

Original Paper

Using Speech Data From Interactions With a Voice Assistant to Predict the Risk of Future Accidents for Older Drivers: Prospective Cohort Study

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Abstract

Background: With the rapid growth of the older adult population worldwide, car accidents involving this population group have become an increasingly serious problem. Cognitive impairment, which is assessed using neuropsychological tests, has been reported as a risk factor for being involved in car accidents; however, it remains unclear whether this risk can be predicted using daily behavior data.

Objective: The objective of this study was to investigate whether speech data that can be collected in everyday life can be used to predict the risk of an older driver being involved in a car accident.

Methods: At baseline, we collected (1) speech data during interactions with a voice assistant and (2) cognitive assessment data—neuropsychological tests (Mini-Mental State Examination, revised Wechsler immediate and delayed logical memory, Frontal Assessment Battery, trail making test-parts A and B, and Clock Drawing Test), Geriatric Depression Scale, magnetic resonance imaging, and demographics (age, sex, education)—from older adults. Approximately one-and-a-half years later, we followed up to collect information about their driving experiences (with respect to car accidents) using a questionnaire. We investigated the association between speech data and future accident risk using statistical analysis and machine learning models.

Results: We found that older drivers (n=60) with accident or near-accident experiences had statistically discernible differences in speech features that suggest cognitive impairment such as reduced speech rate ($P=.048$) and increased response time ($P=.040$). Moreover, the model that used speech features could predict future accident or near-accident experiences with 81.7% accuracy, which was 6.7% higher than that using cognitive assessment data, and could achieve up to 88.3% accuracy when the model used both types of data.

Conclusions: Our study provides the first empirical results that suggest analysis of speech data recorded during interactions with voice assistants could help predict future accident risk for older drivers by capturing subtle impairments in cognitive function.

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KEYWORDS

cognitive impairment; smart speaker; speech analysis; accident; prevention; older adults; prediction; risk; assistant

Introduction

As the world's older adult population increases, car accidents involving older adults have become an increasingly serious

social problem. While it has been reported that older drivers have an increased risk of car accident involvement per unit distance travelled [1-4], they also showed a substantially higher rate of serious injury than that of middle-age car drivers [5,6].

Even in normal aging, there is a decline in many cognitive abilities related to driving, and this cognitive decline is known to be one of the risk factors for older adults being involved in car accidents [7-9]. Associating cognitive assessment scores with either self-reported car accidents, crash records, or on-road driving measures has been investigated to identify predictors of driving safety (in previous empirical studies [7]). In particular, cognitive abilities such as visual attention, short-term memory, and executive functions (evaluated with neuropsychological tests) were consistently shown to have associations with driving safety [7,10-12]. In this respect, if cognitive impairments relevant to driving safety in older adults can be inferred solely from behavior data in everyday situations in a passive way, this would be beneficial for accident prevention.

Speech in daily life can be used a potential data sources for determining cognitive impairments related to driving safety. Speech involves multiple interacting cognitive abilities including attention, memory, and executive functions [13,14]. Many empirical studies have used speech data to identify cognitive impairments resulting from aging and diseases such as Alzheimer disease [15-18] and characterized speech changes related to cognitive impairments by extracting linguistic and paralinguistic features from speech data [19-25]. For example, difficulties with word finding and word retrieving have been quantified by tallying pronoun frequency and pause durations [19,20,24,26-28]. A reduction in speech expressiveness has also been quantified by measuring lexical diversity and speech rate [19,23,29-31]. Using a combination of these features, previous studies [19-25,29] have succeeded in differentiating individuals with cognitive impairments from healthy controls. Although no study has investigated the relationship between speech data and driving safety, it is reasonable to explore the possibility that speech data could be used for inferring ability to drive safely from changes in cognitive functioning in older drivers.

At the same time, there is growing interest in using speech data that can be collected in everyday situations for applications in health care owing to the popularity of voice-based interaction systems such as voice assistants in smart speakers and smartphones [32-34]. One approach is to provide various types of voice-based tests via a smart-speaker platform. For example, previous studies [35,36] have used mobile apps for collecting speech responses to neuropsychological tasks such as verbal fluency and picture description tasks; they showed accurate classification rates in detecting patients with Alzheimer disease [35] and dementia [36]. Another approach is to analyze

health-related insights from speech data collected during daily voice-based interactions. For example, vocal characteristics in speech data during typical tasks on smart speakers appeared to be associated with neuropsychological test scores [37], while linguistic features extracted from phone conversation data were significant indicators for differentiating patients with Alzheimer disease from older adults with normal cognition [38]. This approach, focusing on speech data that can be collected in everyday situations, would increase opportunities for frequent assessment by facilitating passive and unobtrusive monitoring.

In this study, we aimed to investigate the relationship between speech data and future driving experiences related to car accidents in healthy older adults by collecting speech data during interactions with a voice assistant with simulated tasks on smart speakers and smartphones. We hypothesized that these speech data could be used for predicting accident risk for older drivers.

Methods

Participants

We recruited healthy older adults aged 60 years or older through recruiting agencies and advertisements in the local community in Ibaraki, Japan. All examinations were conducted in Japanese. Older adults met the inclusion criteria if they were in good physical and mental health and had no serious diseases, disabilities, mental illness (eg, major depression, bipolar disorder, and schizophrenia), or neurodegenerative diseases (eg, Parkinson disease and dementia). This study was conducted with the approval of the University of Tsukuba Hospital Ethics Committee (H29-065). All participants provided written consent after the procedures of the study had been fully explained.

A total of 71 older individuals participated in the cognitive assessments and speech data collection (women: 38/71, 53.5%; age: range 61-80 years, mean 71.1, SD 4.9). Of the original 71 participants, 60 consented to the follow-up study about their driving experiences (women: 33/60, 55.0%; age: range 61-80 years, mean 70.8, SD 5.1; Table 1). They were contacted again approximately one-and-a-half years after the speech data collection (mean 17.3 months, SD 2.7) and answered a questionnaire on their driving experiences within the past year. The questionnaire included free-form questions about accidents and near accidents; *near accidents* were described as infractions and any other incidents while driving that they deemed to be dangerous regardless of severity and culpability.

Table 1. Demographic and assessment data for study participants.

Variable	Total (N=60)	Individuals without accident or near-accident experiences (n=34)	Individuals with accident or near-accident experiences (n=26)	P value
Age (years), mean (SD)	70.8 (5.1)	70.5 (4.9)	71.3 (5.3)	.45
Education (years), mean (SD)	13.7 (2.2)	13.7 (2.2)	13.6 (2.1)	.93
Sex, n (%)				.53
Men	27 (45)	17 (50)	10 (38)	
Women	33 (55)	17 (50)	16 (62)	
Mini-Mental State Examination ^a , mean (SD)	27.6 (1.8)	27.4 (1.8)	27.9 (1.8)	.28
LM IA ^b , mean (SD)	9.6 (3.8)	9.1 (3.7)	10.2 (4.0)	.43
LM IIA ^c , mean (SD)	7.5 (3.6)	7.3 (3.7)	7.6 (3.6)	.74
Frontal Assessment Battery ^d , mean (SD)	13.7 (2.7)	13.4 (2.7)	14.2 (2.7)	.45
Trail making test-part A (seconds), mean (SD)	33.2 (9.8)	33.6 (9.7)	32.6 (10.1)	.72
Trail making test-part B (seconds), mean (SD)	89.5 (49.7)	95.7 (60.9)	81.3 (28.2)	.71
Clock Drawing Test ^e , mean (SD)	6.7 (0.8)	6.7 (0.7)	6.7 (1.0)	.36
Geriatric Depression Scale ^f , mean (SD)	2.9 (2.4)	2.8 (2.4)	3.1 (2.4)	.62
Severity scores for atrophy in medial temporal structures, mean (SD)	0.9 (0.6)	0.8 (0.4)	0.9 (0.7)	.86

^aThe total possible score ranges from 0 to 30.

^bLM IA: immediate recall of the logical memory-story A of the Wechsler memory scale-revised for episodic memory; the total possible score ranges from 0 to 25.

^cLM IIA: delayed recall of the logical memory-story A of the Wechsler memory scale-revised for episodic memory; the total possible score ranges from 0 to 25.

^dThe total possible score ranges from 0 to 18.

^eThe total possible score ranges from 0 to 7.

^fThe total possible score ranges from 0 to 15.

Cognitive Assessments

Cognitive assessments and examinations were those typically used for the diagnosis of dementia and comprised 12 variables: age, sex, education, 7 neuropsychological test scores (Mini-Mental State Examination for global cognition; immediate and delayed recall of the logical memory-story A of the Wechsler memory scale-revised for episodic memory; the Frontal Assessment Battery for executive function; the trail making test-part A and B for executive function and attention; and the clock drawing test for visuospatial function), and 2 clinical scores (Geriatric Depression Scale and the severity of medial temporal lobe atrophy). The severity of medial temporal lobe atrophy was evaluated using structural magnetic resonance imaging (MRI) scans—1.5 T, T1-weighted images and a 3D gradient-echo sequence—with the following parameters: sagittal orientation with 1.2-mm thick sections; time repetition/time echo: 2400/3.52 milliseconds; flip angle: 8°; field of view: 192×192. We expressed the severity of medial temporal lobe atrophy as a Z score relative to cognitively healthy adults by using a standalone, voxel-based specific regional analysis system for Alzheimer disease [39]. Two psychiatrists (KN and TA) reviewed the results of the cognitive assessments and confirmed that participants did not meet the criteria for dementia based on those of the National Institute on Aging and Alzheimer's

Association and Alzheimer disease Neuroimaging Initiative 2 [40].

Speech Data Collection

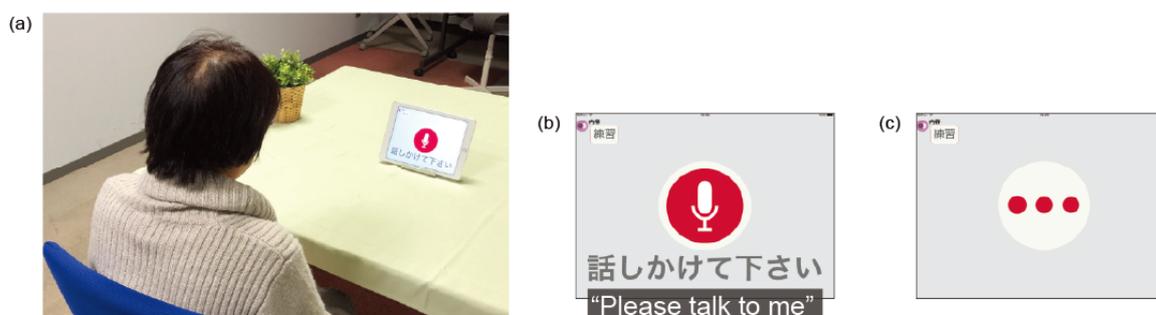
We simulated conversations with a voice assistant on modern smart speakers and smartphones and collected the speech data while performing 3 typical task scenarios: information retrieval (asking for tomorrow's weather), shopping online (booking a movie ticket), and personal schedule management (creating a calendar event). The tasks began with a simple scenario and then advanced to the more complicated ones. Each task started with an initiating question from the system ("what can I help you with?"), with follow-up questions that asked for detailed information related to the task. The follow-up questions were presented in a fixed order. The questions consisted of four categories—open-ended, to which participants responded with a free-form sentence (Multimedia Appendix 1: Table S1); multiple choice, to which participants responded by choosing one of the options stated in the question; prepared input, to which participants responded with information (eg, passcode) specified by the experimenter; and confirmation, to which participants responded by accepting or rejecting a statement made by the system. The system presented at least 22 questions in total to each participant for the 3 tasks.

To simulate conversations, we took a Wizard-of-Oz [41] approach, in which the participants were told that they were talking with a computer system, though in fact the interaction was mediated by an experimenter (ie, the wizard). We chose this approach so that we could avoid uncertain factors such as errors in automatic speech recognition. During the tasks, the experimenter made the system present a question. After the participant responded, the experimenter prompted the system to move onto the next question if the response contained the necessary information corresponding to the question; otherwise, they would repeat the same question. Each open-ended, multiple choice, and prepared input question presented by the system was scripted in advance and the same for all participants. For confirmation questions, we prepared several variations for each question and the experimenter chose one, depending on the participant's previous response. For example, the experimenter

chose "you are purchasing one ticket, is it OK?" or "you are purchasing two tickets, is it OK?" to have the participant confirm the number of tickets to book.

The interface for speech data collection was implemented as a tablet-based app on an Apple iPad Air 2. In the experiment, participants sat down in front of the tablet and talked with the system (Figure 1a). During the tasks, the tablet showed a screen indicating whether it was speaking (Figure 1b) or listening (Figure 1c). The experimenter sat behind the participant and operated the system by using a separate interface hidden from the participants. Speech data were recorded in raw format with a sampling rate of 44.1 kHz through the embedded microphone in the tablet. Each experimental session took approximately 30 minutes per participant, including instructions and wrap-up. Additional details about our apparatus and procedure have been previously published [37].

Figure 1. Overview of experimental setup: (a) setup for collecting speech data, (b) screen showing participant's turn, and (c) screen showing the tablet's turn.



Data Analysis

From each participant's speech data, we automatically extracted 84 paralinguistic speech features used in previous studies on inferring cognitive impairments and detecting early signs of Alzheimer disease [19,20,23,27-29,31,42,43]. They consisted of 56 acoustic features and 28 prosodic features.

The acoustic features consisted of features related to mel-frequency cepstral coefficients (MFCCs), jitter, and shimmer. We used the mean and first-order derivatives of the first 12 MFCCs, which represent the short-term power spectrum of the speech signal. Jitter and shimmer features measure cycle-to-cycle variations of fundamental frequency and amplitude [44]. Prosodic features included speech rate, pitch variability, phonation time, number of phonemes needed for completing tasks, response time, total pause duration, and proportion of long pauses (pauses >0.8 seconds). Both acoustic and prosodic features were extracted from each task's speech data separately. We used Python (version 3.8) audio-processing libraries (librosa, version 0.8.0 [45]; Signal_Analysis, version 0.1.26 [46]).

Statistical analyses were performed using Statistics and Machine Learning Toolbox (version 11.1) for MATLAB (version R2017a, The MathWorks Inc) environment. To assess the differences in each variable between participants with and without accident or near-accident experiences, we used 2-sided Mann-Whitney tests for continuous data and chi-square tests for categorical

data. We did not correct for multiple comparisons, and P values <.05 were considered significant.

The prediction models for differentiating individuals with and without accident or near-accident experiences were built using multiple types of binary classifiers with automatic sequential forward selection of features. Model performance was evaluated with both leave-one-subject-out cross validation and 100 iterations of 10-fold cross-validation methods. The classifiers included k -nearest neighbors [47], random forest [48] and support vector machine [49]. The parameters that we studied were as follows: the number of neighbors for the k -nearest neighbors; the number and the maximum depth of trees for random forest; kernel functions, penalty parameter, and the parameter associated with the width of the radial basis function kernel for the support vector machine. We performed an exhaustive grid search to determine these parameters. The algorithms were implemented using the Python scikit-learn package (version 0.23.2).

Results

For speech data collection (the 30-minute sessions), we obtained an average of 23.8 responses within 100.2 seconds (SD 28.6) from each participant. The average response duration of each task scenario ranged from 17.4 to 59.6 seconds (mean 33.41, SD 9.5). The average duration of a single response for each participant ranged from 1.1 to 7.6 seconds (mean 4.2, SD 1.1). At follow-up, 26 of the 60 participants (43.3%) reported car accident or near-accident experiences within the previous year.

Of those, 23 participants reported a near-accident experience, 2 reported accidents, and 1 reported both. The near-accidents consisted of near-misses with a car or pedestrian resulting in a sense of fear and anxiety (eg, from failure to notice a crossing pedestrian), errors in operation (eg, stepping on the accelerator instead of the brake), and unintentional violations (eg, entering the opposite lane).

In comparisons between individuals with and without accident or near-accident experiences, there were no significant differences in any cognitive assessment variables (age: $P=.45$; education year: $P=.93$; sex: $P=.53$; Mini-Mental State Examination: $P=.28$; immediate and delayed recall of the logical memory-story A of the Wechsler memory scale-revised: $P=.43$, $P=.74$; the Frontal Assessment Battery: $P=.45$; the trail making test-part A and B: $P=.72$, $P=.71$; the clock drawing test: $P=.36$; Geriatric Depression Scale: $P=.62$; severity scores for atrophy in medial temporal structures: $P=.86$; Table 1); however, we found 10 speech features with significant differences— $\Delta MFCC_1$: $P=.005$, $\Delta MFCC_4$: $P=.043$, $\Delta MFCC_5$: $P=.011$, $\Delta MFCC_7$: $P=.035$, $\Delta MFCC_{12}$: $P=.023$; jitter: $P=.034$; response time: $P=.040$; proportion of long pauses: $P=.044$; speech rate: $P=.048$; and number of phonemes needed for completing tasks: $P=.049$ (Figure 2; Multimedia Appendix 1: Table S2). Those with accident or near-accident experiences showed decreased speech rate and jitter as well as increased response time and long pauses. These speech features were reported in previous studies as significant indicators of changes in cognitive function, and the trends in their changes were consistent with those observed in individuals with cognitive impairments and patients with Alzheimer disease and mild

cognitive impairment (for speech rate [23,27,31]; for jitter [42,43]; for response time [20,27]; for proportion of long pause [27,28]).

To visualize whether the variance seen among a variable set is capable of discriminating between individuals with and without potential future accident or near-accident experiences, we performed principal component analysis on 2 variable sets: the 12 cognitive assessment variables and 10 speech features (Figure 3). The cognitive assessment variable set had little capability to differentiate the groups; there was considerable overlap and no clear separation. In contrast, the speech variable set enabled some separation of the groups.

Input variables for the classification models were either or both the 12 cognitive assessment variables and 10 speech features. When model performance was evaluated with leave-one-subject-out cross-validation, with only the cognitive assessment variables, we obtained 75.0% accuracy (65.4% sensitivity, 82.4% specificity, and 69.4% F1 score; Figure 4a), with only the speech features, the model accuracy increased to 81.7% accuracy (65.4% sensitivity, 94.1% specificity, and 75.6% F1 score; Figure 4b), and with speech features and cognitive assessment variables combined, performance improved further (88.3% accuracy, 88.5% sensitivity, 88.2% specificity, and 86.8% F1 score; Figure 4c). When we evaluated the model using 10-fold cross validation, the results showed similar trends (Multimedia Appendix 1: Table S3): the model using the cognitive assessment variables achieved 75.5% accuracy (95% CI 75.1-75.9), the model using speech features achieved 80.1% accuracy (95% CI 79.7-80.5), and the model using both types of features achieved 85.5% accuracy (95% CI 85.1-85.9).

Figure 2. Box plots (line and diamond represent median and mean, respectively) for speech features with significant differences between individuals with and without accident or near-accident experiences—jitter: $P=.034$; response time: $P=.040$; speech rate: $P=.048$.

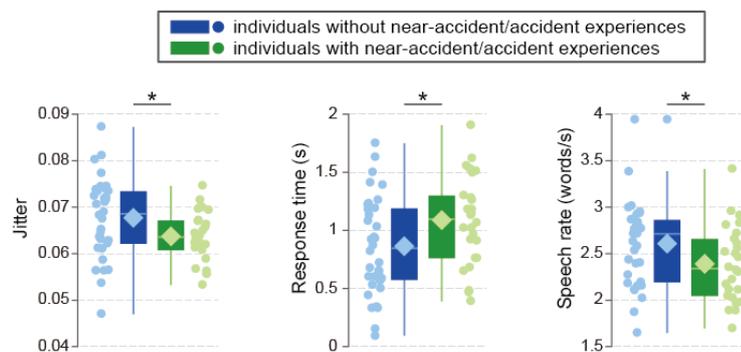


Figure 3. Principal component analysis plots using (a) cognitive assessment variables and (b) speech features, with confidence interval ellipsoid set to 0.95. PC: principal component.

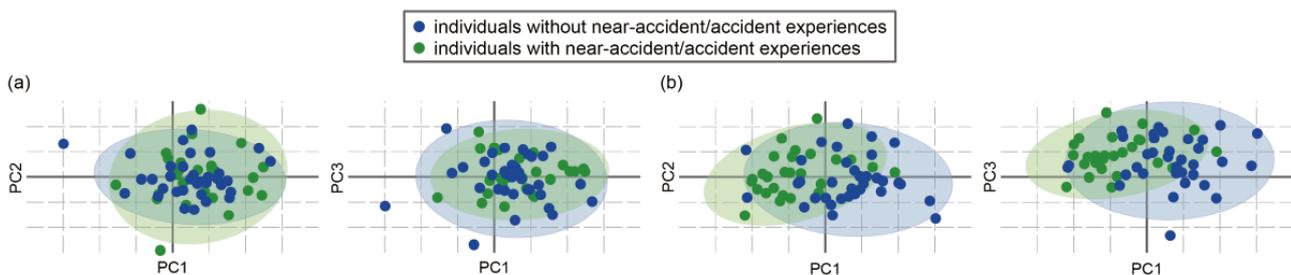
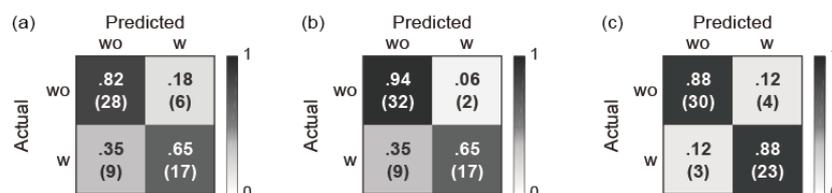


Figure 4. Confusion matrixes for predicting future accident risks of older drivers obtained using leave-one-subject-out cross-validation for models with (a) cognitive assessment variables, (b) speech features, and (c) cognitive assessment variables and speech features combined. The number in parentheses indicates the number of participants. wo: without; w: with.



Discussion

Principal Results

In light of the increasing demand for preventing car accidents involving older adults, we investigated the possibility that future accident risk related to cognitive impairments could be automatically predicted with passive unobtrusive monitoring. To this end, we focused on speech data because many previous studies have succeeded in quantifying and detecting cognitive impairments from speech data [19,20,23,27-29,31,42,43], speech data are becoming more accessible, and voice-based interaction systems such as voice assistants are becoming more popular [32-34].

The statistical analysis showed that the speech data collected during typical tasks on smart speakers and smartphones had statistically discernible speech features between older drivers with and without accident or near-accident experiences. These speech features indicated that older drivers with these experiences tended to show decreased speech rate and jitter as well as increased response time and long pauses. These changes in speech features were reported as statistically significant signatures for cognitive impairments by previous studies on patients with Alzheimer disease and mild cognitive impairment [19,20,23,27-29,31,42,43]. The results suggest that speech features could capture subtle impairments of cognitive function in older drivers. On the other hand, we found no differences in any cognitive assessment variables, but this could be explained by the criteria for driving risks that differed from those in previous studies [7,10,12,50-53]. While previous studies compared older drivers with and without car-accident experiences regardless of having near-car-accident experiences and reported significant differences in cognitive assessment scores between them [7,10,12,50-53], we focused on both accident and near-accident experiences, and the majority of the high-risk group in our study were individuals with near-accident experiences but without actual car accidents. Speech data and cognitive assessment results suggest that eliciting discernible changes relevant to future near-accident experiences may require cognitive assessment for subtle impairments, such as, test batteries used for screening preclinical Alzheimer disease [54,55]. Even so, if speech data during interactions with voice assistants can be used for predicting future accident risk, it would greatly increase the accessibility of early screening with a relatively low burden.

