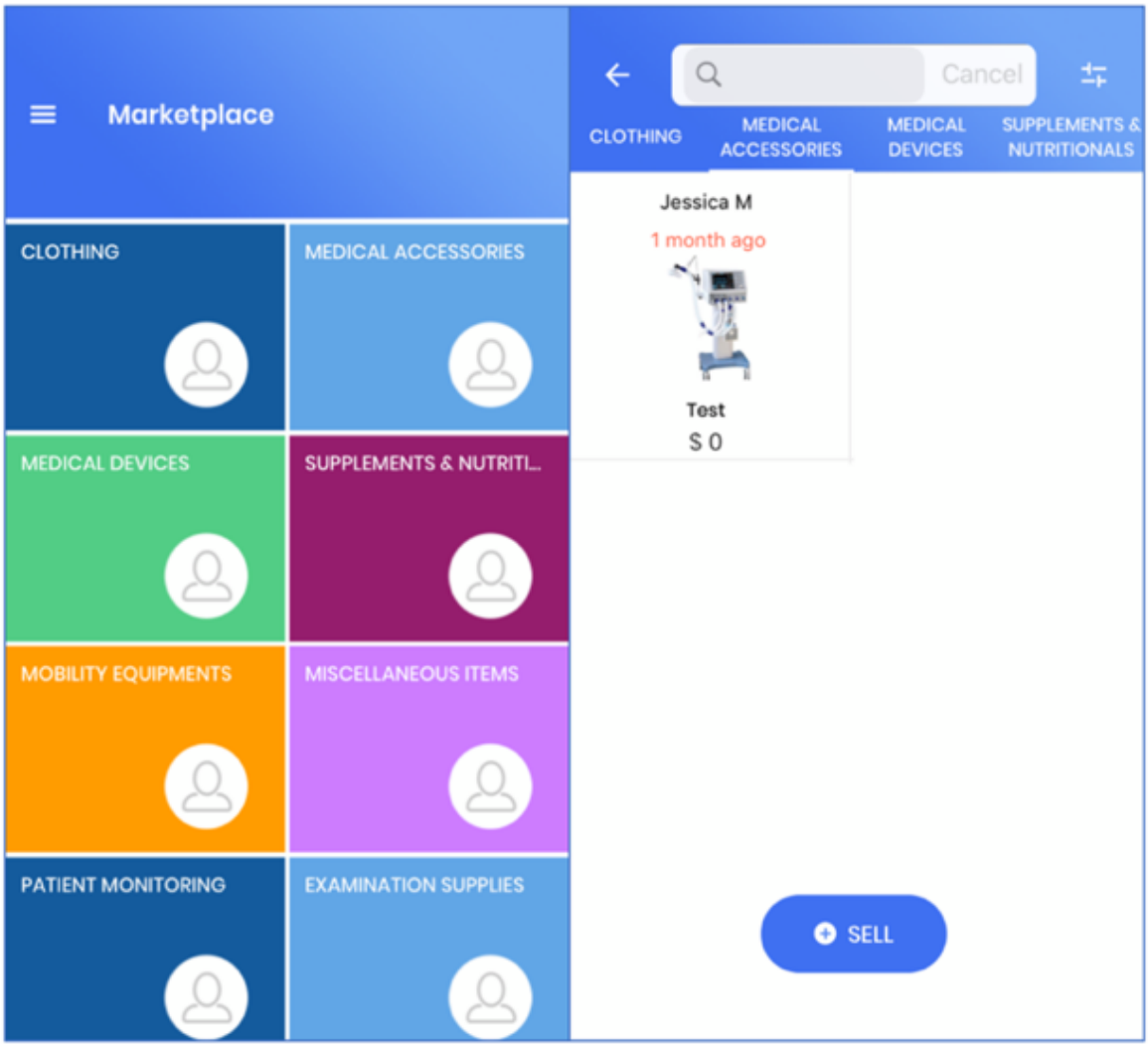
Within the predevelopment research, one of the prominent needs identified was that caregivers want to be able to discuss caregiving within a community of similar minded people within Singapore. Most existing platforms consist of caregivers from other countries who do not discuss locally relevant issues such as government schemes or provisions. Caregivers' Circle will only be accessible to Singapore-based users to ensure that the app is locally relevant. Users can post on public forums categorized by disability type such as autism, physical disability, intellectual disability, hearing impairment, visual impairment, and multiple disabilities. The forums are open to any caregiver within Singapore registered in the app and can be used to discuss any issue or ask any question they think others in the community could assist with. Users can post links to articles, post photos, and write new posts. They can also comment on other users

posts and create new forum categories for more specific discussion themes.

Marketplace Feature

Many caregivers lamented that they had difficulty finding or giving away items related to their care recipient, which led to the marketplace feature being developed (Figure 3). Within the marketplace, users can sell, give away, or buy items from other registered users. The items are categorized by different characteristics such as clothing, medical accessories, and mobility equipment. If a user is interested in purchasing an item, they can chat with the seller privately within the app to discuss the details of the purchase, pick-up location, etc. Sendbird Chat was used to create the chat function for users to talk to sellers in Marketplace. SendBird is a real-time chat and a messaging software development kit that has an easy-to-use and customizable user interface.

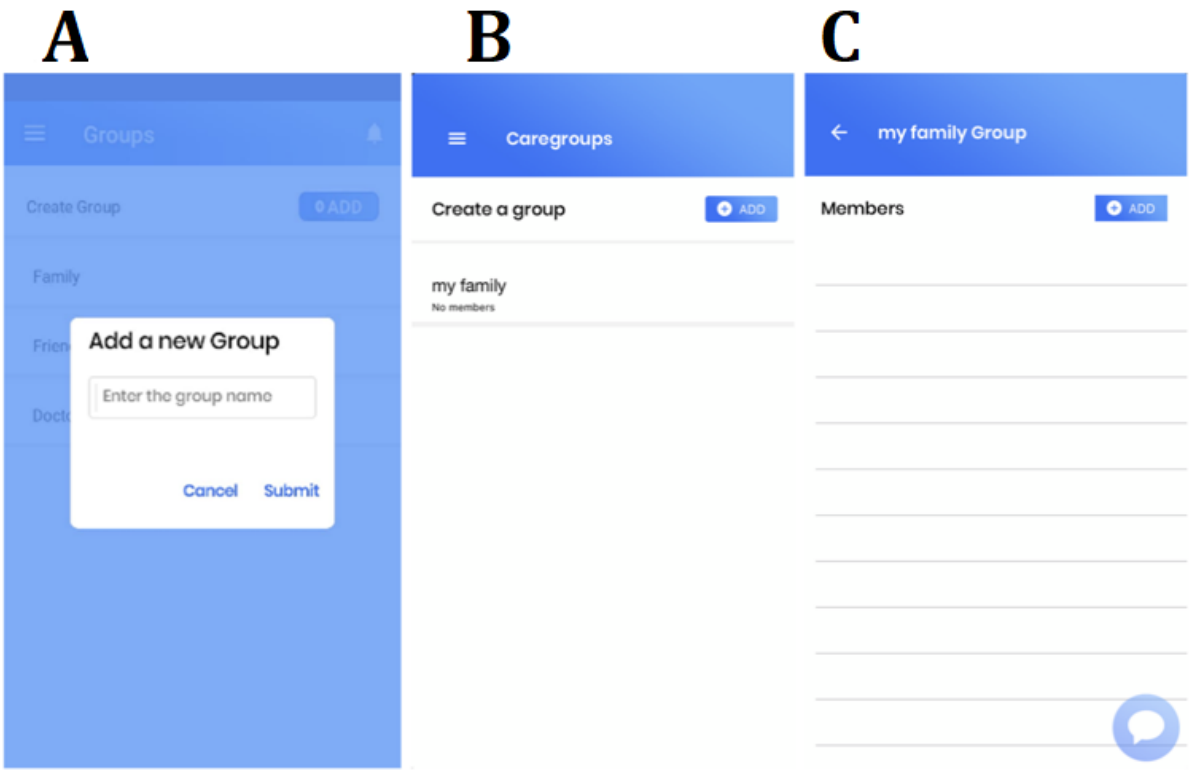
Figure 3. Screenshots depicting marketplace categories and item listings view.