The classification model using speech features achieved 81.7% accuracy, which is 6.7% higher than that using cognitive assessment data, and models achieved up to 88.3% accuracy

with both combined. Dimensional reduction and visualization using principal component analysis, an unsupervised method, showed that the feature space with speech data was better able to separate those with and without accident or near-accident experiences than the feature space with cognitive assessment variables. These results and those of the statistical analysis indicate that speech data during typical tasks with voice assistants could have comparable (or possibly more) information for predicting future accident risks of older drivers compared with the standard cognitive assessments.

Our results show paralinguistic speech characteristics were useful for predicting future accident risks of older drivers. Previous user-interface studies reported that voice input was effective and was preferable as an input modality for older adults [56-58], while other studies reported that the performance of automatic speech recognition tended to be worse in older adults than in other age groups [59,60]. From this perspective, our results suggest that models for predicting future accident risks of older drivers can be made robust against errors of automatic speech recognition by exploiting paralinguistic features.

Our results highlight the possibility that cognitive impairments related to future car accident risks could be detected using speech data collected in everyday life. Assistive and automated driving systems are promising technologies that may help older adults with cognitive challenges to safely continue driving [61]. Recent studies suggested the importance of individual differences in cognitive abilities for assistive and automated driving technologies for older adults [62,63] because literature has suggested that cognitive abilities affect both performance with automated technology and perceptions of automation (ie, trust) [64,65]. Hence, our approach to detect cognitive impairments associated with driving risks might provide useful information for the personalization of assistive and automated driving systems based on the cognitive abilities of older adults.

Limitations

Our work had several limitations. First, we collected speech data in a lab setting. The controlled setting might affect the way people interact with a voice assistant. In future work, data collection in free-living situations using voice assistants would be needed along with additional interaction scenarios. Second, the sample size was limited. In spite of this limitation, our statistical analysis of speech features showed consistent trends indicating subtle cognitive impairments in older adults with future accident or near-accident experiences, and the prediction performance (to predict independent future accidents) using speech features was as high as 88%, even when the classifier was trained on a subsample. From these perspectives, we believe

that our results can be confirmed by future studies. Third, our definition of future car accident risks was based on self-reports of accident and near-accident experiences. In future work, we need to consider obtaining more objective measures for accident risks by combining self-reports with on-road driving assessments, informant reports, or drive recorder videos.

Conclusion

Given the increasing demand for car accident prevention involving older adults, we explored the possibility of predicting future accident risks associated with cognitive impairments by using behavioral data that can be collected in everyday life. To this end, we focused on speech data collected during interactions with voice assistants in smart speakers and smartphones and investigated the associations with future accident risks by

following up with older drivers. We found that (1) older drivers with accident or near-accident experiences had statistically discernible changes in speech features, implying cognitive impairments, and (2) the machine learning model using speech features could predict future accident or near-accident experiences with up to 88.3% accuracy. Although further studies with speech data collected in everyday life and objective data for near-accidents are needed, our study provides the first empirical results suggesting that speech data during interactions with voice assistants in smart speakers and smartphones could help predict future accident risks of older drivers by capturing subtle impairments in cognitive function. We believe that our results can be used in future efforts toward preventing driving accidents of older adults through continuous passive unobtrusive monitoring.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Supplementary tables.

[\[PDF File \(Adobe PDF File\), 194 KB-Multimedia Appendix 1\]](#)

References

1. Cicchino JB, McCartt AT. Trends in older driver crash involvement rates and survivability in the United States: an update. *Accid Anal Prev* 2014 Nov;72:44-54. [doi: [10.1016/j.aap.2014.06.011](https://doi.org/10.1016/j.aap.2014.06.011)] [Medline: [25003969](https://pubmed.ncbi.nlm.nih.gov/25003969/)]
2. Cicchino JB, McCartt AT. Critical older driver errors in a national sample of serious U.S. crashes. *Accid Anal Prev* 2015 Jul;80:211-219. [doi: [10.1016/j.aap.2015.04.015](https://doi.org/10.1016/j.aap.2015.04.015)] [Medline: [25916662](https://pubmed.ncbi.nlm.nih.gov/25916662/)]
3. Ma L, Yan X. Examining the nonparametric effect of drivers' age in rear-end accidents through an additive logistic regression model. *Accid Anal Prev* 2014 Jun;67:129-136. [doi: [10.1016/j.aap.2014.02.021](https://doi.org/10.1016/j.aap.2014.02.021)] [Medline: [24642249](https://pubmed.ncbi.nlm.nih.gov/24642249/)]
4. Lombardi DA, Horrey WJ, Courtney TK. Age-related differences in fatal intersection crashes in the United States. *Accid Anal Prev* 2017 Feb;99(Pt A):20-29 [FREE Full text] [doi: [10.1016/j.aap.2016.10.030](https://doi.org/10.1016/j.aap.2016.10.030)] [Medline: [27855312](https://pubmed.ncbi.nlm.nih.gov/27855312/)]
5. Ryan GA, Legge M, Rosman D. Age related changes in drivers' crash risk and crash type. *Accid Anal Prev* 1998 May;30(3):379-387. [doi: [10.1016/s0001-4575\(97\)00098-5](https://doi.org/10.1016/s0001-4575(97)00098-5)] [Medline: [9663297](https://pubmed.ncbi.nlm.nih.gov/9663297/)]
6. Meuleners LB, Harding A, Lee AH, Legge M. Fragility and crash over-representation among older drivers in Western Australia. *Accid Anal Prev* 2006 Sep;38(5):1006-1010. [doi: [10.1016/j.aap.2006.04.005](https://doi.org/10.1016/j.aap.2006.04.005)] [Medline: [16713982](https://pubmed.ncbi.nlm.nih.gov/16713982/)]
7. Anstey KJ, Wood J, Lord S, Walker JG. Cognitive, sensory and physical factors enabling driving safety in older adults. *Clin Psychol Rev* 2005 Jan;25(1):45-65. [doi: [10.1016/j.cpr.2004.07.008](https://doi.org/10.1016/j.cpr.2004.07.008)] [Medline: [15596080](https://pubmed.ncbi.nlm.nih.gov/15596080/)]
8. Bryan J, Luszcz MA. Measurement of executive function: considerations for detecting adult age differences. *J Clin Exp Neuropsychol* 2000 Feb;22(1):40-55. [doi: [10.1076/1380-3395\(200002\)22:1;1-8;FT040](https://doi.org/10.1076/1380-3395(200002)22:1;1-8;FT040)] [Medline: [10649544](https://pubmed.ncbi.nlm.nih.gov/10649544/)]
9. McGwin, Jr G, Brown DB. Characteristics of traffic crashes among young, middle-aged, and older drivers. *Accid Anal Prev* 1999 May;31(3):181-198. [doi: [10.1016/s0001-4575\(98\)00061-x](https://doi.org/10.1016/s0001-4575(98)00061-x)] [Medline: [10196595](https://pubmed.ncbi.nlm.nih.gov/10196595/)]
10. Odenheimer GL, Beaudet M, Jette AM, Albert MS, Grande L, Minaker KL. Performance-based driving evaluation of the elderly driver: safety, reliability, and validity. *J Gerontol* 1994 Jul;49(4):M153-M159. [doi: [10.1093/geronj/49.4.m153](https://doi.org/10.1093/geronj/49.4.m153)] [Medline: [8014389](https://pubmed.ncbi.nlm.nih.gov/8014389/)]
11. Sims RV, McGwin G, Allman RM, Ball K, Owsley C. Exploratory study of incident vehicle crashes among older drivers. *J Gerontol A Biol Sci Med Sci* 2000 Jan;55(1):M22-M27. [doi: [10.1093/gerona/55.1.m22](https://doi.org/10.1093/gerona/55.1.m22)] [Medline: [10719769](https://pubmed.ncbi.nlm.nih.gov/10719769/)]
12. Daigneault G, Joly P, Frigon J. Executive functions in the evaluation of accident risk of older drivers. *J Clin Exp Neuropsychol* 2002 Apr;24(2):221-238. [doi: [10.1076/jcen.24.2.221.993](https://doi.org/10.1076/jcen.24.2.221.993)] [Medline: [11992205](https://pubmed.ncbi.nlm.nih.gov/11992205/)]
13. Gibson MT, Mangat D, Gagliano G, Wilson M, Fletcher J, Bulman J, et al. Evaluation of the efficacy of a redox agent in the treatment of chronic periodontitis. *J Clin Periodontol* 1994 Nov;21(10):690-700. [doi: [10.1111/j.1600-051x.1994.tb00788.x](https://doi.org/10.1111/j.1600-051x.1994.tb00788.x)] [Medline: [7852614](https://pubmed.ncbi.nlm.nih.gov/7852614/)]
14. Kirshner HS. Primary progressive aphasia and Alzheimer's disease: brief history, recent evidence. *Curr Neurol Neurosci Rep* 2012 Dec;12(6):709-714. [doi: [10.1007/s11910-012-0307-2](https://doi.org/10.1007/s11910-012-0307-2)] [Medline: [22932755](https://pubmed.ncbi.nlm.nih.gov/22932755/)]

15. Taler V, Phillips NA. Language performance in Alzheimer's disease and mild cognitive impairment: a comparative review. *J Clin Exp Neuropsychol* 2008 Jul;30(5):501-556. [doi: [10.1080/13803390701550128](https://doi.org/10.1080/13803390701550128)] [Medline: [18569251](https://pubmed.ncbi.nlm.nih.gov/18569251/)]
16. Garrard P, Lambon Ralph MA, Watson PC, Powis J, Patterson K, Hodges JR. Longitudinal profiles of semantic impairment for living and nonliving concepts in dementia of Alzheimer's type. *J Cogn Neurosci* 2001 Oct 01;13(7):892-909. [doi: [10.1162/089892901753165818](https://doi.org/10.1162/089892901753165818)] [Medline: [11595093](https://pubmed.ncbi.nlm.nih.gov/11595093/)]
17. Oulhaj A, Wilcock GK, Smith AD, de Jager CA. Predicting the time of conversion to MCI in the elderly: role of verbal expression and learning. *Neurology* 2009 Nov 03;73(18):1436-1442 [FREE Full text] [doi: [10.1212/WNL.0b013e3181c0665f](https://doi.org/10.1212/WNL.0b013e3181c0665f)] [Medline: [19794124](https://pubmed.ncbi.nlm.nih.gov/19794124/)]
18. Forbes-McKay KE, Venneri A. Detecting subtle spontaneous language decline in early Alzheimer's disease with a picture description task. *Neurol Sci* 2005 Oct;26(4):243-254. [doi: [10.1007/s10072-005-0467-9](https://doi.org/10.1007/s10072-005-0467-9)] [Medline: [16193251](https://pubmed.ncbi.nlm.nih.gov/16193251/)]
19. Fraser KC, Meltzer JA, Rudzicz F. Linguistic features identify Alzheimer's disease in narrative speech. *J Alzheimers Dis* 2016;49(2):407-422. [doi: [10.3233/JAD-150520](https://doi.org/10.3233/JAD-150520)] [Medline: [26484921](https://pubmed.ncbi.nlm.nih.gov/26484921/)]
20. König A, Satt A, Sorin A, Hoory R, Toledo-Ronen O, Derreumaux A, et al. Automatic speech analysis for the assessment of patients with predementia and Alzheimer's disease. *Alzheimers Dement (Amst)* 2015 Mar;1(1):112-124 [FREE Full text] [doi: [10.1016/j.dadm.2014.11.012](https://doi.org/10.1016/j.dadm.2014.11.012)] [Medline: [27239498](https://pubmed.ncbi.nlm.nih.gov/27239498/)]
21. Roark B, Mitchell M, Hosom J, Hollingshead K, Kaye J. Spoken language derived measures for detecting mild cognitive impairment. *IEEE Trans Audio Speech Lang Process* 2011 Sep 01;19(7):2081-2090 [FREE Full text] [doi: [10.1109/TASL.2011.2112351](https://doi.org/10.1109/TASL.2011.2112351)] [Medline: [22199464](https://pubmed.ncbi.nlm.nih.gov/22199464/)]
22. Sajjadi SA, Patterson K, Tomek M, Nestor PJ. Abnormalities of connected speech in semantic dementia vs Alzheimer's disease. *Aphasiology* 2012 Jun;26(6):847-866. [doi: [10.1080/02687038.2012.654933](https://doi.org/10.1080/02687038.2012.654933)]
23. Themistocleous C, Eckerström M, Kokkinakis D. Voice quality and speech fluency distinguish individuals with mild cognitive impairment from healthy controls. *PLoS One* 2020;15(7):e0236009 [FREE Full text] [doi: [10.1371/journal.pone.0236009](https://doi.org/10.1371/journal.pone.0236009)] [Medline: [32658934](https://pubmed.ncbi.nlm.nih.gov/32658934/)]
24. Jarrold W, Peintner B, Wilkins D, Vergryi D, Richey C, Gorno-Tempini M. Aided diagnosis of dementia type through computer-based analysis of spontaneous speech. *Proceedings of the Workshop on Computational Linguistics and Clinical Psychology: From Linguistic Signal to Clinical Reality*; 2014 Presented at: Association for Computational Linguistics; June 27; Baltimore, Maryland, USA p. 27-37. [doi: [10.3115/v1/w14-3204](https://doi.org/10.3115/v1/w14-3204)]
25. Satt A, Hoory R, König A, Aalten P, Robert P. Speech-based automatic and robust detection of very early dementia. 2014 Presented at: Fifteenth Annual Conference of the International Speech Communication Association; Sep 14-18; Singapore.
26. Ahmed S, Haigh AF, de Jager CA, Garrard P. Connected speech as a marker of disease progression in autopsy-proven Alzheimer's disease. *Brain* 2013 Dec;136(Pt 12):3727-3737 [FREE Full text] [doi: [10.1093/brain/awt269](https://doi.org/10.1093/brain/awt269)] [Medline: [24142144](https://pubmed.ncbi.nlm.nih.gov/24142144/)]
27. Khodabakhsh A, Yesil F, Guner E, Demiroglu C. Evaluation of linguistic and prosodic features for detection of Alzheimer's disease in Turkish conversational speech. *J Audio Speech Music Proc* 2015 Mar 25;2015(1):1-15. [doi: [10.1186/s13636-015-0052-y](https://doi.org/10.1186/s13636-015-0052-y)]
28. Pastoriza-Dominguez P, Torre I, Dieguez-Vide F, Gomez-Ruiz I, Gelado S, Bello-Lopez J. Speech pause distribution as an early marker for Alzheimer's disease. medRxiv. Preprint posted online on January 4, 2021. [doi: [10.1101/2020.12.28.20248875](https://doi.org/10.1101/2020.12.28.20248875)]
29. Hernández-Domínguez L, Ratté S, Sierra-Martínez G, Roche-Bergua A. Computer-based evaluation of Alzheimer's disease and mild cognitive impairment patients during a picture description task. *Alzheimers Dement (Amst)* 2018;10:260-268 [FREE Full text] [doi: [10.1016/j.dadm.2018.02.004](https://doi.org/10.1016/j.dadm.2018.02.004)] [Medline: [29780871](https://pubmed.ncbi.nlm.nih.gov/29780871/)]
30. Aramaki E, Shikata S, Miyabe M, Kinoshita A. Vocabulary size in speech may be an early indicator of cognitive impairment. *PLoS One* 2016;11(5):e0155195 [FREE Full text] [doi: [10.1371/journal.pone.0155195](https://doi.org/10.1371/journal.pone.0155195)] [Medline: [27176919](https://pubmed.ncbi.nlm.nih.gov/27176919/)]
31. Hoffmann I, Nemeth D, Dye CD, Pákási M, Irinyi T, Kálmán J. Temporal parameters of spontaneous speech in Alzheimer's disease. *Int J Speech Lang Pathol* 2010 Feb;12(1):29-34. [doi: [10.3109/17549500903137256](https://doi.org/10.3109/17549500903137256)] [Medline: [20380247](https://pubmed.ncbi.nlm.nih.gov/20380247/)]
32. Kourtis LC, Regele OB, Wright JM, Jones GB. Digital biomarkers for Alzheimer's disease: the mobile/wearable devices opportunity. *NPJ Digit Med* 2019;2:9 [FREE Full text] [doi: [10.1038/s41746-019-0084-2](https://doi.org/10.1038/s41746-019-0084-2)] [Medline: [31119198](https://pubmed.ncbi.nlm.nih.gov/31119198/)]
33. Manfredi C, Lebacq J, Cantarella G, Schoentgen J, Orlandi S, Bandini A, et al. Smartphones offer new opportunities in clinical voice research. *J Voice* 2017 Jan;31(1):111.e1-111.e7. [doi: [10.1016/j.jvoice.2015.12.020](https://doi.org/10.1016/j.jvoice.2015.12.020)] [Medline: [27068549](https://pubmed.ncbi.nlm.nih.gov/27068549/)]
34. Sezgin E, Huang Y, Ramtekkar U, Lin S. Readiness for voice assistants to support healthcare delivery during a health crisis and pandemic. *NPJ Digit Med* 2020;3:122 [FREE Full text] [doi: [10.1038/s41746-020-00332-0](https://doi.org/10.1038/s41746-020-00332-0)] [Medline: [33015374](https://pubmed.ncbi.nlm.nih.gov/33015374/)]
35. König A, Satt A, Sorin A, Hoory R, Derreumaux A, David R, et al. Use of speech analyses within a mobile application for the assessment of cognitive impairment in elderly people. *Curr Alzheimer Res* 2018;15(2):120-129. [doi: [10.2174/1567205014666170829111942](https://doi.org/10.2174/1567205014666170829111942)] [Medline: [28847279](https://pubmed.ncbi.nlm.nih.gov/28847279/)]
36. Hall AO, Shinkawa K, Kosugi A, Takase T, Kobayashi M, Nishimura M, et al. Using tablet-based assessment to characterize speech for individuals with dementia and mild cognitive impairment: preliminary results. *AMIA Jt Summits Transl Sci Proc* 2019;2019:34-43 [FREE Full text] [Medline: [31258954](https://pubmed.ncbi.nlm.nih.gov/31258954/)]

37. Kobayashi M, Kosugi A, Takagi H, Nemoto M, Nemoto K, Arai T. Effects of age-related cognitive decline on elderly user interactions with voice-based dialogue systems. 2019 Presented at: IFIP Conference on Human Computer Interaction (Springer); September 2-6; Cyprus p. 53-74. [doi: [10.1007/978-3-030-29390-1_4](https://doi.org/10.1007/978-3-030-29390-1_4)]
38. Yamada Y, Shinkawa K, Shimmei K. Atypical repetition in daily conversation on different days for detecting Alzheimer disease: evaluation of phone-call data from regular monitoring service. *JMIR Ment Health* 2020 Jan 12;7(1):e16790 [FREE Full text] [doi: [10.2196/16790](https://doi.org/10.2196/16790)] [Medline: [31934870](https://pubmed.ncbi.nlm.nih.gov/31934870/)]
39. Matsuda H, Mizumura S, Nemoto K, Yamashita F, Imabayashi E, Sato N, et al. Automatic voxel-based morphometry of structural MRI by SPM8 plus diffeomorphic anatomic registration through exponentiated lie algebra improves the diagnosis of probable Alzheimer Disease. *AJNR Am J Neuroradiol* 2012 Jun;33(6):1109-1114 [FREE Full text] [doi: [10.3174/ajnr.A2935](https://doi.org/10.3174/ajnr.A2935)] [Medline: [22300935](https://pubmed.ncbi.nlm.nih.gov/22300935/)]
40. Procedures manual. Alzheimer's Disease Neuroimaging Initiative 2 (ADNI 2). 2008. URL: <https://adni.loni.usc.edu/wp-content/uploads/2008/07/adni2-procedures-manual.pdf> [accessed 2021-02-02]
41. Dahlbäck N, Jönsson A, Ahrenberg L. Wizard of Oz studies — why and how. *Knowl Based Syst* 1993 Dec;6(4):258-266. [doi: [10.1016/0950-7051\(93\)90017-n](https://doi.org/10.1016/0950-7051(93)90017-n)]
42. Alhanai T, Au R, Glass J. Spoken language biomarkers for detecting cognitive impairment. 2017 Presented at: Proc IEEE Workshop Autom Speech Recognit Underst; December 16-20; Okinawa, Japan p. 409-416. [doi: [10.1109/asru.2017.8268965](https://doi.org/10.1109/asru.2017.8268965)]
43. Farrús M, Codina-Filbà J. Combining prosodic, voice quality and lexical features to automatically detect Alzheimer's disease. arXiv. Preprint posted online November 18, 2020 [FREE Full text]
44. Farrús M, Hernando J, Ejarque P. Jitter and shimmer measurements for speaker recognition. 2007 Presented at: Eighth annual conference of the international speech communication association; August 27-31; Antwerp, Belgium.
45. McFee B, Raffel C, Liang D, Ellis D, McVicar M, Battenberg E. librosa: Audio and music signal analysis in python. 2015 Presented at: Proceedings of the 14th python in science conference; July 6-12; Austin, Texas. [doi: [10.25080/majora-7b98e3ed-003](https://doi.org/10.25080/majora-7b98e3ed-003)]
46. Signal-Analysis. GitHub. URL: https://brookemosby.github.io/Signal_Analysis/ [accessed 2021-02-26]
47. Goldberger J, Hinton G, Roweis S, Salakhutdinov R. Neighbourhood components analysis. *Adv Neural Inf Process Syst* 2004;17:513-520.
48. Breiman L. Random forests. In: Boehmke B, Greenwell B, editors. *Hands-On Machine Learning With R*. Boca Raton: Chapman and Hall/CRC; 2001:5-32.
49. Boser B, Guyon I, Vapnik V. A training algorithm for optimal margin classifiers. In: Proceedings of the Fifth Annual Workshop on Computational Learning Theory. 1992 Presented at: Fifth Annual Workshop on Computational Learning Theory; July 27-29; Pittsburgh, Pennsylvania p. 144-152. [doi: [10.1145/130385.130401](https://doi.org/10.1145/130385.130401)]
50. Stutts JC, Stewart JR, Martell C. Cognitive test performance and crash risk in an older driver population. *Accid Anal Prev* 1998 May;30(3):337-346. [doi: [10.1016/s0001-4575\(97\)00108-5](https://doi.org/10.1016/s0001-4575(97)00108-5)] [Medline: [9663293](https://pubmed.ncbi.nlm.nih.gov/9663293/)]
51. McKnight AJ, McKnight AS. Multivariate analysis of age-related driver ability and performance deficits. *Accid Anal Prev* 1999 Sep;31(5):445-454. [doi: [10.1016/s0001-4575\(98\)00082-7](https://doi.org/10.1016/s0001-4575(98)00082-7)] [Medline: [10440541](https://pubmed.ncbi.nlm.nih.gov/10440541/)]
52. Owsley C, Ball K, Sloane ME, Roenker DL, et al. Visual/cognitive correlates of vehicle accidents in older drivers. *Psychol Aging* 1991 Sep;6(3):403-415. [doi: [10.1037//0882-7974.6.3.403](https://doi.org/10.1037//0882-7974.6.3.403)] [Medline: [1930757](https://pubmed.ncbi.nlm.nih.gov/1930757/)]
53. Payyanadan R, Gibson M, Chiou E, Ghazizadeh M, Lee J. Contextual design for driving: developing a trip-planning tool for older adults. *Transp Res Part F Traffic Psychol Behav* 2017 Apr;46:462-476. [doi: [10.1016/j.trf.2016.08.005](https://doi.org/10.1016/j.trf.2016.08.005)]
54. Donohue MC, Sperling RA, Salmon DP, Rentz DM, Raman R, Thomas RG, et al. The preclinical Alzheimer cognitive composite: measuring amyloid-related decline. *JAMA Neurol* 2014 Aug;71(8):961-970 [FREE Full text] [doi: [10.1001/jamaneurol.2014.803](https://doi.org/10.1001/jamaneurol.2014.803)] [Medline: [24886908](https://pubmed.ncbi.nlm.nih.gov/24886908/)]
55. Duke Han S, Nguyen CP, Stricker NH, Nation DA. Detectable neuropsychological differences in early preclinical Alzheimer's disease: a meta-analysis. *Neuropsychol Rev* 2017 Dec;27(4):305-325 [FREE Full text] [doi: [10.1007/s11065-017-9345-5](https://doi.org/10.1007/s11065-017-9345-5)] [Medline: [28497179](https://pubmed.ncbi.nlm.nih.gov/28497179/)]
56. Smith AL, Chaparro BS. Smartphone text input method performance, usability, and preference with younger and older adults. *Hum Factors* 2015 Sep;57(6):1015-1028. [doi: [10.1177/0018720815575644](https://doi.org/10.1177/0018720815575644)] [Medline: [25850116](https://pubmed.ncbi.nlm.nih.gov/25850116/)]
57. Liu Y, Chen C, Lin Y, Chen H, Irianti D, Jen T, et al. Design and usability evaluation of mobile voice-added food reporting for elderly people: randomized controlled trial. *JMIR Mhealth Uhealth* 2020 Sep 28;8(9):e20317 [FREE Full text] [doi: [10.2196/20317](https://doi.org/10.2196/20317)] [Medline: [32985999](https://pubmed.ncbi.nlm.nih.gov/32985999/)]
58. Stigall B, Waycott J, Baker S, Caine K. Older adults' perception and use of voice user interfaces: A preliminary review of the computing literature. In: Proceedings of the 31st Australian Conference on Human-Computer-Interaction.: Association for Computing Machinery; 2019 Presented at: 31st Australian Conference on Human-Computer-Interaction; December 3-5; Fremantle Australia p. 423-427. [doi: [10.1145/3369457.3369506](https://doi.org/10.1145/3369457.3369506)]
59. Werner L, Huang G, Pitts B. Automated speech recognition systems and older adults: a literature review and synthesis. 2019 Presented at: Proc Hum Factors Ergon Soc Annu Meet; October 28-November 1; Seattle, Washington, USA p. 42-46.
60. Portet F, Vacher M, Golanski C, Roux C, Meillon B. Design and evaluation of a smart home voice interface for the elderly: acceptability and objection aspects. *Pers Ubiquit Comput* 2011 Oct 2;17(1):127-144. [doi: [10.1007/s00779-011-0470-5](https://doi.org/10.1007/s00779-011-0470-5)]

61. Knoefel F, Wallace B, Goubran R, Sabra I, Marshall S. Semi-autonomous vehicles as a cognitive assistive device for older adults. *Geriatrics (Basel)* 2019 Nov 16;4(4):63 [FREE Full text] [doi: [10.3390/geriatrics4040063](https://doi.org/10.3390/geriatrics4040063)] [Medline: [31744041](https://pubmed.ncbi.nlm.nih.gov/31744041/)]
62. Rovira E, McLaughlin AC, Pak R, High L. Looking for age differences in self-driving vehicles: examining the effects of automation reliability, driving risk, and physical impairment on trust. *Front Psychol* 2019;10:800 [FREE Full text] [doi: [10.3389/fpsyg.2019.00800](https://doi.org/10.3389/fpsyg.2019.00800)] [Medline: [31105610](https://pubmed.ncbi.nlm.nih.gov/31105610/)]
63. Depestele S, Ross V, Verstraelen S, Brijs K, Brijs T, van Dun K, et al. The impact of cognitive functioning on driving performance of older persons in comparison to younger age groups: a systematic review. *Transp Res Part F Traffic Psychol Behav* 2020 Aug;73:433-452. [doi: [10.1016/j.trf.2020.07.009](https://doi.org/10.1016/j.trf.2020.07.009)]
64. Rovira E, Pak R, McLaughlin A. Effects of individual differences in working memory on performance and trust with various degrees of automation. *Theor Issues Ergon Sci* 2016 Nov 21;18(6):573-591. [doi: [10.1080/1463922x.2016.1252806](https://doi.org/10.1080/1463922x.2016.1252806)]
65. Pak R, McLaughlin AC, Leidheiser W, Rovira E. The effect of individual differences in working memory in older adults on performance with different degrees of automated technology. *Ergonomics* 2017 Apr;60(4):518-532. [doi: [10.1080/00140139.2016.1189599](https://doi.org/10.1080/00140139.2016.1189599)] [Medline: [27409279](https://pubmed.ncbi.nlm.nih.gov/27409279/)]

Abbreviations

MFCC: mel-frequency cepstral coefficients

MRI: magnetic resonance imaging

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Review

Social Media and Health Care, Part I: Literature Review of Social Media Use by Health Care Providers

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Abstract

Background: As the world continues to advance technologically, social media (SM) is becoming an essential part of billions of people's lives worldwide and is affecting almost every industry imaginable. As the world is becoming more digitally oriented, the health care industry is increasingly visualizing SM as an important channel for health care promotion, employment, recruiting new patients, marketing for health care providers (HCPs), building a better brand name, etc. HCPs are bound to ethical principles toward their colleagues, patients, and the public in the digital world as much as in the real world.

Objective: This review aims to shed light on SM use worldwide and to discuss how it has been used as an essential tool in the health care industry from the perspective of HCPs.

Methods: A literature review was conducted between March and April 2020 using MEDLINE, PubMed, Google Scholar, and Web of Science for all English-language medical studies that were published since 2007 and discussed SM use in any form for health care. Studies that were not in English, whose full text was not accessible, or that investigated patients' perspectives were excluded from this part, as were reviews pertaining to ethical and legal considerations in SM use.

Results: The initial search yielded 83 studies. More studies were included from article references, and a total of 158 studies were reviewed. SM uses were best categorized as health promotion, career development or practice promotion, recruitment, professional networking or destressing, medical education, telemedicine, scientific research, influencing health behavior, and public health care issues.

Conclusions: Multidimensional health care, including the pairing of health care with SM and other forms of communication, has been shown to be very successful. Striking the right balance between digital and traditional health care is important.

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KEYWORDS

social media; social networking; internet; health care; COVID-19; research activity; medical education; telemedicine; mobile phone

Introduction

Background

A key characteristic of being human is the ability and desire for social networking. Over the ages, humanity has thrived in social communities in which members shared knowledge, opinions, and experiences, empowered by a sense of belonging. As the world continues to advance in terms of technology, social media

(SM)—defined as “a group of Internet-based applications (apps) that allow the creation and exchange of user-generated content”—is becoming an essential part of billions of people's lives worldwide and is affecting almost every industry imaginable [1]. The definition of SM (the “read, write web,” “Web 2.0,” or “social networking”) is constantly evolving [2]. The Merriam-Webster Dictionary defines it as “any form of electronic communication through which users create web-based communities to share information, personal messages, ideas,

and other content such as photos and videos” [3]. SM is considered one of the most powerful communication tools of the 21st century. There has been a proliferation of SM tools in recent years, creating new opportunities to communicate, connect, create, and share information, without requiring exceptional coding skills to create or retrieve content [4].

Specifically, SM is increasingly becoming an augmenting tool in health care by enabling its users to acquire and share information; connect with others in the field; and communicate with colleagues, patients, or the public regarding health topics. Furthermore, SM supports patient empowerment by expanding the knowledge of the patients and placing them in a position where they can take control of their own health care needs [5]. This review is based on numerous studies and reviews that have investigated the different uses of SM in health care and its limitations and shortcomings. Consequently, this narrative is comprehensive and up to date, including the recent use of SM during the COVID-19 pandemic. The topic is relevant in today’s scenario because the use of SM and social networking sites (SNSs) is increasing worldwide, especially in the health care industry. The findings presented in this review have strong implications for health care professionals, educators, and researchers.

Objectives

This review aims to shed light on SM use worldwide and discuss how SM has been an essential tool in the health care industry from the perspective of health care providers (HCPs). The review will be continued in Part II, where the use of SM from the perspective of patients will be discussed.

Methods

Search Strategy and Information Sources

Between March and April 2020, a comprehensive search on 4 databases (MEDLINE, PubMed, Google Scholar, and Web of Science) was conducted for all English-language medical studies that were published since 2007 and discussed SM use in any form for health care. A combination of the following keywords was used to search for titles and abstracts: “social media” (MeSH term) OR “social networking” OR “internet” (MeSH term) OR “WhatsApp” OR “Instagram” OR “Facebook” OR “YouTube” OR “Twitter” OR “LinkedIn” AND “healthcare” OR “health” (MeSH term) OR “medicine” (MeSH term) OR “physician” (MeSH term) OR “nursing” (subheading) OR “dentistry” (MeSH term) OR “telemedicine” (MeSH term), “recruitment” OR “education” (subheading) OR “career” OR “behavior” (MeSH term) OR “research” (MeSH term). Each of the 9 words in the first set was separately searched with each of the 12 words in the second set using “AND.”

Screening Process

The articles were entered into an EndNote library, and duplicate publications were removed. Articles published before 2007 were excluded, as the words *social* and *media* at that time did not represent the current definition of SM. Titles and abstracts were assessed for eligibility. Studies that were not in English were excluded, along with those with inaccessible full text after unsuccessful attempts to access them. Irrelevant studies, such

as studies that were not related to health care, studies whose primary outcome was not the use of SM in health care, or studies that discussed the negative impact of SM on health, were also excluded. Dissertations were also excluded from the study. The full texts of the studies were then appraised. Several relevant studies investigating SM use from patients’ perspectives were found. Reviews on legal and ethical issues pertaining to the use of SM in health care were also obtained, following which, the publications were divided into 4 groups: *HCP*, *patient or the public*, *ethics and legal considerations*, and *shortcomings*. A decision was made to defer reviewing the last 3 groups and focus on this review on SM use by HCPs.

Categorization

After accessing the complete texts of the articles of interest, their reference lists were searched for additional studies, and the cited studies were also located. Thereafter, the articles were comprehensively reviewed. On the basis of the key findings, articles were initially grouped as follows: *sharing information*, *recruitment*, *education*, and *marketing*. As the review proceeded and more information was obtained, the groups were modified. *Sharing information* was divided into 2 groups: *health promotion*, focusing on HCPs sharing scientific information with the public, and *critical public health care issues*, which focuses on health announcements in crisis, especially COVID-19–related publications that warrant special attention. *Recruitment* was also divided into 2 groups: *recruitment*, which included job employment and residency program enrollment, and *scientific research*, in which studies discussed recruiting research participants and analyzing SM data. *Education* was renamed *professional medical education*, as this name specifies medical education. Studies related to continuous education were added to *marketing*, and the group was renamed *career development* and *practice promotion*. Another group was created—*professional networking* and *depressing*—which included findings from *sharing information* that discussed peer-to-peer communication and those from *education* that did not reflect professional education or career development. Finally, an additional group was created, *telemedicine*, as studies on this subject were abundant.

Results

Summary and Characteristics of Included Studies

The search yielded 5683 titles that were scanned with their abstracts. After exclusion of duplicates and noneligible studies, the initial sample comprised 73 publications. The full-text papers were retrieved. Additional studies from the article references or those emerged from the review but were not identified earlier were also added. This was because of variation in the keywords with respect to spellings (eg, behavior and behaviour), terminology (social networking and social network), and synonyms (eg, recruitment and employment) that were not accounted for in the initial search. A total of 142 articles (63 original studies) and 3 textbook chapters were reviewed (Figure 1).

The studies were conducted in the United States (61), Canada (12), Brazil (2), the United Kingdom (12), Europe (22), the Middle East (9), India (9), Asia (8), and Australia (7). The

earliest study was published in 2008, and the latest studies were published in 2020, with most of them being published after 2014 (Figure 2).

Figure 1. Flowchart of the selection procedure.

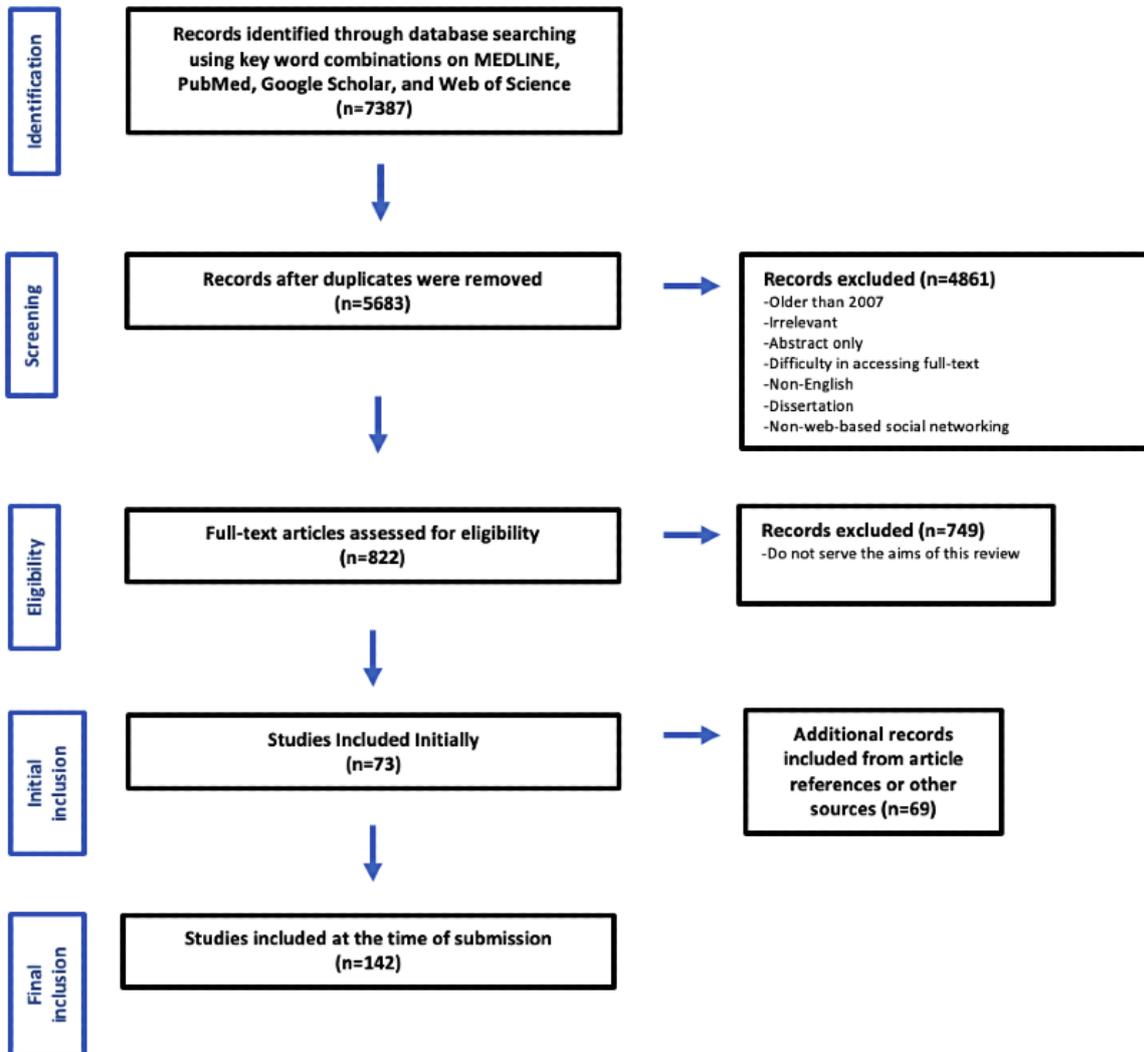
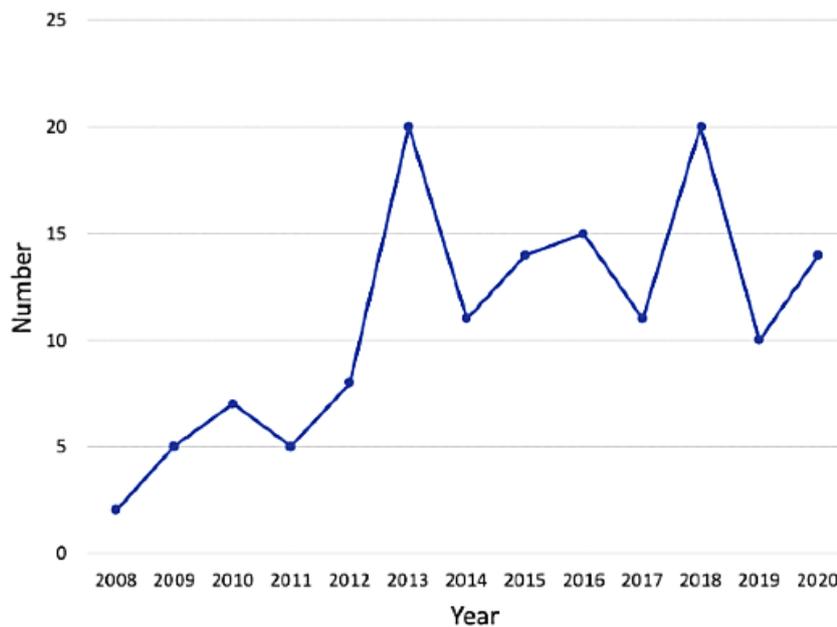


Figure 2. Number of included publications per year.



SM Platforms

Most reviews discussed SM in general and did not specify a particular platform; however, some original studies investigated specific platforms. The platforms investigated were WhatsApp/WeChat (15), Facebook (8), Twitter/Weibo (9), YouTube (4), Instagram (1), LinkedIn (1), Podcast (1), and Wikipedia (1).

Medical Specialties

Some reviews discussed SM use in a particular medical specialty, whereas others reviewed studies from diverse or unspecified specialties. Researchers from a variety of medical specialties investigated SM use in their original studies. These specialties were surgery (1), plastic surgery (4), neurosurgery (1), maxillofacial surgery (2), medicine (2), emergency medicine (2), psychiatry (3), orthopedics (3), otolaryngology (1), immunology (2), dermatology (1), radiology (1), urology (2), anesthesia (1), cardiology (1), pediatrics (1), oncology (3), nursing (5), dentistry (11), and pharmacy (1).

Discussion

Principal Findings

This literature review aimed to examine SM use in the modern world and how it has been recently incorporated into health care. Most of the reviewed articles were published in the past decade, suggesting that this review is both relevant and contemporary. It is evident from the published studies that SM has broad applications in modern health care. As discussed in the subsequent sections, HCPs (the term is used in this review as including physicians, dentists, nurses, medical and dental allied personnel, and health care organizations) not only use SM to provide care to their patients but also for personal development and destressing.

SM Use

SM use is one of the most common web-based activities, with an estimated 2.9 billion users worldwide as of 2019, a number that is projected to increase to 3.4 billion by 2023 [6]. With this, digital networking has witnessed a massive growth, and social communities have become boundless. Facebook, Twitter, Instagram, WhatsApp, and Google are relatively new platforms, but they are being used every day by millions of people worldwide. SM platforms are among the most commonly used sources for acquiring and disseminating information [7,8]. They are not only used for socialization, knowledge acquisition, and entertainment, but they have also been linked to significant political events led by young users [2].

Many SM tools have been introduced, and they continue to evolve. They may be categorized as tools for social networking (eg, Facebook and Instagram), professional networking (eg, Doximity and Sermo), media sharing (eg, YouTube and WhatsApp), content production (eg, Twitter), and blogs [9].

In terms of technological knowledge, SM users belong to 1 of the following 2 groups, as classified by Prensky [10]: digital natives and digital immigrants. Digital natives are those born after 1980, who are skilled in using technology, and who rely heavily on technology and social networking. Most digital

natives were introduced to technology at an early age. Conversely, digital immigrants are those who acquired technological skills and adopted technology later in their careers [9]. SM use is generally high among digital natives, who explicitly prefer it over traditional media [11]. Some researchers believe that there is no dichotomous divide between internet users and nonusers. Although the terms are commonly used, Prensky's model and its usefulness have been challenged [12]. First, basic digital skills are not difficult to acquire, especially with repetitive use. With practice, a person born in the 1960s can become as digitally fluent as a millennial. Second, the distinction between both generations implies that digital immigrants can never completely acquire digital abilities and that digital natives are automatically technologically skilled. This approach is neither scientific nor based on any empirical evidence. Third, the model overlooks the fact that age is not the only factor in determining digital skills. Socioeconomic and cultural factors of digital capability must not be ignored. For instance, a millennial who lacks access to technology is not a digital native.

Regarding SM demographics, its use is prevalent across all ages and professions [13]. However, different SM platforms differ in their demographics. The demographics of some of the most commonly used SM platforms worldwide can be further explored. Facebook has 2.7 billion monthly active users. According to a 2020 report, the highest number of Facebook users were aged between 18 to 29 years and 30 to 49 years, with more female than male users and more urban than suburban or rural users [13]. India had the largest number of users, followed by the United States, Indonesia, and Brazil. Regarding Instagram, there are 1 billion users globally. As of August 2020, there were more female than male users, and the United States had the highest number of users [13]. Users aged between 25 and 34 years represented the largest group of users [14]. Twitter had over 330 million users, who were predominantly male [13]. The top 3 countries for Twitter use were the United States, Japan, and India [13]. Approximately 30% of all users were aged between 25 and 34 years [15]. The Chinese Twitter-like SM platform is Weibo, and it had an estimated 480 million users [16]. WhatsApp is a mobile messaging app that is used by 2 billion users in 180 countries and in 60 different languages [17]. WhatsApp is more commonly used by younger people [17]. WhatsApp's direct Chinese competitor is WeChat, and it has about 1.17 billion users [18]. YouTube is commonly used worldwide, particularly in the United States. It is estimated that it has approximately 2 billion users. The users are more commonly male than female, and its use is prevalent in urban, suburban, and rural locations [13]. Finally, there were about 46 million students and recent college graduates on LinkedIn out of 675 million users [19]. Male users constituted 67% of the total users, and the United States had the highest number of users, followed by India, China, and Brazil.

Although most SM platforms share common features such as free registration, public and private communication, and fast content upload and retrieval, each platform is unique and has distinctive uses. It is common for users to have different accounts across multiple platforms, using each platform for different purposes. Facebook is an SNS that can be accessed

from any internet-enabled device, such as personal computers and smartphones. Registration on Facebook is free, and users can create a profile that reveals selective information about themselves [20]. Users can post text, photos, and multimedia that become available to any user in their *friend list*. Users generally begin by adding family members and friends to their friend list, which can be expanded to include colleagues, acquaintances, and strangers with or without common interests. Apart from being able to share public comments and *likes*, a few years after Facebook was founded, a messaging feature was added that allows users to send private messages to individuals and groups. Users can use a variety of embedded apps; join and create *groups* and *pages*; play games; and receive updates regarding the activities of their friends, pages, and groups. Although the platform was initially limited to students in certain American universities, Facebook now has users worldwide. Instagram is a newer SM platform owned by Facebook and is designed primarily for free photo and video sharing [21]. By modifying their privacy preferences, Instagram users can opt to have either public accounts or limit their content to users that they accepted as *followers*. The platform also allows viewing, commenting on, and *liking* posts shared by users that they follow as well as private messaging between users. WhatsApp, which was acquired by Facebook in 2014, is a text and voice messaging app that has become incredibly popular owing to its features, flexibility, and compatibility with various phone and computer operating systems [22]. Although a free service, WhatsApp allows exchange of messages and calls on both desktop and mobile devices, in addition to media sharing and group features. WhatsApp's objective was to provide an alternative to SMS. Using WhatsApp, billions of users across the globe can simultaneously and instantly connect with others.