Caregroups Feature

Users can also post in private groups that are self-made called as caregroups (Figure 4). This feature allows users to talk privately to any other users within the app. Joint caregivers of a care recipient such as family members can use this feature to discuss specific needs related to their care such as organizing hospital visits and posting information regarding the care of their recipient and any private matters they wish to discuss. If users become friends within the forums and wish to talk privately, they can create a private group. There are no limits to the number of friends that can be added to a group nor the number of groups that can be created.

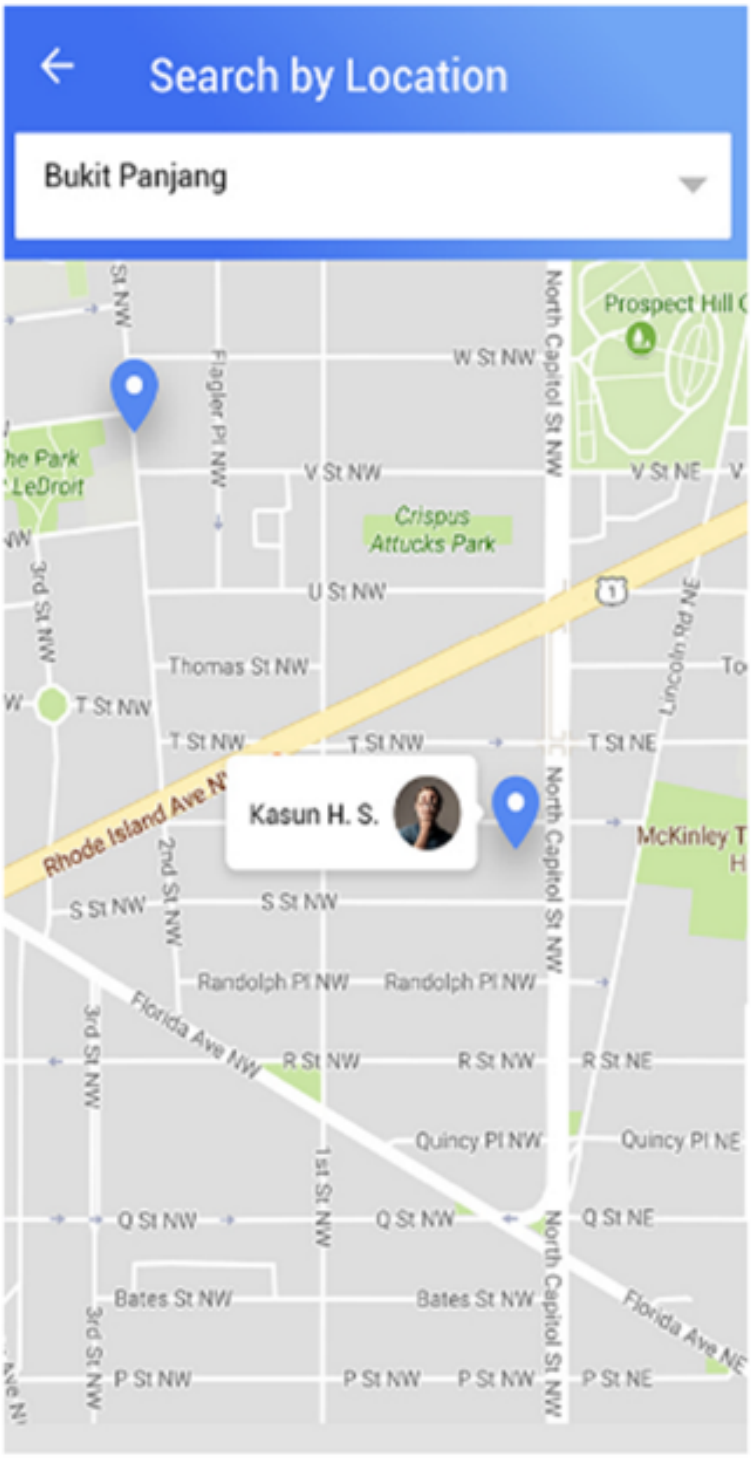
Figure 4. Screenshots depicting the functions of A. creating care groups, B. viewing list of care groups, and C. adding members to care groups and starting group chats.