"Twitter is what's happening in the world and what people are talking about right now"—this is how Twitter describes itself [23]. It is a microblogging platform that allows users to post and access short text, image, or video posts called tweets. Although tweets were originally limited to 140 characters, the limit was increased to 280 characters in 2018, along with permitting the sharing of website links and multimedia. Twitter's mission is to provide users with the ability to create and share ideas and information instantly and without barriers. Users follow other personal, official, or organizational accounts. They can either create their own tweets or *retweet* those by others to their followers. YouTube is a web-based video-sharing platform that allows users to upload, view, share, rate, report, comment on videos, and subscribe to other users [24]. Its mission is to provide users with a voice through video sharing, stemming from the belief that the world would be a better place when people listen, share, and build a community through their stories. The name of this platform is straightforward: *You* represents content that is user-generated and not created by the site itself, and *Tube* is an older term for television. Most YouTube content is uploaded by individuals, but some media corporations have established partnerships with YouTube to offer some of their materials on this platform. LinkedIn, acquired by Microsoft in 2016, is a business and employment-oriented SM service that operates as both a website and mobile app. LinkedIn is mainly used for professional networking, allowing employers to post about job openings and seekers to share their *curricula vitae*

[25]. Using the platform, users can build strategic professional relationships rather than expand their friend circle. LinkedIn's vision is to provide professional opportunities to its users, and its mission is to connect professionals worldwide. It originated in the living room of one of its cofounders a year before its launch in 2003. LinkedIn today has a diversified business model that has generated successful recruitments.

SM users have claimed that they have more digital friends and connections than real-world ones, which highlights the transformation of the ways in which people connect with each other and the importance of web-based relationships in today's world [26]. Over time, social networking platforms have targeted different age cohorts, making SM use widespread among the general population. For example, as of April 2020, men aged between 25 and 34 years constituted the largest demographic group of Facebook users, and those aged 65 years and older were the fastest-growing group [27,28]. Similarly, the largest group of Twitter users were people aged 25 to 34 years, whereas 15% of users were older than 50 years [15].

The public attitude toward SM use has drastically changed over the years as it became more accessible and diverse in its offerings. Consequently, SM has become a universal communication channel, and responses in reality and on the web have increasingly become intertwined and concurrent [29,30]. Furthermore, SM offers lucrative opportunities to disseminate information and thoughts directly to the public, share experiences, build communities, and connect people with common interests, something unthinkable 20 years ago [31].

SM Use in Health Care

The more digitally oriented the world becomes, the more the health care industry visualizes SM as an important channel for health care promotion, employment, recruitment of new clients or patients, marketing for HCPs, and building a captivating brand name. HCPs have realized that SM is not just a platform to post vacation photos and interact with followers. Perhaps the 4 most common areas where SM plays a major role in the health care industry are health promotion, research, marketing and branding for individuals and practices, and recruitment. It has been evident that web-based content can be spread to offline environments, such as classrooms and meeting rooms. Furthermore, SM has undeniably changed patient-practitioner relationships because of patients' better understanding of health information and their more active role in health maintenance [32].

The effect of behavioral and social factors on health outcomes has evolved significantly in recent decades [33]. HCPs continually search for new and more efficient methods to reach larger populations, especially those who were inaccessible via traditional methods. It is incumbent upon them to use every available tool to reach their intended audience. Thus, HCPs and health organizations should capitalize on the opportunities provided by SM and update strategies to reach communities and age cohorts at a relatively low cost [7,34]. In other words, SM brings a new dimension to health care and is changing the nature and speed of health-related interactions between individuals and health organizations. For example, communicating through photos and videos along with text is

part of the mobile revolution, and messaging apps are now regarded as a viable medium for sharing knowledge and discussing clinical cases [35]. In summary, using SM could be a key strategy in addressing some of the challenges and limitations often faced by HCPs in traditional health communication through faster and cheaper dissemination, more accessibility, better interaction, and increased patient empowerment [7]. Moreover, information can now be easily brought to audiences with special needs or low literacy [36].

In the fast-paced modern world, time constraints are common in medical practice, and when combined with the demands of individuals with chronic conditions or unplanned emergency situations, it is challenging for HCPs to dedicate extra time to patients. SM can provide efficient and easy-to-use platforms that encourage patient-practitioner interaction and facilitate necessary actions from both ends [37]. In fact, as of April 2018, there were more than 200,000 health apps, including social networks for people living with a specific medical condition; approximately 19% of smartphone users have at least one health app on their phones [38]. Furthermore, in a 2013 survey of more than 4000 physicians, 65% stated that they used SM for professional reasons [39]. SM use has not been limited to HCPs. Patients have also incorporated SM in their daily lives, which encourages HCPs to explore different ways of making their mark in this growing market [31].

Technology is evolving very rapidly [40]. Competition produces better services, and the diversity of options enables users to choose a tool that best matches their individual needs. Although different platforms often have different target demographics, audience overlapping may occur and should be considered by health organizations when devising their SM health promotion strategies. In health care, SM tools can be used for different purposes (health promotion; dissemination of health information; education; professional development; recruitment; communication with the public, colleagues, and patients; and research) and in diverse medical specialties (cardiology, nursing, radiology, dentistry, surgery, pathology, pediatrics, pharmacy, emergency, and critical and palliative care) [41]. As of August 4, 2020, 27,546 results appeared when searching for *social media* on PubMed, demonstrating the growing interest in SM within the health care industry.

Health care systems, especially in times of crisis and outbreaks, require the dissemination of information to practitioners, patients, and the general public rapidly and effectively [34]. Health organizations and officials, by taking upon a more active SM presence, gain access to vast global networks capable of quickly spreading information and promptly mobilizing large numbers of people toward public health goals [2,42]. Never before has the entire world united as it has in recent months in its fight against the disease caused by SARS-CoV-2, more commonly known as COVID-19. Searching *COVID-19* on PubMed on August 4, 2020, yielded 37,576 results, which exposes the abundance of information and data that has become available in 7 months since the beginning of the pandemic [8]. However, the World Health Organization (WHO) has expressed concerns about fighting 2 battles at once: the pandemic and the *infodemic*—the latter refers to a rapid and far-reaching spread

of both accurate and inaccurate information about the disease [43].

It is important to mention that the popularity of SM is directly linked to its many advantages. Advantages of using SM in health care include its expressive nature, accessibility from a smartphone, prompt content sharing and response generation, improved and two-sided communication, reduction of consultation time, smoothing of hierarchy, more efficient teamwork, ability to forge connections between people, and ability to reach large masses [44,45]. Furthermore, SM facilitates the access to health information for extended population groups, regardless of geographic location, age, or education, compared with traditional communication methods [41]. However, the most influential advantage of SM remains its cost-benefit feature: it can reach an increasing number of people without the high cost of traditional means and the information remains available 24 hours a day, 7 days a week.

Similar to most technologies, SM has its disadvantages. In the health care industry, these include increased workload, risk of unprofessional behavior, disparity in the sense of urgency, a demanding sense of needing to stay connected 24 hours a day, difficulty in obtaining discussion records, worries about leading to or identifying patients, privacy breach, change of patient-practitioner relationship from a professional to a personal one, and the risk of reducing the autonomy of junior doctors [45]. Those who choose to use SM should be aware of the potential risks and problems that they could encounter but should not shy away from using SM because it can greatly increase the reach and impact of HCPs' work and improve patients' health [34]. In the following section, the specific uses of SM in health care are discussed in more depth.

SM Use From the Perspective of HCPs

The literature review yielded an abundance of information. The studies were categorized as follows to best present the findings: health promotion, career development or practice promotion, recruitment, professional networking and destressing, professional medical education, telemedicine, scientific research, and critical public health care issues.

Health Promotion

Producing and disseminating information has played a pivotal role in the history of humanity. Over the years, an increasing number of public health organizations, medical institutes, and HCPs are using SM tools to disseminate visually rich public health messages to the general public. The primary goal is to share solid, evidence-based, and up-to-date health information that educates and affects millions of SM users and to dispel common misconceptions and counterbalance inaccurate material rapidly spreading through SM [2,32]. Examples of how SM can increase the accessibility of a massive number of recipients to health care information around the world include concise educational tweets on Twitter, a pediatric dentistry group on Facebook where fellow specialists discuss anonymized cases and share ideas, photos of a salvation mission to an underprivileged community on Instagram, and the results of a clinical study broadcasted via WhatsApp. These are all examples of how SM can not only increase accessibility, but it can do so

at a faster rate than any other means, and perhaps in the cheapest way possible.

Access to oral health care services is limited by a lack of universal coverage. SM, which is a method of mass communication, offers an alternative to traditional communication, which extends to reach underprivileged and underserved communities. The WHO and the United States Centers for Disease Control and Prevention (CDC) are among many other public health institutions that use SM to communicate with the public during public health crises and natural disasters [8,29,35]. Physicians also use SM to promote patient health care education on a smaller scale within their networks. Research has shed light on the many tools that have been used for this purpose. For example, HCPs can tweet, record videos, and participate in health-related discussion forums, which provides an opportunity for physicians to share scientific information and broaden their knowledge [46,47]. Furthermore, information from international conferences and findings from the latest research and clinical trials can be presented in mainstream media to be shared with millions of people [48].

Sharing such information not only helps improve knowledge but can also improve attitudes and practices related to health. For example, in dentistry, SM has played a role in helping patients cope with challenges such as dental anxiety and in presenting dental management options in a convenient and nonthreatening manner [42,49]. Evidence now shows that SM-based interventions are linked to healthy practices such as tobacco cessation, increased physical activity, and diversion from risky sexual behaviors [39,50].

In conclusion, there is evidence that SM helps to improve access to health information. When designing SM campaigns and interventions to disseminate health information, it is important to develop messages that may be more likely to resonate with and elicit reactions from individuals [2]. Messages tailored to certain population segments are more effective than generic messages, as tailored messages address the specific needs of their recipients [51]. Furthermore, interactive (two-way) communication is more effective than linear (one way) communication [7]. Importantly, SM must complement rather than replace traditional health promotion. More research is needed to investigate strategies that can increase access to health information for minorities and marginalized communities and for populations deprived of internet access.

Career Development or Practice Promotion

One of the measures of the success of HCPs is their ability to attract and retain patients. This will not only maximize income but will also boost reputation. SM has played an important role in enhancing practice or practitioner ranking on search engines, even more than academic pedigree and experience [52]. As search engines generally direct patients' traffic, a strong presence on the web can be crucial to attract patients to a practice.

HCPs at all stages of their careers can use SM to brand their name. SM aids in developing their name, expanding their network, and learning about career-enhancing opportunities [53]. It can also be used as a marketing strategy to attract

patients of various demographics and has been proven to be effective in engaging and obtaining new patients [54]. In a survey conducted in 2013, 12.5% of health care organizations reported attracting new patients through SM [39]. Moreover, a 2012 study of dental practices in the United States revealed that 51% of the practices used SM, of which 91% used it for marketing purposes and 73% used it to increase their presence on the web [55].

With the extended use of SM among patients and HCPs, practitioners must now compete for patients' attention and need to be strategic regarding the content they share and platforms they use [7]. HCPs should advertise their professional trajectories, areas of experience, and treatment outcomes by focusing on information tailored to the target audience in an educational manner that does not typify commodification or unfair competition. The eagerness to achieve popularity and to attract new customers or compete with colleagues results in some HCPs thinking only with a short-term approach and prioritizing greater financial gains. For example, some orthodontists and plastic surgeons post before-and-after photographs with drastic improvements without explaining that biological variations among patients, differences in response to treatment, and other external factors may affect the course and outcome of the intervention. Without such information, patients tend to have unrealistic expectations and end up being disappointed [56]. Unfortunately, some practitioners tend to digitally modify images to accentuate treatment-led improvements. This misuse of technology could lead to serious reputational damage for the practitioner and the profession in general in addition to unfavorable court decisions [56].

HCPs build their status using SM in diverse ways. They begin by creating a profile page on one or multiple platforms, which allows them to create and upload content. By connecting with colleagues, they can begin to establish a digital social network. Moreover, groups based on common interests further expand their social network and raise the practitioner's name in bigger circles. These processes can create a haven for viral marketing, which can be leveraged to create a name, develop a digital voice, and disseminate health information in a timely and cost-efficient way [7,30,42]. Moreover, for newly qualified practitioners, contributing to discussions on forums and virtual meetings raises their profile among more experienced practitioners who may be geographically distant. This can leverage word-of-mouth referrals and attract fellow researchers to collaborate.

In terms of cost-effectiveness, a 2017 study on the SM return on investment (ROI) showed an upward trend that represented stable growth for Facebook, whereas Instagram demonstrated substantial ROI. It was concluded that SM resources were superior to standard internet-based resources. When all SM platforms were combined into one graph, there was a consistent finding of growth associated with all SM sources over time [57]. As the following quote summarizes, "physicians have to realize that our patients are doing it (SM), so this is where we need to be" [58].

In summary, there is no one-size-fits-all SM platform, and there is no single way to share content that is superior to all others. It is essential for an HCP to emphasize the importance of their

specialty; present the strengths in their particular practice; understand the features and user demographics for SM platforms; and, most importantly, know their target audience. For example, a plastic surgeon or orthodontist may find it beneficial to share pre- and posttreatment or procedure photos of anonymized patients, for which Instagram may be the ideal platform. A practice that is community friendly may invest in a Facebook page to keep the audience updated on offers and services. A family medicine office may share announcements regarding the arrival of a flu-vaccine and post photos of staff members vaccinating themselves to motivate people. Twitter may be useful for posting specialty-related educational messages or sharing information on health-related matters to make HCPs more visible. A pediatric dentist may use YouTube to share videos of tricks used in the office to make the experience less threatening for children. More training courses and talks on how to leverage SM to establish a presence and build a name may be beneficial for HCPs who are not SM savvy.

Recruitment

SM is making great strides not only in the modern world of technology but also in the workplace: it is transforming the way people find and engage in work. It seems that the conventional channels for recruiting employees are not as effective as they once were. Instead, we are shifting toward SM not only as a platform for social interaction, photograph exhibition, and creative expression but also as a space for far-reaching, low-cost job searches. Regarding employment, the interest in SM is bidirectional. On the one hand, employers are often keen to know more about a candidate applying for a position than what is stated in their resume. On the other hand, employees, especially millennials, will first want to know more about the dynamics of a firm and the personalities of their future boss and coworkers before they commit to the job. Recruitment in the medical field requires more than an application. In this section, the recruitment of HCPs for employment or students for residency programs is discussed.

Human capital is of major importance to any organization because humans produce income and are a source of competitive advantage [59]. Recruitment of qualified employees who are fit for the job is not a simple, one-way decision as it used to be. Performing due diligence in hiring a new employee is more essential than ever and is a multidimensional process, including at least one interview, drug screenings, and background checks. More recently, employers have turned to nontraditional methods and to SM to further analyze potential candidates [60]. SM prescreening may have the potential to offer information about the applicant above and beyond what is stated in the resume and can be assessed in a more traditional screening [61]. For job seekers, because of the large number of SM users and the relatively low cost of setting up, SM platforms are ideal for finding employment. Furthermore, many organizations are now investing in SM to display their employer brand and, in return, attract qualified applicants [59,62]. Organizations aiming to attract applicants, especially in fields where competition and demand are high, such as in nursing, must make every effort to promote a unique brand image and attract potential candidates [59,63].

There is evidence that recruiters can accurately determine productivity-related traits solely on the basis of personal information about a candidate available on SNSs [64]. Baert [65] found that personal photographs have become more effective as objects of communication than of memory. This research described interesting theoretical mechanisms that underlie better labor market outcomes for more attractive people. For example, it proposed that self-confidence from good looks could drive productivity, leading to emotional stability, and, consequently, labor market success [66]. The study also found a higher impact of face pictures seen on Facebook's profile photo compared with those attached to a resume [65].

From a job seeker's point of view, SM makes it possible to apply to hundreds of jobs, even globally, at once. Through SM, job applicants can increase their presence on the web to grab the attention of employers [60]. In the health care industry, it is advisable for job seekers to be active in various medical societies to expand their connections and to make a positive impression on future employers. Similar to the real world, it is advisable for applicants to attend virtual conferences and discussion boards and to introduce themselves to others at every reasonable opportunity [67]. It is important to note that employers do not use only professional platforms such as LinkedIn for hiring. In fact, they check many SM platforms when screening for prospective employees [60]. It is not a bad idea that employers and applicants conduct periodic searches for their own names to ensure that their SM persona projects a professional image [2].

Several studies have investigated the effects of SM on recruitment in health care. It was found that a hospital's profile on SM can shape employer brand perceptions and attract nurses. In addition, nurses who visited the hospital's Facebook page were more attracted to work there [59]. In another study, over 92% of employers stated that they were planning to use SM for recruiting [68]. Moreover, a study conducted in 2012 found that the recruitment and screening costs were reduced by 50% by using SM and that 65% of employers were evaluating the integrity and character of potential employees based on their SM profiles [60]. As shown in a review by Davison et al [61], a study found that 20% of the organizations surveyed were planning to use SM for applicant screening. Furthermore, LinkedIn was the most commonly used SM platform for screening applicants, whereas the use of Twitter for screening purposes increased from 11% to 31% between 2011 and 2013 [61]. Interestingly, a study found that there were 38% more job interview invitations to candidates with the most beneficial Facebook pictures [65]. In addition, a Microsoft survey revealed that 79% of employers searched for web-based information regarding prospective employees, but only 7% of the candidates were aware of this possibility [69,70].

Regarding residency programs, SM is a mechanism to accentuate the programs' visibility on the web and to screen residency applicants [71]. It is important to note that it is not only credentials and high scores that secure a spot in a specialty program; personality traits and characters are becoming more significant than ever. Program directors (PDs) now want to know applicants on a personal level. As much of this information would be illegal to obtain in a traditional interview, they may

search for it on SM [72]. Admission officers and PDs are now capitalizing on the abundance of information and the popularity of SM [72]. They may encounter content that seems unprofessional or exposes negative character traits that are useful in making decisions about applicants. Many residency programs now search Facebook and other personal SM platforms to screen applicants [73]. Even residents are now using SM platforms to obtain information on possible postgraduate opportunities [71].

There is an abundance of research on the use of SM for applicant selection in residency programs. In one study, 17% of PDs screened applicants on SM, 33% gave lower rankings to applicants based on SM findings, and 69% stated that they will continue to use SM for applicant screening [74]. In another survey, most school children who were interested in studying medicine felt that behaviors on SM should be considered for admission to medical schools [75]. Furthermore, a study conducted in 2016 found that 18% of PDs visited the SM profiles of residency applicants, 10% gave a lower rank or completely disqualified an applicant because of negative web-based behavior, and 10% took formal disciplinary action against a resident because of negative web-based behavior, with Facebook being the platform used by most PDs [76,77]. Another survey found that 97% and 90% of PDs agreed that candidates should be held accountable for illegal acts and unprofessional behavior on the web, respectively, whereas 89% of them agreed that information voluntarily published on the web is fair to use in judging character and professionalism. Furthermore, 82.4% of PDs indicated that they would favor the candidate with a sterile Facebook profile if they were choosing between 2 mock candidates [78]. Moreover, student pharmacists demonstrated a general attitude that web-based personas on SM should not be used to judge professional attitudes and abilities [79]. Although most medical school PDs believed that screening applicants on SM does not constitute a violation of the applicants' privacy, the topic remains controversial and views regarding the appropriateness of using SM profiles to judge character and professionalism vary [78,80]. There is general agreement that SM information is open for judgment by others, especially among older PDs [78].

Professionalism is advocated by the American College of Surgeons as a quality that extends beyond the clinic, operating room, and hospital and into the community in the real world and on the web [81]. There are some issues associated with using SM to judge a possible employee's or resident's professionalism and character. First, screening is usually done by a single person without a standardized scoring rubric. Second, content is unstandardized among the different SM platforms, and the information displayed differs across platforms; for instance, it would not be fair to compare someone's Facebook photo album of a Spring Break trip with someone's contribution to a medical discussion on Twitter. Moreover, screening SM content showed poor test-retest reliability, especially as the content could change rapidly. Interrater reliability is potentially affected by the content being rated and the characteristics of the rater. Construct validity also seems to be weak as no specific construct is usually in mind; instead, a rater casually scans profiles to make a judgment on an applicant or screen potential new hires. Finally, there is a problem with generalizability across

platforms. It is suggested that personality traits should be judged from platforms with flexible formats (eg, Facebook), whereas professional traits and experiences should be judged from more structured platforms (eg, LinkedIn) [61].

In summary, although e-professionalism is a new topic, it is receiving considerable attention from recruiters and is being taught as a part of medical curricula [76,79,82,83]. It is necessary in this age to educate job or residency candidates about their digital voice and persona management [65]. Job or residency candidates should consider their publicly available web-based information as an extension of their resume' and should be aware that many employees use SM to investigate applicants. Therefore, candidates should ensure that their public SM profiles include nothing unprofessional about themselves [65,67]. Finally, the establishment of clear and equitable guidelines for searching candidates on SM is essential to prevent potential bias.

Professional Networking and Distressing

Professional connections represent important channels through which HCPs exchange knowledge, share expertise, refer patients, seek a second opinion, collaborate on research, hire and employ, provide social support, and improve health care outcomes. In the last few years, work-related communication has changed considerably with the advent of electronic communication tools, especially with the aid of instant messaging on smartphones [30,84]. Virtual professional communities can enable members to quickly access evidence-based information and disseminate work, which can lead to increased immediate impact [85,86]. Most SM platforms are found to be easy to implement, effective, quick, and low cost [87]. In a recent systematic review, positive predictors for using SM among HCPs were identified to be younger age, lower rank, and fewer years of experience, and the most commonly used platforms for communicating with colleagues were Facebook, Twitter, LinkedIn, and WhatsApp [88].

Owing to the exceedingly large number of HCPs on SM, platforms that are designed only for medical personnel have been introduced. Digital communication and social interactions occur between people who may or may not be known to each other [44]. In addition to medical issues, discussions usually address diverse subjects such as politics, practice management, career enhancement opportunities, and even dating in a medical environment [2,89]. Sermo, the world's largest virtual doctors' lounge, is a leading social network for physicians that is now available in 30 countries [90]. Doximity is a newer physician-only social networking platform with more than 500,000 members as of 2020 [91]. In addition, there is the Medical Directors Forum, which is an SNS exclusively for medical directors that provides a secure environment for peer-to-peer interaction [92]. Studies on HCPs' preferred SM platform showed that Facebook was used most frequently (86%). Other commonly used platforms were Medscape Physician Connect (52%), Sermo (44%), LinkedIn (42%), YouTube (40%), Blogging (25%), and Twitter (20%) [26]. These statistics have been confirmed in subsequent studies [32]. For health-related reasons, physicians primarily used LinkedIn (70.7%) and Twitter (51.2%) [32]. Another study reported that HCPs spent an

average of 11 to 13 hours per week on medical professional networking sites [26].

WhatsApp has been used as an intradepartmental, patient-related communication method because of its instant and more efficient handovers [93]. When physical proximity was a barrier, physicians preferred to use WhatsApp to exchange work-related knowledge over traditional text messages [84]. The American Academy of Pediatric Dentistry has a private group on Facebook with fewer than 3800 members who share clinical cases, clinical experiences, research results, new products, and relevant events [9]. Facebook has many other groups for dentists that are open to the public to view and join [30]. Microblogs such as Twitter allow a dynamic and concise exchange of information that is instantly accessible by an increasingly large number of readers [89]. Furthermore, the dissemination of scientific literature on SM (eg, Twitter) has increased the number of citations and downloads of published articles [94-96]. LinkedIn serves as a professional space for HCPs to demonstrate their expertise and capabilities; 54% of physicians have used it to communicate with colleagues [32,42].