Friends Feature

Loneliness is a major issue among caregivers who do not know where to go to find like-minded individuals going through similar life experiences. Within the app, users can search for new friends based on several key indicators. If the user knows the username of another caregiver, they can search for them by their username. If the user wishes to become friends with someone who is located near to them to make it easier to meet up in person or to discuss locally situated services, they can search for other caregivers via a location map (Figure 5). To create the mapping feature to search for friends, the Google Maps Software Development Kit was used along with Google Places. Both these platforms allow the app to provide geographic-based location services if the user wishes to divulge such information. Users can also search for friends by the care recipients' disability type and the care recipients' age, which are both entered by each user upon registration. This filter can allow caregivers to approach and befriend caregivers with similar needs. Once they become friends, users can view their friends' details such as who they are taking care of, whether they are receiving assistance, how many friends they have, the number of forum posts they have created, and the number of items posted within the marketplace. Users can also click on the created posts of their friends or items they are selling. To ensure that the app is running smoothly, Crashlytics was used in both the Android and iOS systems. The Crashlytics crash reporter is a real-time software development kit that tracks, prioritizes, and fixes any stability issues that affect the app quality. The participants who took part in the pre–app development survey were asked to evaluate the app prototype. In addition, the caregiving organizations that were previously contacted for recruitment were contacted again to further enlist participants. Owing to time constraints during development, some participants could not download the app into their phones but were asked to either view screenshots of the app, which were then explained further by interviewers, or were guided through the app on the interviewers' phone. However, some participants were able to test the app for 6-8 weeks. Participants were then asked their opinions on the app—whether they would use it and what could further be improved. The interviews were audio recorded with consent from the interviewee and were later transcribed for analysis.

Figure 5. Screenshot depicting "Search by location" function for users to find other caregivers to befriend.



Usability Testing Results of the App

The prototype underwent the initial assessment by 32 end users. The users included caregivers of children with special needs and older adults with mental or physical disability (Table 2). The usability testing was conducted after seeking approval from the institutional review board (IRB-2018-11-016).

Table 2. Demographics of the app testers (n=32).

Characteristics	Values
Age (years), mean (SD)	43.2 (11)
Gender, n (%)	
Male	10 (31)
Female	22 (69)
Ethnicity, n (%)	
Chinese	24 (75)
Malay	2 (6)
Indian	5 (16)
Other	1 (3)
Care recipient disability, n (%)	
Autism	9 (28)
Physical disability	7 (22)
Intellectual disability (including dementia)	9 (28)
Other	7 (22)
Care recipient age (years), n (%)	
Child (<18 years)	13 (41)
Adult (18-69 years)	13 (41)
Older adult (70+ years)	6 (19)

Overall Look and Feel of the App

Overall, most participants stated that they would definitely download and try the app if it was available. They also mentioned that the look and feel of the app was neat and easy to navigate. Most users also said that the app will be useful to them.

> *…For me, I usually am the one who likes to have everything in one platform, I haven't really found that.* [Mother of an 11-year-old special needs child, speaking about the overall features of the app and previous apps in the market]

> *…Oh, I would, I would definitely use that, yeah, because there is so much more information which I may need in the future which I don't even know what the question is going to be. So, when the time comes, yeah, it will just be very useful.* [Daughter taking care of an 89-year-old bedridden mother]

Usability of Forum Feature

Participants mentioned that the way in which the forums were designed was convenient and valuable. Care recipients may have a varied set of problems, many of which may require unorthodox solutions. They felt that the forum could connect them with other caregivers within Singapore who may be going through similar experiences and are able to share and learn from one another. Users also mentioned that forums could also help them in providing local information that international groups cannot provide.

> *…This is definitely useful; this is actually a part of sharing I think it's most useful. Because very often you don't go to doctor for something minor, in fact we never go to doctor for things like how do you address the fact that your kid keep grooming, how do we control that. Sometimes like questions like this you get tips from people who has been successful in trying out something, whether something they have read or something they accidentally bumped into which can be a solution.* [Mother of a 16-year-old special needs child]

> *…Yeah I think that will be very useful…Because, I previously went with my mom to a weekly session run by NNI … and then I met some of the daughters and sons of the patients and then we were chatting, and, you know, we find that we have common problems of course, yeah, but after that thing ended we just didn't (we didn't catch up), there was no platform to keep in touch, I guess.* [Daughter taking care of an 80-year-old mother with dementia]

Usability of Marketplace Feature

Many participants agreed that the marketplace was a good feature in the app as these participants frequently found it difficult to find specific products for their care recipients. They envisioned that it could also be a place where they could give away/sell preloved items that they no longer need. Many participants highlighted the fact that the marketplace feature caters toward caregiving and care-recipient needs, unlike other general selling sites; this was received positively as the marketplace helped them to find specific products.

> *…the market is also quite good because sometimes this people, their parents passed away already, they got wheelchair they got bed, then they can come in here and sell or even free. You know? So, they can post and then easier sometimes, you ask people, nobody wants also.* [Daughter of an 86-year-old mother with dementia]

> *…I also like the marketplace, because we don't know where to buy the things sometimes, very difficult to find.* [Mother of a 10-year-old special needs child]

> *…I like the concept of market place because overtime you do have stuffs that perhaps you don't use anymore or you buy extra off, then you don't need them anymore and it's a waste. You can follow the Marie kondo method if you don't want to throw it away, so this will be something great, and it helps other, even if it's a giveaway, I think this will be a very nice thing.* [Father of 15-year-old girl with intellectual disability]

Usability of Caregroups and Friends Features

Several participants stated that they do not have a lot of time to socialize and if there was a web-based community to share their experiences, it would be an easier way for them to make new friends at their own convenience. Some of the participants liked the "search by location" feature as they felt they could meet caregivers who are based geographically near to them and not lose time travelling to socialize.

> *…You get to know other parents with same condition kids, very difficult to make a new friends also.* [Mother of a 10-year-old special needs child]

> *…I'm very impressed with the map, and like for me who was needing, I think I'm surely going for the one. And this one was also quite good, because for us, we have other need, a special need, I think this would be very useful for me who don't have much time.* [Mother of a 5-year-old special needs child]

> *…one good thing is if there's critical mass of people in this, and then we can search by location by disability, it's easier to reach out to the same people, people in the same situation and that's something that we don't really have now.* [Mother of an 11-year-old child with autism discussing about the finding friend's location-based searching]

Users also highlighted few features that could be improved and added to the app to enhance the app use. Even though some participants liked the "search by location" feature in the app, others felt that this feature may be a concern for privacy. Although location was an optional feature based on initial interviews with caregivers, a few participants still raised concerns regarding general privacy in the app as they may be sharing information about vulnerable groups and suggested that if the app is supported and hosted by reputed organizations, it would help them to gain more trust.