SM also has a positive impact on students. The sense of belonging is crucial for undergraduate training. By being part of a well-respected learning environment, students benefit educationally and socially [97]. Moreover, having guidance and support on a 24/7 basis can ease their transition from university to more independent training centers [30].

In recent months, SM platforms have become helpful in maintaining communication with friends and family and reducing isolation and sense of loneliness, which could have a negative psychological impact [98]. Amid the COVID-19 pandemic, many practices have been affected and many jobs have been lost worldwide [99]. The sense of unity and comradery introduced by SM among users has helped countless individuals overcome hardships, including HCPs. In the first half of 2020, HCPs were deployed into unfamiliar environments because of the COVID-19 pandemic, worked beyond their areas of expertise and over long hours, and had to involuntarily isolate themselves from their families. This crisis has been anxiety inducing and stressful for HCPs, who often resorted to SM to voice their frustrations, experiences, and opinions not only with family and friends but also with the global network of frontline staff enduring similar challenges. The unique virtual siblinghood united the global health care community like never before. A Facebook page was created to facilitate the renting of recreational vehicles for HCPs to self-isolate outside their homes [100]. The public played an important role in paying due respect to HCPs, who were often referred to as heroes, both literally and figuratively. Illustrations portraying their pivotal role were shared on every known SM platform. Videos showing countless people applauding for HCPs at certain hours of the day went viral. Many HCPs engaged in what was labeled as *COVID-19-free zones* to escape, even if momentarily, from the pandemic stress. Clinicians from all specialties in diverse locations joined forces against a single enemy. Their voices echoed louder when they addressed lawmakers demanding improved access to personal protective equipment (PPE), increased testing for COVID-19, reduced reimbursement barriers to telemedicine, and improved mental health care.

To conclude, SM plays an important role in the lives of HCPs at a personal level. Whether SM is used for amusement, *zoning out*, or commiserating, it provides a safe haven for HCPs to put off their metaphoric heroes' capes and find comfort in their humanity again. Future research should investigate the role of SM in helping HCPs individually and collectively tackle the challenges resulting from the COVID-19 pandemic.

Professional Medical Education

Millennial students of health professions are increasing in numbers each year. They possess qualities consistent with being lifelong learners [71]. As Prensky [10] discussed, traditional education systems are no longer suitable for contemporary students. Millennials and younger generations process information in a fundamentally different manner from their predecessors. SM offers formal and informal educational opportunities and has the ability to remove physical barriers that could otherwise impede access to educational resources [51]. Not only is SM rich in educational resources but coupling the information with the interactive exchange of ideas and the live discussions has also made it a valuable educational tool. When SM was integrated into teaching, students were motivated by content obtained from SM, and positive behavioral changes were promoted [101]. Moreover, when SM was incorporated into clinical education, students perceived better collaboration with their peers, improved professional and career development, and larger supportive learning communities [102].

Social networks are an underutilized educational resource, not only for trainees but also for experienced clinicians. A large array of educational material is abundant on SM from seniors with advanced experience and from fellow trainees as well, usually at no cost to the user [30]. The differences between experts and novices are slowly diminishing because of novel forms of peer learning and knowledge production facilitated by SM [35]. Most platforms are frequently used to engage learners. YouTube in particular is more commonly used to teach technical skills and has been acknowledged by dentists as a convenient educational platform [30,71,103,104]. YouTube can also be used in classrooms to forge discussion, illustrate a procedure, or reinforce information, which promotes critical thinking and problem-solving skills [70]. A study conducted in Saudi Arabia found that YouTube was the most commonly used SM platform in medical education [105].

Evidence suggests that SM has a place in health care education. Universities use SM to create virtual classrooms and increase access to academic libraries [70]. In the United States, 95% of medical schools have some Facebook presence, and 71% of them have student groups [106]. In a study on nursing students, Twitter was used to view videos of clinical scenarios, and students tweeted their observations for instructor feedback [70]. Internet and SM content have been successfully used to train older caregivers to improve the caregivers' and patients' quality of life [5]. In a unique experience, the University of Rhode Island managed to connect students to geriatric patients on Facebook. It promoted students' empathy and communication skills while helping patients advance their SM skills to battle loneliness [2]. In addition, students in an oral and maxillofacial radiology course perceived using Twitter as a helpful learning

tool that enhanced access to faculty [107]. Moreover, medical students and professionals in cardiology reported the use of social networks for education and professional training [103].

Learning may be considered a social activity [106]. The more senses the students stimulate in their learning process, the more likely the information acquired is to be retained. Thus, the greater the engagement and contribution of the students, the better the learning outcomes. SM provides a medium for active collaboration rather than passive learning. In nursing, 92.4% of students perceived a positive learning impact from the podcasting of lecture materials [108]. In another study, students who were more heavily engaged in blog-based discussion of relevant learning material had higher grades than peers who had contributed less to the discussion [109]. Passing an examination was significantly associated with combining discussion on a WhatsApp group with the web-based question bank, and so were their higher grades [110]. Medical students who used Wikipedia had superior short-term knowledge acquisition compared with those who used a digital textbook, which suggested a potential role for Wikipedia in medical education [111]. In addition, medical students who integrated the use of SM in 2 elective courses were satisfied with the new approach [112]. Twitter and Instagram have also been described as helpful tools in radiology education [113]. Participants in a study reported that SM was perceived as helpful and very helpful for improving knowledge, creativity, decision making, critical skills, and problem-solving abilities [114].

In a study by Alsuraihi et al [105], YouTube, Facebook, and Twitter were among the most commonly used resources for learning. Although 95.8% of the students believed that SM was beneficial for learning, 40% thought it might be distracting [105]. In a review by Chan et al [85], it was found that multiple residencies used SM to broaden the horizons of trainees and facilitate engagement in journal clubs using virtual classrooms; a wide range of SM platforms were featured, including Facebook, blogs, Wikipedia, and podcasts. Specifically, dermatologists in a study agreed that WhatsApp discussions enriched their scientific knowledge of clinical cases and promoted learning about relevant references and upcoming meetings [115]. Participants of a 2015 study on surgical teams expressed that WhatsApp helped to flatten the hierarchy among students, residents, and experienced consultants, enabling them all to actively contribute to discussions without inhibition. This comfortable environment is especially helpful for shy and marginalized students [116].

Once students move beyond structured, supervised learning environments, they must recognize their own gaps in knowledge and skills over time and make every effort to fill them, adopting skills for lifelong learning [106]. The increasing mutability of knowledge in the digital age and its exchangeability and accessibility on mobile phones make learning through SM platforms a common practice for many medical students [35,117]. However, learning cannot be done through SM alone but is used to augment learning from textbooks, peer-reviewed research publications, and mentors, and just like with other sources of information, critical appraisal to information retrieved from SM must be applied; this is what lays the foundation for a future competent web-based learner [85,106,118]. It is

important that students understand that educational material shared through SM cannot be accepted as is without a great degree of skepticism and objective evaluation.

To summarize, today's students are unique in how they learn and acquire skills. Current educational systems must adapt to the needs and qualities of modern students and augment, if not replace, the traditional teaching methods with more digital means. It is essential for educators to put every effort in determining the best means of presenting information to their students and guiding them in their information search and appraisal. Retrospective research can be planned to compare the performances, learning outcomes, and teaching strategies between 2 student cohorts: those that were taught in a traditional manner and those that relied on SM.

Telemedicine

As people are becoming increasingly fluent in using novel technologies, health care has recently changed when, where, and how patients and HCPs communicate [119]. Telemedicine is the use of communication technologies and electronic information to provide health care support to patients or health care workers who are physically distant from HCPs [120]. Many branches of medicine are now adopting electronically mediated care; terms such as teledentistry and telepsychiatry are not uncommon, and publications related to telemedicine have been increasing [121-123]. Among the specialties that use telemedicine are pediatrics, psychiatry, diabetes, dentistry, nursing, palliative care, and allergies [124-130]. HCPs can now overcome their limited clinical time by communicating with their patients remotely. With the aid of novice technology, they provide a more convenient type of care for patients, especially for following up patients with chronic health care needs [131].

As young and highly qualified HCPs prefer staying in urban communities, telemedicine significantly augments clinical care, especially in underprivileged and underserved communities in rural areas [2,82,132,133]. Furthermore, as health care costs continue to increase, organizations are aiming to reduce costs without jeopardizing the quality of care being provided [134]. Recruitment and workforce sustainability are often an issue, and some countries with large, sparsely populated rural areas have grappled with how to overcome medical and dental provider shortages in these rural areas. Telemedicine and teledentistry can be of great use to ensure that new practitioners appointed in rural locations are not secluded and have the advice and support they need to promote their clinical work and psychological well-being [135]. It may also be used to connect HCPs in third-world countries with specialists in more medically advanced regions; for example, surgical procedures may be streamed live, and questions can be asked in real time [69].

Smartphones are fast, portable, and simple to use; mobile apps now seem to be ideal for quick learning or communication between colleagues or HCPs and the public or patients. Mobile apps are among the most commonly used tools for telemedicine [82]. Globally, but particularly in low- and middle-income countries, communication among HCPs is facilitated via WhatsApp, providing faster diagnosis and immediate management of acute findings [136-138]. A systematic review on telehealth concluded that 74% of the studies reported

economic benefits of eHealth interventions for different medical conditions [134].

Programs for electronically monitoring intensive care units allowed HCPs to remotely monitor the conditions of up to 100 patients in multiple hospitals [139]. Pandemics and natural disasters pose challenges to effective and prompt health care delivery. Although telemedicine and eHealth might not solve them all, they can aid HCPs in providing the necessary management in scenarios in which the infrastructure is intact. In recent weeks, the distant triage that allowed patients to be efficiently screened for COVID-19 was patient centered and in compliance with self-quarantine; thus, it protected patients, clinicians, and the community from exposure to the virus [139]. For instance, replacing scheduled office visits with telemedicine visits in case HCPs were quarantined, absent, or sick was a productive initiative at Jefferson Health, Philadelphia, Pennsylvania [139]. An interesting model of telemedicine was explained by Baker and Stanley [40], in which patients use an app to navigate to a specific medical site, answer a few triage questions about their medical condition, wait in a virtual queue to be connected by video to an HCP, and discuss their condition or concern.

Sending clinical photographs privately between colleagues for a second opinion or to enrich discussion is not uncommon. A comprehensive review by Boulos et al [35] shares findings from multiple studies on the use of WhatsApp and Instagram in those contexts. One study found excellent inter- and intraobserver agreement in the assessment images of tibial fractures using WhatsApp [140]. There was a report of a life-saving use of WhatsApp in a resource-limited situation in which the life of a critically ill patient was saved by sending clinical monitor images with electrocardiogram changes and receiving feedback from an expert consultant who was 40 km away from the center where the patient was admitted [141]. Moreover, evaluating maxillofacial computed tomography scans using WhatsApp has been reported to be easy and rapid [142]. WhatsApp was also useful for communication between emergency department consultants when they were not onsite [143]. In dentistry, a study showed that 67.32% of dentists used WhatsApp to send clinical images to colleagues seeking second opinions, and 35.29% of them did so on a weekly basis. About 60.29% of the dentists received a prompt response, whereas 38.23% received delayed responses. In addition, about 98.52% of dentists sent radiographs on WhatsApp for a second opinion [144].

In conclusion, it is noteworthy that telemedicine is not a *practice in and of itself* [145]. It is not the most suitable model of care for every patient and is not the preferred approach when physicians cannot meet clinical standards of care. Patients using telemedicine must also have access to traditional emergency care, if needed. Although these innovations have significant potential benefits, the electronic exchange of health information and care may pose risks to patients' privacy, confidentiality, and safety and to quality and continuity of care. Furthermore, the limitations of electronically mediated physical examination may weaken the relationship between patients and HCPs, thereby jeopardizing care [119]. High-quality research is needed to improve the utilization of telemedicine, and more

well-designed studies comparing telemedicine with traditional patient care are essential.

Scientific Research

The perceived benefits of using SM in health care include the ability to connect with geographically distant researchers and to build and foster research communities [4]. SM is a potential tool to revolutionize health research, as it has fewer temporal and spatial limitations and can overcome boundaries between research communities and the public [146,147]. SM can aid research in several ways: by recruiting participants, disseminating surveys, connecting with fellow researchers, identifying research opportunities, sharing study findings, and gaining access to published work.

There are conveniences in taking scientific research to the digital world. Publishing study findings on SM provides enhanced dissemination of research and increases the access to valid evidence-based information for patients. Furthermore, because not all studies end in a publication in a traditional journal, their findings can thus be shared via SM to a wider audience and be of substantial value to a broader research community [4]. Another advantage of SM for scientific research became evident during the COVID-19 pandemic, which made it possible to break geographical barriers and arrange collaborative research projects, surveys, and multicenter studies [8]. Sites such as Google Scholar and ResearchGate create communities for researchers to network, collaborate with each other, and promote publications [53,148]. The anonymity of posts, not having to answer questions in the presence of others and acquiring large samples that attenuate the effect of false information or extreme views were viewed as advantages unique to SM surveys and possible factors that improve research accuracy [146]. Content posted on the web may be used as data for research without interacting with the authors of the content, and perhaps without even considering them to be *human subjects* [146]. Moreover, compared with traditional recruitment methods, web-based surveys have the ability to store large numbers of responses, which can be easily accessed for analysis [5].

Recruiting research participants on SM has gained popularity in recent years. In a review by Lafferty and Manca [4], it was found that the most common tools used for recruiting participants were Facebook, Twitter, and a combination of both. Snowballing sampling method involves participants themselves recruiting more participants by contacting people in their networks [149]. A study on 8252 participants found that web-based recruitment was more efficient and had lower costs per recruited participant compared with traditional methods [150].

Disseminating surveys on the web is now a common practice. One study chose SM platforms to send its survey because it was cost effective, time saving, and easily accessible [151]. In another dentist or patient study, the survey for dentists was distributed via a dentist-only Facebook group that had more than 4500 members; for patients, the survey distribution was mainly through Facebook, LinkedIn, and Twitter, and the recipients were asked to share it with their connections [42]. Furthermore, in a study involving health care quality personnel, the survey was distributed through WhatsApp [114]. In a study

in Saudi Arabia, the link to the web-based questionnaire was made available through Twitter and Facebook, the 2 most popular SNSs in the country [152]. Over half of university students strongly or somewhat liked using Facebook for research conducted by university researchers [153]. Zaballos et al [154] developed a web-based multiplatform that integrated WhatsApp and emails to assess the quality of life of individuals with hearing loss issues; the tool facilitated data collection in an easy-to-use platform.

A review by Topolovec-Vranic and Natarajan [155] showed that 40% of the studies found SM to be the most effective recruitment method, whereas 50% of them stated that their target population was *hard to reach*. Approximately 43% of the studies reported cost-effectiveness [155]. In addition, SM helped in recruiting a large number of individuals and reached challenging populations such as adolescents and young adults. Another review found that traditional recruitment methods tend to underrepresent users of marijuana, ecstasy, cocaine, or alcohol or people with at-risk sexual behavior; in comparison, Facebook recruitment yielded more representative results [156].

Researchers who plan to recruit participants on SM must consider their target populations' SM use patterns and preferences. For example, a study on sexual health might consider dating sites for recruitment, whereas Facebook may be more suitable for a nonsexual health study [157]. To best tailor recruitment campaigns, the selection of hashtags or keywords that reflect the interests of the target population might be useful [45].

Regarding shortcomings, it is important to note that research participants recruited from web-based environments may not truly represent the population of interest as a whole, suggesting that SM should only augment traditional recruitment methods [4]. A study suggested that people with disabilities may disproportionately be living in conditions with lower standards of living and may not have access to the internet [158]. In another study, subjects recruited from SM were largely middle class, whereas those recruited at a local hospital were more disadvantaged [159]. A review by Whitaker et al [156] showed an overrepresentation of young White women resulting from web-based recruitment.

Other limitations of using SM for research include that researchers have little control over distractions, the research idea may be copied, or participants may share research information with other participants, which puts the scientific integrity of the study at risk [4]. In a review by Denecke et al [5], the most reported ethical concerns for using SM for research recruitment were self-selection—that is, users with an interest in the study area will be recruited preferentially, which will affect the representativeness of the sample—and a skew toward well-educated and higher socioeconomic status cohorts on the web [5].

Ethical and privacy concerns regarding SM for research recruitment must be addressed because tracking, profiling, and targeting of users are common in the digital world [45]. Bender et al [160] proposed privacy-enhanced SM recruitment guidelines, including proactive measures to protect privacy and declaration of potential risks. Vulnerable groups such as children

and teenagers, homosexuals in regions where homosexuality is illegal, and individuals with mental illnesses require extra emphasis on respect, confidentiality, and caution in obtaining consent [146].

To summarize, there is growing evidence to suggest that SM is a useful research tool that enables researchers to connect with each other, recruit participants, and share their findings with the public. Moreover, the data obtained from SM can be investigated. Nevertheless, researchers must not overlook the shortcomings of SM that may ultimately debilitate the integrity of the study. Privacy concerns and ethical considerations must also be considered. The development of guidelines for ethical conduct in web-based research should be based on the best available practices and should be comprehensive and standardized to minimize a study's error margin. Future studies that compare different recruitment methods and varying participant demographics recruited using various methods should be encouraged. Research investigating the cost-effectiveness of SM research and those with large sample sizes that enable the generalizability of findings is also recommended.

Critical Public Health Care Issues

SM can be used by emergency notification systems to mass communicate information to large groups in a fast and low-cost manner. Studies have shown that SM can be a source of data to detect outbreaks, infection distribution, and areas of acute health care needs [29]. It can also help understand the public's knowledge, fears, attitudes, and behaviors during a crisis [161-163]. For example, the Red Cross tracks Twitter posts during natural disasters, such as hurricanes and earthquakes, to assess where the greatest needs lie [50,164]. Perhaps one of the first publications investigating SM use during a pandemic is a study that analyzed tweets posted during the 2009 H1N1 outbreak; this study found that SM can be a useful tool for disseminating information and for the public to share their opinions and experiences [165]. Twitter posts were also helpful in monitoring disease activity during the cholera and influenza outbreaks [166,167]. When interaction and collaboration were essential, as with the influenza A-H1N1 pandemic, SM provided an unmatched opportunity to engage the public and was used by prominent health organizations such as the WHO [7,41]. However, coordination between web-based and real-world response activities is also important [29].

Perhaps there is no more powerful example of SM use during a health crisis than what has happened during the COVID-19 pandemic. The dissemination of information during a pandemic has never been this quick and effective in the past. Information on the virus spread as quickly as the virus itself and dominated conversations on SM. On March 11, 2020, there were more than 20 million mentions of coronavirus-related terms on SM [168]. Since the beginning of the outbreak, SM has been one of the most commonly used communication channels by international health organizations such as the WHO and the CDC to possibly disseminate information to every person on earth with access to SM. Thousands of smaller health authorities may have also used SM to communicate with local communities. Although traditional access to medical guidelines and policies often requires some form of affiliation or membership, it is available

to internet users today with a tap on a keyboard or a finger slide on a smartphone. The distribution of PPE, sharing treatment protocols, clinical trial results, and allocation of medical resources have been efficient with the aid of SM [8]. A recent study evaluated the 100 most viewed *coronavirus* videos on YouTube; as of March 5, 2020 (very early in the pandemic), these videos had 165 million views [169]. Another study in China collected data from 250 million Weibo users, a Twitter-like SM platform. Posts mentioning symptoms or diagnoses significantly predicted daily case counts ahead of the statistics announced by officials in Hubei Province, the epicenter of the initial outbreak, and the rest of China [170].

Perhaps the founders of Twitter did not expect it to become a helpful tool in the fight against COVID-19. For example, using Twitter, a cardiologist was able to expedite the delivery of a drug to a COVID-19 patient within just 6 hours of his tweet [171]. The American Heart Association launched a registry on Twitter to aggregate COVID-19 cases to better understand risk factor profiles and treatment algorithms [171]. Hashtags such as #GetUsPPE highlighted the scarcity of PPE, resulting in technology pioneers ramping up their production of PPE [171]. After calls were raised on Twitter and other SM platforms, HCPs flew to other parts of their countries that were in crisis, retired clinicians volunteered to rejoin the work force in several countries, and those who were unable to be present helped colleagues through telemedicine. Another example of SM use during the pandemic is the COVIDBRONCH Initiative—an international network of airway specialists who foster rapid acquisition and dissemination of knowledge regarding airway procedures during the pandemic [172].

Despite its catastrophic impact and the substantial loss of lives, humans will overcome the existential threat brought by COVID-19 and will also likely overcome future pandemics. Over time, humans have survived environmental, biological, and man-made calamities because of their innate adaptability, resilience, innovativeness, and persistence. Today, humans use SM to disseminate information quickly and to a large number of people, thus eliciting an almost immediate response. More research is already taking place and will continue to investigate the key role of SM in the fight against pandemics, not only from a medical perspective but also from social and economic viewpoints.

Conclusions

This review provided an overview of the different uses of SM in health care. It is evident that SM use indicates not a trend but a fundamental shift in how people communicate today. Multidimensional health care, which includes SM and other forms of communication, has been shown to be highly successful. Not only can SM be used to improve direct patient care but it can also be used to increase the public's knowledge, facilitate research, connect HCPs, improve medical education, and combat public health crises. However, striking the right balance between digital and traditional health care is imperative. As SM is a relatively recent phenomenon, further research is needed to determine its long-term effectiveness and to identify the best strategies for maximizing its advantages and limiting risks. This review will be continued in the second part, in which the use of SM from patients' perspectives will be discussed. This discussion will be supplemented with specific barriers, ethical considerations, and disadvantages reported in the extant literature.

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Conflicts of Interest

None declared.

References

1. Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons* 2010 Jan;53(1):59-68. [doi: [10.1016/j.bushor.2009.09.003](https://doi.org/10.1016/j.bushor.2009.09.003)]
2. Ventola CL. Social media and health care professionals: benefits, risks, and best practices. *P T* 2014 Jul;39(7):491-520 [FREE Full text] [Medline: [25083128](https://pubmed.ncbi.nlm.nih.gov/25083128/)]
3. Dictionary M. Merriam-Webster. Social Media. URL: <https://www.merriam-webster.com/dictionary/social%20media>
4. Lafferty NT, Manca A. Perspectives on social media in and as research: A synthetic review. *International Review of Psychiatry* 2015 Mar 05;27(2):85-96. [doi: [10.3109/09540261.2015.1009419](https://doi.org/10.3109/09540261.2015.1009419)]
5. Denecke K, Bamidis P, Bond C, Gabarron E, Househ M, Lau AYS, et al. Ethical Issues of Social Media Usage in Healthcare. *Yearb Med Inform* 2018 Mar 10;24(01):137-147. [doi: [10.15265/iy-2015-001](https://doi.org/10.15265/iy-2015-001)]
6. Statista. Number of social network users worldwide from 2017 to 2025. Statista. URL: <https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/> [accessed 2020-07-23]
7. Levac JJ, O'Sullivan T. Social Media and its Use in Health Promotion. *RISS-IJHS* 2010 Feb 10;1(1):47. [doi: [10.18192/riss-ijhs.v1i1.1534](https://doi.org/10.18192/riss-ijhs.v1i1.1534)]
8. González-Padilla DA, Tortolero-Blanco L. Social media influence in the COVID-19 Pandemic. *Int. braz j urol* 2020 Jul;46(suppl 1):120-124. [doi: [10.1590/s1677-5538.ibju.2020.s121](https://doi.org/10.1590/s1677-5538.ibju.2020.s121)]
9. Dhar V. Social Media and Its Implications in Pediatric Dentistry. *Pediatr Dent* 2018 May 15;40(3):174-176. [Medline: [29793562](https://pubmed.ncbi.nlm.nih.gov/29793562/)]

10. Prensky M. Digital Natives, Digital Immigrants. Prensky. 2001 Oct 23. URL: <https://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf> [accessed 2020-10-23]
11. Tkalc Verčič A, Verčič D. Digital natives and social media. *Public Relations Review* 2013 Dec;39(5):600-602. [doi: [10.1016/j.pubrev.2013.08.008](https://doi.org/10.1016/j.pubrev.2013.08.008)]
12. Helsper EJ, Eynon R. Digital natives: where is the evidence? *British Educational Research Journal* 2010 Jun;36(3):503-520. [doi: [10.1080/01411920902989227](https://doi.org/10.1080/01411920902989227)]
13. Sprout S. Social media demographics to inform your brand's strategy in 2020. Sprout. URL: <https://sproutsocial.com/insights/new-social-media-demographics/> [accessed 2020-10-17]
14. Statista. Distribution of Instagram users worldwide as of July 2020, by age and gender. Statista. URL: <https://www.statista.com/statistics/248769/age-distribution-of-worldwide-instagram-users/> [accessed 2020-10-17]
15. Statista. Distribution of Twitter users worldwide as of April 2020, by age group. Statista. URL: <https://www.statista.com/statistics/283119/age-distribution-of-global-twitter-users/> [accessed 2020-07-23]
16. Statista. Number of Sina Weibo users in China from 2017 to 2021. Statista. 2002. URL: <https://www.statista.com/statistics/941456/china-number-of-sina-weibo-users/> [accessed 2020-10-23]
17. Oberlo. 10 WhatsApp Statistics. Oberlo. URL: <https://www.oberlo.com/blog/whatsapp-statistics> [accessed 2020-10-17]
18. Business Of Apps. WeChat Revenue and Usage Statistics (2020). Business Of Apps. URL: <https://www.businessofapps.com/data/wechat-statistics/> [accessed 2020-10-22]
19. Omnicore. LinkedIn by the Numbers: Stats, Demographics & Fun Facts. Omnicore. URL: <https://www.omnicoreagency.com/linkedin-statistics/> [accessed 2020-10-23]
20. Facebook. About Facebook. Facebook. URL: <https://about.fb.com/> [accessed 2020-10-23]
21. Instagram. About Instagram. Instagram. URL: <https://about.instagram.com/> [accessed 2020-10-23]
22. WhatsApp. About WhatsApp. WhatsApp. URL: <https://www.whatsapp.com/about/>
23. Twitter. About Twitter. Twitter. URL: <https://about.twitter.com/> [accessed 2020-10-24]
24. YouTube. About YouTube. YouTube. URL: <https://www.youtube.com/about/> [accessed 2020-10-23]
25. LinkedIn. About LinkedIn. LinkedIn. URL: <https://about.linkedin.com/> [accessed 2020-10-22]
26. Barreto JE, Whitehair CL. Social Media and Web Presence for Patients and Professionals: Evolving Trends and Implications for Practice. *PM&R* 2017 May 18;9:S98-S105. [doi: [10.1016/j.pmrj.2017.02.012](https://doi.org/10.1016/j.pmrj.2017.02.012)]
27. Sprout S. 18 Facebook statistics every marketer should know in 2020. Sprout. URL: <https://sproutsocial.com/insights/facebook-stats-for-marketers/> [accessed 2020-07-23]
28. Statista. Distribution of Facebook users worldwide as of April 2020, by age and gender. Statista. URL: <https://www.statista.com/statistics/376128/facebook-global-user-age-distribution/> [accessed 2020-07-23]
29. Abd-Alrazaq A, Alhuwail D, Househ M, Hamdi M, Shah Z. Top Concerns of Tweeters During the COVID-19 Pandemic: Infoveillance Study. *J Med Internet Res* 2020 Apr 21;22(4):e19016. [doi: [10.2196/19016](https://doi.org/10.2196/19016)]
30. Bhola S, Hellyer P. The risks and benefits of social media in dental foundation training. *Br Dent J* 2016 Nov 18;221(10):609-613. [doi: [10.1038/sj.bdj.2016.854](https://doi.org/10.1038/sj.bdj.2016.854)]
31. Nayak LM, Linkov G. Social Media Marketing in Facial Plastic Surgery. *Facial Plastic Surgery Clinics of North America* 2019 Aug;27(3):373-377. [doi: [10.1016/j.fsc.2019.04.002](https://doi.org/10.1016/j.fsc.2019.04.002)]
32. Antheunis ML, Tates K, Nieboer TE. Patients' and health professionals' use of social media in health care: Motives, barriers and expectations. *Patient Education and Counseling* 2013 Sep;92(3):426-431. [doi: [10.1016/j.pec.2013.06.020](https://doi.org/10.1016/j.pec.2013.06.020)]
33. Edington DW, Schultz AB, Pitts JS, Camilleri A. The Future of Health Promotion in the 21st Century. *American Journal of Lifestyle Medicine* 2015 Sep 22;10(4):242-252. [doi: [10.1177/1559827615605789](https://doi.org/10.1177/1559827615605789)]
34. Chan TM, Stukus D, Leppink J, Duque L, Bigam BL, Mehta N, et al. Social Media and the 21st-Century Scholar: How You Can Harness Social Media to Amplify Your Career. *Journal of the American College of Radiology* 2018 Jan;15(1):142-148. [doi: [10.1016/j.jacr.2017.09.025](https://doi.org/10.1016/j.jacr.2017.09.025)]
35. Kamel Boulos M, Giustini D, Wheeler S. Instagram and WhatsApp in Health and Healthcare: An Overview. *Future Internet* 2016 Jul 26;8(3):37. [doi: [10.3390/fi8030037](https://doi.org/10.3390/fi8030037)]
36. Adams SA. Revisiting the online health information reliability debate in the wake of "web 2.0": An inter-disciplinary literature and website review. *International Journal of Medical Informatics* 2010 Jun;79(6):391-400. [doi: [10.1016/j.ijmedinf.2010.01.006](https://doi.org/10.1016/j.ijmedinf.2010.01.006)]
37. Gabarron E, Bradway M, Fernandez-Luque L, Chomutare T, Hansen AH, Wynn R, et al. Social media for health promotion in diabetes: study protocol for a participatory public health intervention design. *BMC Health Serv Res* 2018 Jun 5;18(1):1-5. [doi: [10.1186/s12913-018-3178-7](https://doi.org/10.1186/s12913-018-3178-7)]
38. We Go Health. 50 Social Media Healthcare Statistics to Watch. We Go Health. 2018 Jul 23. URL: <https://www.wegohealth.com/2018/04/02/social-media-healthcare-statistics-to-watch/> [accessed 2020-07-23]
39. Househ M. The use of social media in healthcare: organizational, clinical, and patient perspectives. *Stud Health Technol Inform* 2013;183:244-248. [Medline: [23388291](https://pubmed.ncbi.nlm.nih.gov/23388291/)]
40. Baker J, Stanley A. Telemedicine Technology: a Review of Services, Equipment, and Other Aspects. *Curr Allergy Asthma Rep* 2018 Sep 26;18(11):1-8. [doi: [10.1007/s11882-018-0814-6](https://doi.org/10.1007/s11882-018-0814-6)]

41. Moorhead SA, Hazlett DE, Harrison L, Carroll JK, Irwin A, Hoving C. A New Dimension of Health Care: Systematic Review of the Uses, Benefits, and Limitations of Social Media for Health Communication. *J Med Internet Res* 2013 Apr 23;15(4):e85. [doi: [10.2196/jmir.1933](https://doi.org/10.2196/jmir.1933)]
42. Parmar N, Dong L, Eisingerich AB. Connecting With Your Dentist on Facebook: Patients' and Dentists' Attitudes Towards Social Media Usage in Dentistry. *J Med Internet Res* 2018 Jun 29;20(6):e10109. [doi: [10.2196/10109](https://doi.org/10.2196/10109)]
43. World Health Organization. Working together to tackle the Infodemic? World Health Organization. URL: <https://www.euro.who.int/en/health-topics/Health-systems/e-health/news/news/2020/6/working-together-to-tackle-the-infodemic> [accessed 2020-07-23]
44. Neville P, Waylen A. Social media and dentistry: some reflections on e-professionalism. *Br Dent J* 2015 Apr 24;218(8):475-478. [doi: [10.1038/sj.bdj.2015.294](https://doi.org/10.1038/sj.bdj.2015.294)]
45. De Benedictis A, Lettieri E, Masella C, Gastaldi L, Macchini G, Santu C, et al. WhatsApp in hospital? An empirical investigation of individual and organizational determinants to use. *PLoS ONE* 2019 Jan 11;14(1):e0209873. [doi: [10.1371/journal.pone.0209873](https://doi.org/10.1371/journal.pone.0209873)]
46. Dizon DS, Graham D, Thompson MA, Johnson LJ, Johnston C, Fisch MJ, et al. Practical Guidance: The Use of Social Media In Oncology Practice. *JOP* 2012 Sep;8(5):e114-e124. [doi: [10.1200/jop.2012.000610](https://doi.org/10.1200/jop.2012.000610)]
47. Chretien KC, Kind T. Social Media and Clinical Care. *Circulation* 2013 Apr 02;127(13):1413-1421. [doi: [10.1161/circulationaha.112.128017](https://doi.org/10.1161/circulationaha.112.128017)]
48. Stukus DR. Using Twitter to expand the reach and engagement of allergists. *The Journal of Allergy and Clinical Immunology: In Practice* 2016 Mar;4(2):345-346.e1. [doi: [10.1016/j.jaip.2015.11.002](https://doi.org/10.1016/j.jaip.2015.11.002)]
49. Gao X, Hamzah S, Yiu CKY, McGrath C, King NM. Dental Fear and Anxiety in Children and Adolescents: Qualitative Study Using YouTube. *J Med Internet Res* 2013 Feb 22;15(2):e29. [doi: [10.2196/jmir.2290](https://doi.org/10.2196/jmir.2290)]
50. George D. R., L.S. Rovniak, and J. L. Kraschewski, Dangers and opportunities for social media in medicine. *Clin Obstet Gynecol* 2013;56(3):453-462. [doi: [10.1097/grf.0b013e318297dc38](https://doi.org/10.1097/grf.0b013e318297dc38)]
51. Stellefson M, Paige SR, Chaney BH, Chaney JD. Evolving Role of Social Media in Health Promotion: Updated Responsibilities for Health Education Specialists. *IJERPH* 2020 Feb 12;17(4):1153. [doi: [10.3390/ijerph17041153](https://doi.org/10.3390/ijerph17041153)]
52. Dorfman RG, Mahmood E, Ren A, Turin SY, Vaca EEE, Fine NA, et al. Google Ranking of Plastic Surgeons Values Social Media Presence Over Academic Pedigree and Experience. *Aesthet Surg J* 2019;39(4):447-451. [doi: [10.1093/asj/sjy285](https://doi.org/10.1093/asj/sjy285)]
53. Escoffery C, Kenzig M, Hyden C, Hernandez K. Capitalizing on Social Media for Career Development. *Health Promotion Practice* 2017 Sep 29;19(1):11-15. [doi: [10.1177/1524839917734522](https://doi.org/10.1177/1524839917734522)]
54. Alalawi A, Aljuaid H, Natto ZS. <p>The Effect Of Social Media On The Choice Of Dental Patients: A Cross-Sectional Study In The City Of Jeddah, Saudi Arabia</p>. *PPA* 2019 Oct;Volume 13:1685-1692. [doi: [10.2147/ppa.s213704](https://doi.org/10.2147/ppa.s213704)]
55. Henry RK, Molnar A, Henry JC. A survey of US dental practices' use of social media. *J Contemp Dent Pract* 2012 Mar 01;13(2):137-141. [doi: [10.5005/jp-journals-10024-1109](https://doi.org/10.5005/jp-journals-10024-1109)] [Medline: [22665737](https://pubmed.ncbi.nlm.nih.gov/22665737/)]
56. Simplicio AHDM. Social media and Dentistry: ethical and legal aspects. *Dental Press J. Orthod* 2019 Dec;24(6):80-89. [doi: [10.1590/2177-6709.24.6.080-089.sar](https://doi.org/10.1590/2177-6709.24.6.080-089.sar)]
57. Gould D, Nazarian S. Social Media Return on Investment: How Much is it Worth to My Practice? *Aesthet Surg J* 2018;38(5):565-574. [doi: [10.1093/asj/sjx152](https://doi.org/10.1093/asj/sjx152)]
58. Thompson MA, Younes A, Miller RS. Using social media in oncology for education and patient engagement. *Oncology (Williston Park)* 2012;26(9):84-85.
59. Carpentier M, Van Hoyer G, Stockman S, Schollaert E, Van Theemsche B, Jacobs G. Recruiting nurses through social media: Effects on employer brand and attractiveness. *J Adv Nurs* 2017 Jun 13;73(11):2696-2708. [doi: [10.1111/jan.13336](https://doi.org/10.1111/jan.13336)]
60. Parks-Yancy R, Cooley D. The Impact of Traditional and Internet/Social Media Screening Mechanisms on Employers? Perceptions of Job Applicants. *Social Media in Society* 2016;5(3):151-186.
61. Davison K, Bing M, Kluemper D, Roth P. Social media as a personnel selection and hiring resource: Reservations and recommendations. *Social media in employee selection and recruitment: Theory, practice, and current challenges. Social Media as a Personnel Selection and Hiring Resource: Reservations and Recommendations* 2016:15-42. [doi: [10.1007/978-3-319-29989-1_2](https://doi.org/10.1007/978-3-319-29989-1_2)]
62. Nikolaou I. Social Networking Web Sites in Job Search and Employee Recruitment. *Int J Select Assess* 2014 Apr 23;22(2):179-189. [doi: [10.1111/ijsa.12067](https://doi.org/10.1111/ijsa.12067)]
63. Collins C, Kanar A. The oxford handbook of recruitment Employer brand equity and recruitment research. *The oxford handbook of recruitment Employer brand equity and recruitment research* 2014:15-42. [doi: [10.1093/oxfordhb/9780199756094.013.0016](https://doi.org/10.1093/oxfordhb/9780199756094.013.0016)]
64. Kluemper DH, Rosen PA. Future employment selection methods: evaluating social networking web sites. *Journal of Managerial Psych* 2009 Aug 14;24(6):567-580. [doi: [10.1108/02683940910974134](https://doi.org/10.1108/02683940910974134)]
65. Baert S. Facebook profile picture appearance affects recruiters' first hiring decisions. *New Media & Society* 2017 Feb 01;20(3):1220-1239. [doi: [10.1177/1461444816687294](https://doi.org/10.1177/1461444816687294)]
66. Baert S, Decuyper L. Better sexy than flexy? A lab experiment assessing the impact of perceived attractiveness and personality traits on hiring decisions. *Applied Economics Letters* 2014 Mar 05;21(9):597-601. [doi: [10.1080/13504851.2013.877564](https://doi.org/10.1080/13504851.2013.877564)]

67. Harolds J. Tips for a physician in getting the right job part III: Networking and social media, references, and recruiters. *Clin Nucl Med* 2013;38(10):805-807. [doi: [10.1097/rlu.0b013e31829e8146](https://doi.org/10.1097/rlu.0b013e31829e8146)]
68. Jobvite. Social recruiting survey. Jobvite. 2014. URL: https://www.jobvite.com/wp-content/uploads/2014/10/Jobvite_SocialRecruiting_Survey2014.pdf [accessed 2020-07-23]
69. MacMillan C. Social media revolution and blurring of professional boundaries. *Imprint* 2013;60(3):44-46. [Medline: [23821819](https://pubmed.ncbi.nlm.nih.gov/23821819/)]
70. Peck JL. Social Media in Nursing Education: Responsible Integration for Meaningful Use. *J Nurs Educ* 2014 Feb 19;53(3):164-169. [doi: [10.3928/01484834-20140219-03](https://doi.org/10.3928/01484834-20140219-03)]
71. Sterling M, Leung P, Wright D, Bishop TF. The Use of Social Media in Graduate Medical Education. *Academic Medicine* 2017;92(7):1043-1056. [doi: [10.1097/acm.0000000000001617](https://doi.org/10.1097/acm.0000000000001617)]
72. Wells DM. When Faced With Facebook: What Role Should Social Media Play in Selecting Residents? *J Grad Med Educ* 2015;7(1):14-15. [doi: [10.4300/jgme-d-14-00363.1](https://doi.org/10.4300/jgme-d-14-00363.1)]
73. Chauhan B, George R, Coffin J. Social media and you: what every physician needs to know. *J Med Pract Manage* 2012;28(3):206-209. [doi: [10.4324/9780080460574-19](https://doi.org/10.4324/9780080460574-19)]
74. Go PH, Klaassen Z, Chamberlain RS. Attitudes and Practices of Surgery Residency Program Directors Toward the Use of Social Networking Profiles to Select Residency Candidates: A Nationwide Survey Analysis. *Journal of Surgical Education* 2012 May;69(3):292-300. [doi: [10.1016/j.jsurg.2011.11.008](https://doi.org/10.1016/j.jsurg.2011.11.008)]
75. Foley NM, Maher BM, Corrigan MA. Social media and tomorrow's medical students--how do they fit? *J Surg Educ* 2014;71(3):385-390. [doi: [10.1016/j.jsurg.2013.10.008](https://doi.org/10.1016/j.jsurg.2013.10.008)] [Medline: [24797855](https://pubmed.ncbi.nlm.nih.gov/24797855/)]
76. Go P, Klaassen Z, Chamberlain R. Residency selection: do the perceptions of US programme directors and applicants match? *Med Educ* 2012;46(5):491-500. [doi: [10.1111/j.1365-2923.2012.04257.x](https://doi.org/10.1111/j.1365-2923.2012.04257.x)]
77. Langenfeld SJ, Cook G, Sudbeck C, Luers T, Schenarts PJ. An Assessment of Unprofessional Behavior Among Surgical Residents on Facebook: A Warning of the Dangers of Social Media. *Journal of Surgical Education* 2014 Nov;71(6):e28-e32. [doi: [10.1016/j.jsurg.2014.05.013](https://doi.org/10.1016/j.jsurg.2014.05.013)]
78. Cain J, Scott D, Smith K. Use of social media by residency program directors for resident selection. *Am J Health Syst Pharm* 2010;67(19):1635-1639. [doi: [10.2146/ajhp090658](https://doi.org/10.2146/ajhp090658)]
79. Cain J, Scott DR, Akers P. Pharmacy Students' Facebook Activity and Opinions Regarding Accountability and E-Professionalism. *Am J Pharm Educ* 2009 Sep;73(6):104. [doi: [10.5688/aj7306104](https://doi.org/10.5688/aj7306104)]
80. Schulman CI, Kuchkarian FM, Withum KF, Boecker FS, Graygo JM. Influence of social networking websites on medical school and residency selection process. *Postgrad Med J* 2012 Nov 08;89(1049):126-130. [doi: [10.1136/postgradmedj-2012-131283](https://doi.org/10.1136/postgradmedj-2012-131283)]
81. McGinnis L. Presidential address: Professionalism in the 21st century. *Bull Am Coll Surg* 2009;94(12):8-18. [doi: [10.1142/9789812799647_0017](https://doi.org/10.1142/9789812799647_0017)]
82. Gorrindo T, Gorrindo PC, Groves JE. Intersection of Online Social Networking with Medical Professionalism: Can Medicine Police the Facebook Boom? *J GEN INTERN MED* 2008 Oct 2;23(12):2155-2155. [doi: [10.1007/s11606-008-0810-y](https://doi.org/10.1007/s11606-008-0810-y)]
83. Chretien KC. Online Posting of Unprofessional Content by Medical Students. *JAMA* 2009 Sep 23;302(12):1309. [doi: [10.1001/jama.2009.1387](https://doi.org/10.1001/jama.2009.1387)]
84. Mascia D, Rinninella E, Pennacchio NW, Cerrito L, Gasbarrini A. It's how we communicate! Exploring face-to-face versus electronic communication networks in multidisciplinary teams. *Health Care Manage Rev* 2019 Apr 18;46(2):153-161. [doi: [10.1097/hmr.0000000000000246](https://doi.org/10.1097/hmr.0000000000000246)]
85. Chan TM, Dzara K, Dimeo SP, Bhalariao A, Maggio LA. Social media in knowledge translation and education for physicians and trainees: a scoping review. *Perspect Med Educ* 2019 Dec 13;9(1):20-30. [doi: [10.1007/s40037-019-00542-7](https://doi.org/10.1007/s40037-019-00542-7)]
86. Ting DK, Thoma B, Luckett-Gatopoulos S, Thomas A, Syed S, Bravo M, et al. CanadiEM: Accessing a Virtual Community of Practice to Create a Canadian National Medical Education Institution. *AEM Education and Training* 2018 Nov 02;3(1):86-91. [doi: [10.1002/aet2.10199](https://doi.org/10.1002/aet2.10199)]
87. Wani SA, Rabah SM, AlFadil S, Dewanjee N, Najmi Y. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. *Indian J Plast Surg* 2019 Oct 07;46(03):502-505. [doi: [10.4103/0970-0358.121990](https://doi.org/10.4103/0970-0358.121990)]
88. Chan WS, Leung AY. Use of Social Network Sites for Communication Among Health Professionals: Systematic Review. *J Med Internet Res* 2018 Mar 28;20(3):e117. [doi: [10.2196/jmir.8382](https://doi.org/10.2196/jmir.8382)]
89. Grajales III FJ, Sheps S, Ho K, Novak-Lauscher H, Eysenbach G. Social Media: A Review and Tutorial of Applications in Medicine and Health Care. *J Med Internet Res* 2014 Feb 11;16(2):e13. [doi: [10.2196/jmir.2912](https://doi.org/10.2196/jmir.2912)]
90. Sermo Expands Global Network to Include 30 Countries. Sermo. 2016 Jul 24. URL: <https://www.sermo.com/press-releases/sermo-expands-global-network-to-include-30-countries/> [accessed 2020-07-24]
91. Doximity. Doximity. Doximity. URL: <https://www.doximity.com/> [accessed 2020-07-24]
92. Medical Directors Forum. Medical Directors Forum. Medical Directors Forum. URL: <https://medicaldirectorsforum.com/> [accessed 2020-07-24]
93. Khanna V, Sambandam SN, Gul A, Mounasamy V. "WhatsApp"ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center. *Eur J Orthop Surg Traumatol* 2015 Jan 30;25(5):821-826. [doi: [10.1007/s00590-015-1600-y](https://doi.org/10.1007/s00590-015-1600-y)]