> *…really, I would say that the tools are there… I think that's really helpful because myself and quite a lot of people will be feeling quite reassured (organization name) is well-known and is getting an interest in it (app), may be more willing to more actively participate in such event or activity because there is some sort of body that's supporting. It could be a communication portal for them to reach out to customers like us with their services. And whatever information that comes from there…It comes from an official body, or partners who is their official body who can share I've got this workshop or promotion for special trust one.* [Father of a 15-year-old special needs child]

Although participants were pleased with the community aspect of the app in assisting to alleviate some mental stress, some participants suggested including features such as inspirational quotes or messages and guides to motivate caregivers to remind them to take care of themselves and suggest simple ways on how they could destress and relax in their busy lives to enhance the current app.

> *…Ya, self-care. Self-care, I need a lot of that. I really want to make it, but I don't know who. I don't know how.* [Mother of a 5-year-old special needs child]

> *…You know caregivers are very stress, so I hope that's something like music to distress me, would there be something to like there to, something like maybe fun. Maybe games, music, or something else. You know when you want to burst right, you need something to cool down.* [Mother of a special needs 5-year-old child]

Currently, the app is intended to accommodate all caregivers, although there are a few features such as the forums that can be tailored toward specific caregiving groups. Few users mentioned that it would be good if the app was further customizable according to their care recipients' needs.

Discussion

Caregivers face many burdens in life and often struggle to cope, feeling like they lack support or people to talk to. With time constraints and convenience issues, many caregivers cannot participate in face-to-face events that are often run by nonprofit organizations or the government and find that web-based groups tend to cater toward global or Western audiences rather than locally based Singapore residents. The rise of technology and, in particular, mobile phones has created the opportunity to utilize technology to serve the caregiving community. The development of the Caregivers' Circle app incorporated caregiver feedback and previous literature to create a unique and usable community network app.

Overall, users were positive about the app and were confident that it could help them to live a better quality of life daily. The forums were seen as a positive space to discuss caregiving issues, make new friends, and answer caregiving queries to make them feel less alone in their situation. The marketplace was also well received as a place for caregivers to buy and sell or give away items related to caregiving that may be difficult or expensive to find elsewhere. There were mixed reviews about friend searching by location, with some caregivers seeing it as a way to make local friends and meet new people without having

to travel far, while some caregivers were wary about the privacy issues that can arise from knowing a person's geographical location. Users also liked the caregroups feature, which is similar in its function to other messaging apps, but with the added bonus of being contained within 1 caregiving platform to prevent the need to have several different apps. They also provided valuable feedback to improve the app to enhance usability. Taking user feedbacks into consideration on improving the features in the app, first, the research team aims to collaborate with trustworthy organizations that can help to launch the app to build trust with the users and to protect their privacy. Second, suggested features such as self-care tips, relaxing music, and inspirational messages to motivate the users will also be incorporated in the app. One of the limitations of this study was that owing to the delays in the development, the usability testing of the app for many participants could only be done using either screenshots or testing it for a short while on the interviewers' phone. Future testing should investigate the usability of the app over a longer period of time to truly gauge the longevity and sustainability of the app. Upon taking the user feedback into consideration, further testing should also investigate the effects of the app on caregivers' quality of life and the effect on loneliness over a longer period of time to evaluate the impact of the app.

In conclusion, our paper discusses the development of Caregivers' Circle, an app that integrates ideas from caregivers, previous literature, and that uses new technological solutions to create a novel app for easier caregiving. Caregivers' Circle is unique in its integrated approach. By integrating many features that caregivers need on a daily basis into an easy app can save time as well as provide help to navigate their caregiving smoothly.

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Authors' Contributions

MOL, AS, and CP were involved in the conceptualization of the paper. AS and CP wrote the main sections of the paper. MOL, AS, and CP were involved in the overall editing. CP and AS were involved in data collection. MOL is the principal investigator and the overall coordinator for this project.

Conflicts of Interest

None declared.

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Abbreviations

iOS: iPhone operating system

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