94. Eysenbach G. Can Tweets Predict Citations? Metrics of Social Impact Based on Twitter and Correlation with Traditional Metrics of Scientific Impact. *J Med Internet Res* 2011 Dec 16;13(4):e123. [doi: [10.2196/jmir.2012](https://doi.org/10.2196/jmir.2012)]
95. Allen HG, Stanton TR, Di Pietro F, Moseley GL. Social Media Release Increases Dissemination of Original Articles in the Clinical Pain Sciences. *PLoS ONE* 2013 Jul 17;8(7):e68914. [doi: [10.1371/journal.pone.0068914](https://doi.org/10.1371/journal.pone.0068914)]
96. Teoh JY, Mackenzie G, Tortolero L, Rivas JG. Social Media Analytics: What You Need to Know as a Urologist. *European Urology Focus* 2020 May;6(3):434-436. [doi: [10.1016/j.euf.2019.08.005](https://doi.org/10.1016/j.euf.2019.08.005)]
97. Radford DR, Hellyer P. Belongingness in undergraduate dental education. *Br Dent J* 2016 May 27;220(10):539-543. [doi: [10.1038/sj.bdj.2016.379](https://doi.org/10.1038/sj.bdj.2016.379)] [Medline: [27228935](https://pubmed.ncbi.nlm.nih.gov/27228935/)]
98. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet* 2020 Mar;395(10227):912-920. [doi: [10.1016/s0140-6736\(20\)30460-8](https://doi.org/10.1016/s0140-6736(20)30460-8)]
99. Kaiser health News. Dentists, Physicians Offices Hit Hardest During April's Loss Of 1.4M Health Care Jobs. Kaiser health News. URL: <https://khn.org/morning-breakout/dentists-physicians-offices-hit-hardest-during-aprils-loss-of-1-4m-health-care-jobs/> [accessed 2020-07-24]
100. Lee A. A Facebook group matches RVs that are sitting idle with health care workers who need a place to isolate after long hospital shifts. CNN.com. 2018. URL: <https://edition.cnn.com/2020/04/01/us/coronavirus-rvs-4-mds-healthcare-isolate-trnd/index.html> [accessed 2020-07-24]
101. de Peralta TL, Fariori OF, Flake NM, Gallagher D, Susin C, Valenza J. The Use of Social Media by Dental Students for Communication and Learning: Two Viewpoints. *Journal of Dental Education* 2019 Jun 01;83(6):663-668. [doi: [10.21815/jde.019.072](https://doi.org/10.21815/jde.019.072)]
102. Cheston CC, Flickinger TE, Chisolm MS. Social Media Use in Medical Education. *Academic Medicine* 2013;88(6):893-901. [doi: [10.1097/acm.0b013e31828ffc23](https://doi.org/10.1097/acm.0b013e31828ffc23)]
103. Camm CF, Sunderland N, Camm AJ. A Quality Assessment of Cardiac Auscultation Material on YouTube. *Clin Cardiol* 2012 Nov 21;36(2):77-81. [doi: [10.1002/clc.22080](https://doi.org/10.1002/clc.22080)]
104. Knösel M, Jung K, Bleckmann A. YouTube, dentistry, and dental education. *J Dent Educ* 2011 Dec;75(12):1558-1568. [Medline: [22184594](https://pubmed.ncbi.nlm.nih.gov/22184594/)]
105. Alsuraihi AK, Almaqati AS, Abughanim SA, Jastaniah NA. Use of social media in education among medical students in Saudi Arabia. *Korean J Med Educ* 2016 Dec;28(4):343-354. [doi: [10.3946/kjme.2016.40](https://doi.org/10.3946/kjme.2016.40)]
106. Kind T, Genrich G, Sodhi A, Chretien KC. Social media policies at US medical schools. *Medical Education Online* 2010 Sep 15;15(1):5324. [doi: [10.3402/meo.v15i0.5324](https://doi.org/10.3402/meo.v15i0.5324)]
107. Gonzalez SM, Gadbury-Amyot CC. Using Twitter for Teaching and Learning in an Oral and Maxillofacial Radiology Course. *Journal of Dental Education* 2016 Feb 01;80(2):149-155. [doi: [10.1002/j.0022-0337.2016.80.2.tb06070.x](https://doi.org/10.1002/j.0022-0337.2016.80.2.tb06070.x)]
108. Forbes M, Hickey M. Podcasting: implementation and evaluation in an undergraduate nursing program. *Nurse Educ* 2008;33(5):224-227. [doi: [10.1097/01.nne.0000334775.98018.e8](https://doi.org/10.1097/01.nne.0000334775.98018.e8)]
109. Carvas M, Imamura M, Hsing W, Dewey-Platt L, Fregni F. An innovative method of global clinical research training using collaborative learning with Web 2.0 tools. *Med Teach* 2010;32(3):270. [doi: [10.4018/978-1-61520-963-7.ch012](https://doi.org/10.4018/978-1-61520-963-7.ch012)]
110. Oyewole BK, Animasahun VJ, Chapman HJ. A survey on the effectiveness of WhatsApp for teaching doctors preparing for a licensing exam. *PLoS ONE* 2020 Apr 2;15(4):e0231148. [doi: [10.1371/journal.pone.0231148](https://doi.org/10.1371/journal.pone.0231148)]
111. Scaffidi MA, Khan R, Wang C, Keren D, Tsui C, Garg A, et al. Comparison of the Impact of Wikipedia, UpToDate, and a Digital Textbook on Short-Term Knowledge Acquisition Among Medical Students: Randomized Controlled Trial of Three Web-Based Resources. *JMIR Med Educ* 2017 Oct 31;3(2):e20. [doi: [10.2196/mededu.8188](https://doi.org/10.2196/mededu.8188)]
112. George D, Dellasega C. Social media in medical education: two innovative pilot studies. *Med Educ* 2011;45(11):1158-1159. [doi: [10.1111/j.1365-2923.2011.04124.x](https://doi.org/10.1111/j.1365-2923.2011.04124.x)]
113. Ranginwala S, Towbin AJ. Use of Social Media in Radiology Education. *Journal of the American College of Radiology* 2018 Jan;15(1):190-200. [doi: [10.1016/j.jacr.2017.09.010](https://doi.org/10.1016/j.jacr.2017.09.010)]
114. Alanzi T, Al-Habib DK. The Use of Social Media by Healthcare Quality Personnel in Saudi Arabia. *Journal of Environmental and Public Health* 2020 May 22;2020:1-9. [doi: [10.1155/2020/1417478](https://doi.org/10.1155/2020/1417478)]
115. Kaliyadan F, Ashique K, Jagadeesan S, Krishna B. What's up dermatology? A pilot survey of the use of WhatsApp in dermatology practice and case discussion among members of WhatsApp dermatology groups. *Indian J Dermatol Venereol Leprol* 2016;82(1):67. [doi: [10.4103/0378-6323.171638](https://doi.org/10.4103/0378-6323.171638)]
116. Johnston MJ, King D, Arora S, Behar N, Athanasiou T, Sevdalis N, et al. Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams. *The American Journal of Surgery* 2015 Jan;209(1):45-51. [doi: [10.1016/j.amjsurg.2014.08.030](https://doi.org/10.1016/j.amjsurg.2014.08.030)]
117. Nettle M. Social media in medical education: Can you trust it? Yes. *Emergency Medicine Australasia* 2018 May 06;30(3):416-417. [doi: [10.1111/1742-6723.13100](https://doi.org/10.1111/1742-6723.13100)]
118. Chan R. Social media in medical education: Can you trust it? No. *Emergency Medicine Australasia* 2018 May 06;30(3):418-419. [doi: [10.1111/1742-6723.13101](https://doi.org/10.1111/1742-6723.13101)]
119. Chaet D, Clearfield R, Sabin JE, Skimming K. Ethical practice in Telehealth and Telemedicine. *J Gen Intern Med* 2017 Jun 26;32(10):1136-1140. [doi: [10.1007/s11606-017-4082-2](https://doi.org/10.1007/s11606-017-4082-2)]

120. Shah MN, McDermott R, Gillespie SM, Philbrick EB, Nelson D. Potential of Telemedicine to Provide Acute Medical Care for Adults in Senior Living Communities. *Acad Emerg Med* 2013 Feb 13;20(2):162-168. [doi: [10.1111/acem.12075](https://doi.org/10.1111/acem.12075)]
121. AlShaya MS, Assery MK, Pani SC. Reliability of mobile phone teledentistry in dental diagnosis and treatment planning in mixed dentition. *J Telemed Telecare* 2018 Aug 22;26(1-2):45-52. [doi: [10.1177/1357633x18793767](https://doi.org/10.1177/1357633x18793767)]
122. Klaassen B, van Beijnum BJB, Hermens HJ. Usability in telemedicine systems-A literature survey. *Int J Med Inform* 2016 Sep;93:57-69. [doi: [10.1016/j.ijmedinf.2016.06.004](https://doi.org/10.1016/j.ijmedinf.2016.06.004)] [Medline: [27435948](https://pubmed.ncbi.nlm.nih.gov/27435948/)]
123. Turvey C, Coleman M, Dennison O, Drude K, Goldenson M, Hirsch P, et al. ATA Practice Guidelines for Video-Based Online Mental Health Services. *Telemedicine and e-Health* 2013 Sep;19(9):722-730. [doi: [10.1089/tmj.2013.9989](https://doi.org/10.1089/tmj.2013.9989)]
124. Burke BL, Hall RW. Telemedicine: Pediatric Applications. *Pediatrics* 2015 Jun 29;136(1):e293-e308. [doi: [10.1542/peds.2015-1517](https://doi.org/10.1542/peds.2015-1517)]
125. Fortney JC, Pyne JM, Kimbrell TA, Hudson TJ, Robinson DE, Schneider R, et al. Telemedicine-Based Collaborative Care for Posttraumatic Stress Disorder. *JAMA Psychiatry* 2015 Jan 01;72(1):58. [doi: [10.1001/jamapsychiatry.2014.1575](https://doi.org/10.1001/jamapsychiatry.2014.1575)]
126. Estai M, Kanagasigam Y, Huang B, Checker H, Steele L, Kruger E, et al. The efficacy of remote screening for dental caries by mid-level dental providers using a mobile teledentistry model. *Community Dent Oral Epidemiol* 2016 Apr 25;44(5):435-441. [doi: [10.1111/cdoe.12232](https://doi.org/10.1111/cdoe.12232)]
127. Lee JY, Lee SWH. Telemedicine Cost-Effectiveness for Diabetes Management: A Systematic Review. *Diabetes Technology & Therapeutics* 2018 Jul;20(7):492-500. [doi: [10.1089/dia.2018.0098](https://doi.org/10.1089/dia.2018.0098)]
128. Simon P. [Telemedicine in current nursing practices]. *Soins* 2016 Nov;61(810):24-27 [FREE Full text] [doi: [10.1016/j.soins.2016.09.003](https://doi.org/10.1016/j.soins.2016.09.003)] [Medline: [27894474](https://pubmed.ncbi.nlm.nih.gov/27894474/)]
129. Portnoy JM, Waller M, Farrell K. Telemedicine Improves Allergy Care for Hospitalized Patients. *The Journal of Allergy and Clinical Immunology: In Practice* 2018 Nov;6(6):2041-2042. [doi: [10.1016/j.jaip.2018.05.016](https://doi.org/10.1016/j.jaip.2018.05.016)]
130. Worster B, Swartz K. Telemedicine and Palliative Care: an Increasing Role in Supportive Oncology. *Curr Oncol Rep* 2017 Apr 18;19(6):1-5. [doi: [10.1007/s11912-017-0600-y](https://doi.org/10.1007/s11912-017-0600-y)]
131. Dixon RF, Rao L. Asynchronous Virtual Visits for the Follow-Up of Chronic Conditions. *Telemedicine and e-Health* 2014 Jul;20(7):669-672. [doi: [10.1089/tmj.2013.0211](https://doi.org/10.1089/tmj.2013.0211)]
132. van Velthoven MH, Li Y, Wang W, Du X, Wu Q, Chen L, et al. mHealth Series: mHealth project in Zhao County, rural China – Description of objectives, field site and methods. *J Glob Health* 2013 Dec;3(2):1-22. [doi: [10.7189/jogh.03.020401](https://doi.org/10.7189/jogh.03.020401)]
133. Leung R, Guo H, Pan X. Social Media Users' Perception of Telemedicine and mHealth in China: Exploratory Study. *JMIR Mhealth Uhealth* 2018 Sep 25;6(9):e181. [doi: [10.2196/mhealth.7623](https://doi.org/10.2196/mhealth.7623)]
134. van den Heuvel JF, Groenhof TK, Veerbeek JH, van Solinge WW, Lely AT, Franx A, et al. eHealth as the Next-Generation Perinatal Care: An Overview of the Literature. *J Med Internet Res* 2018 Jun 05;20(6):e202. [doi: [10.2196/jmir.9262](https://doi.org/10.2196/jmir.9262)]
135. Irving M, Stewart R, Spallek H, Blinkhorn A. Using teledentistry in clinical practice as an enabler to improve access to clinical care: A qualitative systematic review. *J Telemed Telecare* 2017 Jan 16;24(3):129-146. [doi: [10.1177/1357633x16686776](https://doi.org/10.1177/1357633x16686776)]
136. Joshi SS, Murali-Krishnan S, Patankar P, Choudhari KA. Neurosurgical referral service using smartphone client WhatsApp: preliminary study at a tertiary referral neurosurgical unit. *British Journal of Neurosurgery* 2018 Jul 13;32(5):553-557. [doi: [10.1080/02688697.2018.1490944](https://doi.org/10.1080/02688697.2018.1490944)]
137. Dhiliwal S, Salins N. Smartphone applications in palliative homecare. *Indian J Palliat Care* 2015;21(1):88. [doi: [10.4103/0973-1075.150199](https://doi.org/10.4103/0973-1075.150199)]
138. Choudhari P. Study on effectiveness of communication amongst members at department of orthopedics surgery unit 3 using smartphone and mobile WhatsApp. *Int Surg J* 2014;1(1):9. [doi: [10.5455/2349-2902.isj20140504](https://doi.org/10.5455/2349-2902.isj20140504)]
139. Hollander JE, Carr BG. Virtually Perfect? Telemedicine for Covid-19. *N Engl J Med* 2020 Apr 30;382(18):1679-1681. [doi: [10.1056/nejmp2003539](https://doi.org/10.1056/nejmp2003539)]
140. Giordano V, Koch HA, Mendes CH, Bergamin A, de Souza FS, do Amaral NP. WhatsApp messenger is useful and reproducible in the assessment of tibial plateau fractures: Inter- and intra-observer agreement study. *International Journal of Medical Informatics* 2015 Feb;84(2):141-148. [doi: [10.1016/j.ijmedinf.2014.11.002](https://doi.org/10.1016/j.ijmedinf.2014.11.002)]
141. Thota R, Divatia J. WhatsApp: What an App!. *Indian J Crit Care Med* 2015;19(6):363-365. [doi: [10.4103/0972-5229.158288](https://doi.org/10.4103/0972-5229.158288)]
142. Kelahmetoglu O, Firinciogullari R, Yagmur C. Efficient Utility of WhatsApp: From Computer Screen to the Surgeon's Hand to Determine Maxillofacial Traumas. *J Craniofac Surg* 2015;26(4):1437. [doi: [10.1097/scs.0000000000001627](https://doi.org/10.1097/scs.0000000000001627)]
143. Gulacti U, Lok U, Hatipoglu S, Polat H. An Analysis of WhatsApp Usage for Communication Between Consulting and Emergency Physicians. *J Med Syst* 2016 Apr 15;40(6):1-7. [doi: [10.1007/s10916-016-0483-8](https://doi.org/10.1007/s10916-016-0483-8)]
144. Sarode S, Sarode G, Gaikwad T, Patekar, D, Gadail A, Gondivkar S, et al. Usage Analysis of WhatsApp for Dentistry-related Purposes among General Dental Practitioners. *J Contemp Dent Pract* 2018;19(10):1267-1272. [doi: [10.5005/jp-journals-10024-2415](https://doi.org/10.5005/jp-journals-10024-2415)]
145. Merrell RC, Doarn CR. Ethics in Telemedicine Research. *Telemedicine and e-Health* 2009 Mar;15(2):123-124. [doi: [10.1089/tmj.2009.9992](https://doi.org/10.1089/tmj.2009.9992)]
146. Golder S, Ahmed S, Norman G, Booth A. Attitudes Toward the Ethics of Research Using Social Media: A Systematic Review. *J Med Internet Res* 2017 Jun 06;19(6):e195. [doi: [10.2196/jmir.7082](https://doi.org/10.2196/jmir.7082)]

147. Fordis M, Street RL, Volk RJ, Smith Q. The Prospects for Web 2.0 Technologies for Engagement, Communication, and Dissemination in the Era of Patient-Centered Outcomes Research: Selected Articles Developed From the Eisenberg Conference Series 2010 Meeting. *Journal of Health Communication* 2011 Jul 29;16(sup1):3-9. [doi: [10.1080/10810730.2011.598398](https://doi.org/10.1080/10810730.2011.598398)]
148. Thelwall M, Kousha K. ResearchGate: Disseminating, communicating, and measuring Scholarship? *J Assn Inf Sci Tec* 2014 May 23;66(5):876-889. [doi: [10.1002/asi.23236](https://doi.org/10.1002/asi.23236)]
149. Child RJH, Mentis JC, Pavlish C, Phillips LR. Using Facebook and participant information clips to recruit emergency nurses for research. *Nurse Researcher* 2014 Jul 25;21(6):16-21. [doi: [10.7748/nr.21.6.16.e1246](https://doi.org/10.7748/nr.21.6.16.e1246)]
150. Christensen T, Riis AH, Hatch EE, Wise LA, Nielsen MG, Rothman KJ, et al. Costs and Efficiency of Online and Offline Recruitment Methods: A Web-Based Cohort Study. *J Med Internet Res* 2017 Mar 01;19(3):e58. [doi: [10.2196/jmir.6716](https://doi.org/10.2196/jmir.6716)]
151. Sudha B, Samuel AJ, Narkeesh K. Feasibility online survey to estimate physical activity level among the students studying professional courses: a cross-sectional online survey. *J Exerc Rehabil* 2018 Feb 26;14(1):58-63. [doi: [10.12965/jer.1835130.565](https://doi.org/10.12965/jer.1835130.565)]
152. AlShahrani I, Tikare S, Togoo R, AlAsere Y, AlAsmari A. Self-perception of personal oral health in Saudi population: a social media approach. *Easter Mediterr Health J* 2015 May 01;21(5):342-348. [doi: [10.26719/2015.21.5.342](https://doi.org/10.26719/2015.21.5.342)]
153. Moreno MA, Grant A, Kacvinsky L, Moreno P, Fleming M. Older Adolescents' Views Regarding Participation in Facebook Research. *Journal of Adolescent Health* 2012 Nov;51(5):439-444. [doi: [10.1016/j.jadohealth.2012.02.001](https://doi.org/10.1016/j.jadohealth.2012.02.001)]
154. Pérez Zaballos M, Ramos Macías, Pérez Placencia D, Borkoski Barreiro S, Ramos de Miguel. LifeQuestionnaire. A new tool for the evaluation of quality of life in patients with hearing loss-using WhatsApp. *European Annals of Otorhinolaryngology, Head and Neck Diseases* 2016 Jun;133:S44-S49. [doi: [10.1016/j.anorl.2016.04.020](https://doi.org/10.1016/j.anorl.2016.04.020)]
155. Topolovec-Vranic J, Natarajan K. The Use of Social Media in Recruitment for Medical Research Studies: A Scoping Review. *J Med Internet Res* 2016 Nov 07;18(11):e286. [doi: [10.2196/jmir.5698](https://doi.org/10.2196/jmir.5698)]
156. Whitaker C, Stevelink S, Fear N. The Use of Facebook in Recruiting Participants for Health Research Purposes: A Systematic Review. *J Med Internet Res* 2017 Aug 28;19(8):e290. [doi: [10.2196/jmir.7071](https://doi.org/10.2196/jmir.7071)]
157. Holloway IW, Rice E, Gibbs J, Winetrobe H, Dunlap S, Rhoades H. Acceptability of Smartphone Application-Based HIV Prevention Among Young Men Who Have Sex With Men. *AIDS Behav* 2013 Dec 1;18(2):285-296. [doi: [10.1007/s10461-013-0671-1](https://doi.org/10.1007/s10461-013-0671-1)]
158. Morris R. 'Unjust, inhumane and highly inaccurate': the impact of changes to disability benefits and services – social media as a tool in research and activism. *Disability & Society* 2013 Jul;28(5):724-728. [doi: [10.1080/09687599.2013.808093](https://doi.org/10.1080/09687599.2013.808093)]
159. Balfe M, Doyle F, Conroy R. Using Facebook to recruit young adults for qualitative research projects: how difficult is it? *Comput Inform Nurs* 2012;30(10):511-515. [doi: [10.1097/nxn.0b013e31826e4fca](https://doi.org/10.1097/nxn.0b013e31826e4fca)]
160. Bender JL, Cyr AB, Arbuckle L, Ferris LE. Ethics and Privacy Implications of Using the Internet and Social Media to Recruit Participants for Health Research: A Privacy-by-Design Framework for Online Recruitment. *J Med Internet Res* 2017 Apr 06;19(4):e104. [doi: [10.2196/jmir.7029](https://doi.org/10.2196/jmir.7029)]
161. Jordan S, Hovet S, Fung I, Liang H, Fu K, Tse Z. Using Twitter for Public Health Surveillance from Monitoring and Prediction to Public Response. *Data* 2018 Dec 29;4(1):6. [doi: [10.3390/data4010006](https://doi.org/10.3390/data4010006)]
162. Shah Z, Surian D, Dya A, Coiera E, Mandl KD, Dunn AG. Automatically Appraising the Credibility of Vaccine-Related Web Pages Shared on Social Media: A Twitter Surveillance Study. *J Med Internet Res* 2019 Nov 4;21(11):e14007. [doi: [10.2196/14007](https://doi.org/10.2196/14007)]
163. Shah Z, Dunn AG. Event detection on Twitter by mapping unexpected changes in streaming data into a spatiotemporal lattice. *IEEE Trans. Big Data* 2019:1-1. [doi: [10.1109/tbdata.2019.2948594](https://doi.org/10.1109/tbdata.2019.2948594)]
164. Fogelson N, Rubin Z, Ault A. Beyond likes and tweets: an in-depth look at the physician social media landscape. *Clin Obstet Gynecol* 2013;56(3):a-508. [doi: [10.1097/grf.0b013e31829e7638](https://doi.org/10.1097/grf.0b013e31829e7638)]
165. Chew C, Eysenbach G. Pandemics in the Age of Twitter: Content Analysis of Tweets during the 2009 H1N1 Outbreak. *PLoS ONE* 2010 Nov 29;5(11):e14118. [doi: [10.1371/journal.pone.0014118](https://doi.org/10.1371/journal.pone.0014118)]
166. Collier N, Son N, Nguyen N. OMG U got flu? Analysis of shared health messages for bio-surveillance. *J Biomed Sem* 2011;2(Suppl 5):S9. [doi: [10.1186/2041-1480-2-s5-s9](https://doi.org/10.1186/2041-1480-2-s5-s9)]
167. Denecke K, Kriek M, Otrusina L, Smrz P, Dolog P, Nejd W, et al. How to Exploit Twitter for Public Health Monitoring? *Methods Inf Med* 2018 Jan 20;52(04):326-339. [doi: [10.3414/me12-02-0010](https://doi.org/10.3414/me12-02-0010)]
168. Molla R. How coronavirus took over social media. *vox.com*. URL: <https://www.vox.com/recode/2020/3/12/21175570/coronavirus-covid-19-social-media-twitter-facebook-google> [accessed 2020-10-22]
169. Basch CH, Hillyer GC, Meleo-Erwin ZC, Jaime C, Mohlman J, Basch CE. Preventive Behaviors Conveyed on YouTube to Mitigate Transmission of COVID-19: Cross-Sectional Study. *JMIR Public Health Surveill* 2020;6(2):e18807. [doi: [10.2196/preprints.18807](https://doi.org/10.2196/preprints.18807)]
170. Shen C, Chen A, Luo C, Zhang J, Feng B, Liao W. Using Reports of Symptoms and Diagnoses on Social Media to Predict COVID-19 Case Counts in Mainland China: Observational Infoveillance Study. *J Med Internet Res* 2020;22(5):e19421. [doi: [10.2196/preprints.19421](https://doi.org/10.2196/preprints.19421)]
171. Aggarwal NR, Alasnag M, Mamas MA. Social media in the era of COVID-19. *Open Heart* 2020 Sep 29;7(2):e001352. [doi: [10.1136/openhrt-2020-001352](https://doi.org/10.1136/openhrt-2020-001352)]

172. Mulrennan S, Colt H. Medical information and social media in the time of covid - 19. *Respirology* 2020 Apr 28;25(6):578-579. [doi: [10.1111/resp.13832](https://doi.org/10.1111/resp.13832)]

Abbreviations

CDC: Centers for Disease Control and Prevention

HCP: health care provider

PD: program director

PPE: personal protective equipment

ROI: return on investment

SM: social media

SNS: social networking site

WHO: World Health Organization

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Tutorial

The Healing Hearts Together Randomized Controlled Trial and the COVID-19 Pandemic: A Tutorial for Transitioning From an In-Person to a Web-Based Intervention

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Abstract

Supportive couple relationships are associated with reduced risk of chronic illness development, such as cardiovascular disease, as well as improved secondary prevention. Healing Hearts Together (HHT) is an 8-week couples-based intervention designed to improve relationship quality, mental health, quality of life, and cardiovascular health among couples in which one partner has experienced a cardiac event. A randomized controlled trial began in October 2019 to test the efficacy of the in-person, group-based HHT program as compared to usual care. In March of 2020, all recruitment, assessments, and interventions halted due to the COVID-19 pandemic. Guided by optimal virtual care principles, as well as by Hom and colleagues' four-stage framework—consultation, adaptation, pilot-testing, and test launch—this paper is a tutorial for the step-by-step transition planning and implementation of a clinical research intervention from an in-person to a web-based format, using the HHT program as an example. Clinical and research considerations are reviewed, including (1) privacy, (2) therapeutic aspects of the intervention, (3) group cohesion, (4) research ethics, (5) participant recruitment, (6) assessment measures, (7) data collection, and (8) data analyses. This tutorial can assist clinical researchers in transitioning their research programs to a web-based format during the pandemic and beyond.

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KEYWORDS

web-based intervention; internet-based intervention; randomized controlled trial; COVID-19; research; tutorial; digital medicine; behavioral medicine; telehealth; telemedicine; cardiovascular rehabilitation

Introduction

This tutorial aims to help clinical researchers transition their in-person research programs to a web-based format during the pandemic and beyond. To our knowledge, no literature exists on how to navigate the steps required to transition a randomized controlled trial (RCT), designed for in-person delivery, to an online world. No one has outlined, for example, contacts with sponsors and research ethics boards, recruitment procedures,

or informed consent changes. This paper expands the previous transitional work in a clinical-only environment by accounting for the unique demands of clinical research and RCTs. The Healing Hearts Together (HHT) RCT provides researchers a current example of this challenging transition. We begin by briefly describing the original in-person HHT intervention and research protocol. We then guide clinical researchers through five important stages of transition: (1) consultation and assessment of needs, (2) adaptation of procedures and materials

for web-based delivery, (3) adaptation of procedures and materials for the research protocol, (4) pilot sessions, and (5) the final launch of the web-based intervention and research protocol. We have also included a useful checklist of all the critical clinical and research elements that must be addressed so that the transition can be done in an efficient and ethical manner (see [Multimedia Appendix 1](#) for checklist).

Original In-Person HHT Program

A healthy couple relationship (ie, one in which partners feel loved, emotionally supported, respected, and cared for) is a significant protective factor, particularly against cardiac disease incidence and outcomes [1-5]. Healthy relationships can influence positive cardiac outcomes in direct and indirect ways. Direct examples include improved high-frequency heart rate variability and decreased diastolic blood pressure in supportive relationships [6-8]. Indirect links to cardiovascular health include adaptive behavioral pathways, such as partners influencing health behaviors (eg, prepare low sodium meals), modeling healthy behavior (eg, exercise), or assisting in the management of disease (eg, medication management) [9-11]. In contrast to their more distressed peers, happily married cardiac patients demonstrate stronger adherence to blood pressure medication regimens and cardiac rehabilitation programs [12,13].

Unfortunately, the reverse is also true. Relationship distress can have a negative impact on heart disease. A recent meta-analysis showed that poor social relationships were associated with a 29% increase in risk of incident coronary artery disease [14]. Uchino and colleagues found that coronary artery calcification scores were higher for individuals who expressed ambivalence rather than positivity about their couple relationship [15]. Other researchers have highlighted the indirect pathways by which relationship distress influences cardiac outcomes, including smoking and alcohol use in response to relationship problems [16].

Despite burgeoning evidence indicating that healthy relationships are vital for reducing chronic disease incidence and management, current secondary prevention programming inadvertently neglects a crucial resource for disease management: the patient's partner. In order to address this gap in clinical care, the HHT program [17] was created with the aim of helping both cardiac patients and their partners better manage cardiac disease by strengthening the emotional bond between them. The goals of HHT are to help couples improve their relationship quality, mental health, quality of life, and cardiovascular health. The HHT couples-based intervention is adapted from the Hold Me Tight: Conversations for Connection (HMT) program [18], an intervention based on emotionally focused therapy (EFT) for couples, which is an empirically supported treatment for relationship distress [19,20]. EFT, HMT, and HHT are based on attachment theory, which states that humans have an innate need for close emotional bonds to significant others [10,11]. This need becomes especially pertinent when faced with a threat or stress (eg, a cardiac event); it triggers proximity seeking to "attachment figures" in order

to regulate affect. EFT interventions help couples identify and articulate their vulnerability (eg, "I almost died/I almost lost you") and respond to these feelings in comforting ways, thereby solidifying their sense of security and emotional connection [19,21]. Couples who achieve this connection are happier in their relationships and are more effective problem solvers (eg, managing cardiovascular disease) [22-24]. Inspired by HMT, the HHT program guides couples through seven conversations, based on EFT principles, in which they learn to clearly communicate their need for connection and reassurance, with a focus on heart disease and healthy coping.

Preliminary results from a proof-of-concept study indicated that couples who participated in the HHT program reported significant improvements in relationship quality, mental health, and quality of life [25]. Based on these promising results and to assess the efficacy of the HHT program on a larger sample with additional cardiovascular outcomes, an RCT was initiated. Eligible patients and their partners who consent to participation undergo a baseline assessment and then are randomly assigned to either the HHT program or usual care at the hospital. Usual care participants are followed by their physician for clinical assessment and are referred to the standard programming at the center. All participants are reassessed at 8 and 24 weeks.

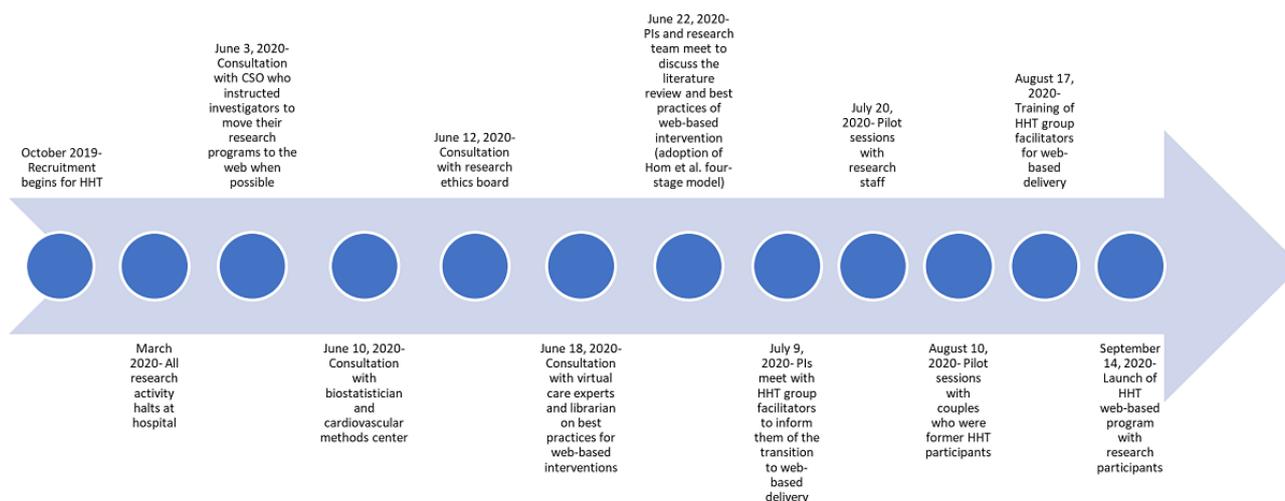
Prior to the COVID-19 pandemic, participants who were randomly assigned to the HHT group attended, in person, eight weekly 2-hour sessions led by two facilitators. The eight sessions focus on understanding love, attachment, and their relationship to heart health; provide an opportunity to share experiences related to cardiovascular disease with partners and peers; and assist in identifying and improving communication patterns that may inhibit positive interactions and healthy behaviors. Throughout each 2-hour session, participants are introduced to concepts through didactic presentations, videos, group and couple discussions, and homework exercises. Additional study procedures and intervention content will be reviewed below as the in-person and web-based HHT programs are compared.

Stage I: Consultation and Assessment of Needs for the Intervention and Research Protocol

Overview

During the first few months of the COVID-19 lockdown in March, April, and May of 2020, the chief scientific officer stopped all research in the hospital. At that time, it was not clear that HHT would have to transition to a web-based platform; many researchers were hoping that the situation with COVID-19 would stabilize within a few months. However, in June 2020, researchers at the hospital were asked to adapt their research protocols to allow for as much virtual care as possible. Following these directives, the HHT research team began to focus on how to do this while following best practices and preserving the integrity of the trial (see [Figure 1](#) for a timeline of the transition to a web-based intervention during COVID-19).

Figure 1. Timeline of the transition to a web-based intervention during COVID-19. CSO: chief scientific officer; HHT: Healing Hearts Together; PI: principal investigator.



Literature Review

The principal investigators of HHT met at the beginning of June 2020 to outline a plan for transitioning to a web-based intervention as well as to review all study procedures to identify areas of required revision (eg, recruitment procedures and presentation of intervention content online). An examination of the current literature to aid in this transition was completed. We were able to identify best practices for virtual care (1) by seeking the help of a research librarian, who assisted with a literature review of resources on how to transition from an in-person psychological intervention to a web-based format, and (2) by consulting with internationally renowned experts in virtual care, who also directed our attention to pertinent literature.

The literature review yielded a small number of resources that provided a framework for the transition [26-33]. More specifically, these articles highlighted key areas of telehealth development, including patient involvement [29], technological support and training for the group facilitators [27], a strong working alliance during web-based therapy [33], ethical considerations [30], and the importance of comprehensive information technology (IT) training and support [28]. A systematic review of telehealth interventions delivering home-based support with group videoconferencing highlighted several benefits of web-based interventions, including improved accessibility, engagement with others facing similar challenges (eg, cardiovascular disease), development of health knowledge and skills, and improved mental health outcomes similar to face-to-face groups [28]. Finally, Hom and colleagues [26] provided a useful framework for modifying a clinical psychiatric program for a web-based platform using four stages: consultation, adaptation, pilot-testing, and test launch.

Research Staff Communication

Following the literature review and consultation with virtual care experts, a focus on ensuring open and clear communication among the members of the research team, who were all working from home, was needed. We chose a web-based collaborative workspace (eg, Trello and Slack) to streamline staff

communication and to assign tasks and deadlines to research staff. This avoided the hassle and confusion of sending multiple emails regarding project updates. Instead, we simply log in to our web-based communication board to view the task list to be completed and by whom. Regular weekly lab meetings were also transitioned to a videoconferencing platform. These meetings assisted in the organization of deliverables and facilitated lab staff cohesion, morale, and motivation during these unprecedented times.

Updating the Funding Agency and Ethics Board

Shortly after research was halted at the hospital, the study's federal funding agency reached out to the nominated principal investigator proactively with an update reassuring all researchers that the funding window would be extended due to the COVID-19 crisis, and that no extra report or documentation would be required. The research coordinator updated the study registry, ClinicalTrials.gov, and the hospital's electronic medical record, noting that the study was no longer actively recruiting. Researchers may need to contact their sponsors or funding agencies to inquire about their specific requirements.

Consultation with our institutional ethics board regarding required study updates for the transition from a predominantly in-person-based study to one with virtual methods was then conducted. Within days of the shutdown, we informed the research ethics board of all changes in research activities (eg, phone contact to inform patients, no recruitment, and temporary follow-up by mail). Although the move to a web-based HHT program does lower the risk of COVID-19 transmission to our participants, there is also an increased risk of privacy breaches with an online format. In response to privacy concerns, a form outlining the changes to our methods and protocol, noting strategies to protect personal health information and privacy, was submitted to the research ethics board for approval. Once the approval was received, a form requesting permission to restart our research study was submitted to our research services department lead by the chief scientific officer of our institution. In this form, we outlined the safety protocols for the in-person baseline and follow-up assessments at the hospital, including appropriate personal protective equipment, cleaning the

workspace once participants have left, physical distancing when possible, and equipment changes to ensure that COVID-19 is not transmitted (eg, new valve in the carbon monoxide monitor). Our research staff attended a consenting and documentation seminar for studies conducting virtual recruitment, consent, and interventions at our facility. The principal investigator completed an online training seminar on how to use the hospital-approved secure videoconferencing platform linked with the hospital's secure electronic medical record software. This information was subsequently shared with staff.

Stage II: Adaptation of Procedures and Materials for Web-Based Delivery

Optimal Web-Based Care Principles

To ensure that we were following best practices in the provision of psychological services via telepsychology, we referred to the guidelines provided by the American Psychological Association [34], the Canadian Psychological Association, and the Ontario Psychological Association, in addition to the previously mentioned resources from the literature review [26-32]. For the purposes of this tutorial, we will highlight the best practices that were most relevant to our study and the adjustments that were required for the research protocol.

Provincial Jurisdiction of Psychological Services

Patients from the neighboring province of Quebec frequently seek services at our Ontario hospital. Because Quebec patients would no longer be able to come to the hospital to participate in the HHT program, the principal investigator contacted the Order of Psychologists of Quebec to obtain their permission to provide services to Quebec residents via a web-based platform. Due to the unusual pandemic circumstances, this permission was swiftly granted. It is recommended that clinician researchers ensure they have the appropriate credentials to provide care in the jurisdiction of the patient.

Security and Transmission of Data and Information

As per the directives at our institution, the hospital-approved videoconferencing platform was employed to run the HHT groups online. The principal investigators reviewed every session of the HHT program and determined that the intervention elements could be delivered securely via videoconferencing.

Appropriate Medium of Delivery

Another crucial factor in successful web-based therapy is the existence of adequate technology, equipment, and usability for research staff and participants. Previous research has shown that web-based interventions face common IT and visual issues, such as audio difficulties, delays, dropouts, background noise, difficulties downloading software, and poor lighting [28]. In response to these common challenges, a checklist for facilitators and potential participants was created to confirm that they had the necessary equipment, technology, and space to do HHT in a web-based format in a secure and private manner. It includes questions that assess whether they have (1) internet access (ie, Wi-Fi or ethernet) at home; (2) two devices that allow for videoconferencing (ie, camera and microphone), such as a desktop computer or laptop, a tablet or iPad, a Chromebook, or

a smartphone; and (3) a quiet and private room in their residence.

Stage III: Adaptation of Procedures and Materials for the Research Protocol

Recruitment

Before the pandemic, recruitment was conducted in person at the hospital when patients came to see their cardiologists for follow-up appointments. Members of the research staff spoke with patients after their appointments and presented an overview of the HHT program. Interested patients agreed to be contacted by study staff, who described the study in greater detail and answered any questions. If still interested, an initial assessment appointment was scheduled. With the new COVID-19 restrictions, most clinical care is done virtually (ie, phone or video appointments). A new standard operating procedure for HHT recruitment was developed outlining the steps to call patients who have already given general consent to be contacted for research purposes at our center. With no in-person clinical visits, recruitment is now completed entirely over the phone. Members of the research staff call potential participants shortly after their phone consultation with their cardiologist and review the technology checklist before proceeding with the recruitment script. If patients do not have the necessary computer equipment, they are not eligible for the study at this time. As the pandemic restrictions ease, patients without the necessary technology will be provided the option to engage in person if randomized to the HHT condition.

Informed Consent

As our study is nonregulated and low risk, our institutional ethics review board informed us that we could adopt a well-documented verbal consent process that permits the research coordinator to read the full written informed consent form to potential participants via telephone. Participants can then ask the research coordinator any questions they have about the study before granting verbal consent. The research coordinator must document the consent process in the participant's research file and electronic medical record, with the help of a verbal consent checklist. If requested by the participant, the consent process may also be completed in person at the time of the assessment at the hospital. In this case, the in-person consent process will still be completed verbally with no transfer of paper between staff and participants.

Other secure methods of obtaining consent via electronic signature software and electronic consent platforms (eg, Research Electronic Data Capture [REDCap] e-consent framework, DocuSign, and Adobe Sign) may also be considered. The advantage of these systems is that they provide a user-friendly option for individuals to personally sign the consent form. However, there are potential disadvantages that include cost, the need for additional institutional approval, and complexity barriers for less tech-savvy individuals. Finally, there is the traditional method of obtaining informed consent by which the study team establishes a process, in alignment with research regulations, whereby the paper consent form is mailed to the participant and, following the consent discussion,

the participant signs the paper consent form and mails it back to the institution. Researchers who are working with external sponsors need to verify with their institution and their sponsor the appropriate informed consent process to use during the pandemic.

Assessment

In the original protocol, patients are asked to come to the hospital for a baseline assessment and two follow-up assessments. Physiological measurements are taken, including heart rate variability, blood pressure, height, weight, waist circumference, carbon monoxide concentration, and salivary samples. In addition, all the couples are asked to participate in a conflict resolution task (ie, a discussion of topics that engender conflict, such as finances, in-laws, or jealousy) that is video-recorded for analysis. The research team initially explored ways to complete these measures remotely, but realized it was not possible for many reasons (eg, cost, coordination of assessment, and variability in measurement). To facilitate coordination of staff on site, the hospital research support office implemented a shared calendar for staff to indicate when they would be on site so as to not exceed maximum pandemic capacity and to allow the coordination of clinical research activity among staff.

Stage IV: Pilot-Testing and Streamlining of Procedures

Pilot Tests

Once the HHT in-person intervention was adapted for web-based administration, the principal investigators (ie, trained group facilitators) ran pilot web-based HHT group sessions with volunteers from the research staff and their partners to identify any issues or problems. During these sessions, features of the videoconferencing platform were explored and problems addressed (eg, chat function and breakout rooms). During the traditional in-person format, the facilitators can quietly and respectfully check in with couples who are working privately on an in-class exercise together. The facilitators realized, however, that without the in-person visual cues, it would prove difficult to identify couples in need of assistance during the breakout sessions or to enter these sessions unannounced. Couples also have the option of notifying their hosts that they are in need of assistance. In addition, to prevent an intrusive interruption, facilitators now provide participants with a screen announcement—audio and video off—letting them know that a facilitator would like to join their breakout room. Next, permission to join is requested via audio, before their video

image is shown. It is important to note that videoconferencing services now have excellent online support centers with helpful videos and tutorials where researchers can learn and explore the features and strategies that exist to enhance their web-based intervention. The lessons learned from the pilot tests were used to create separate tutorials for group facilitators and participants.

Test Launch With Previous HHT Participants

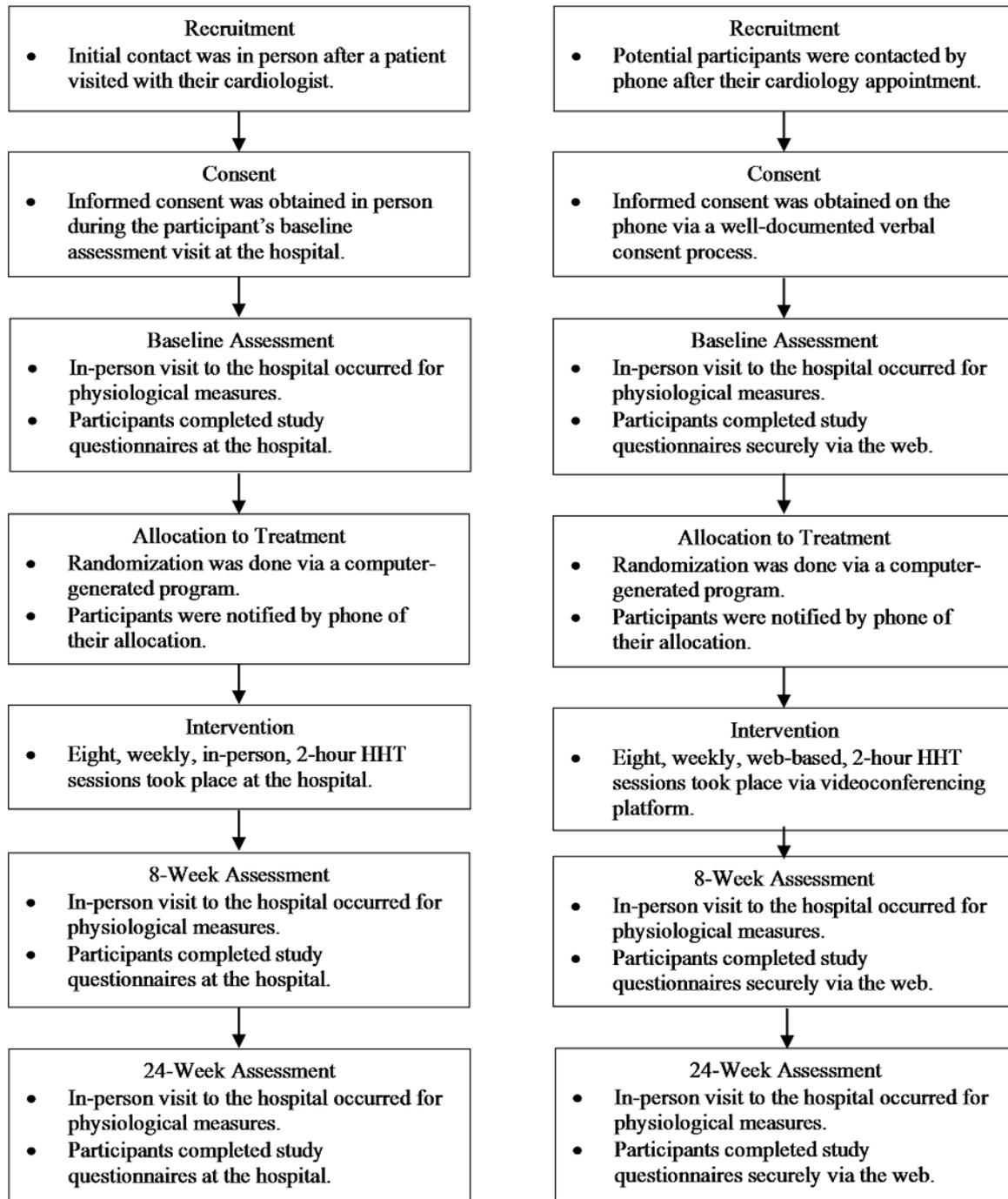
After running the pilot sessions with volunteer research staff and their partners, the principal investigators conducted a pilot HHT session with couples who were previous participants of the in-person HHT program. The research coordinator contacted these individuals in advance to review the technology checklist and to provide a brief tutorial on how to use the videoconferencing platform. By consulting previous participants of the traditional in-person HHT group, the facilitators gained instructive feedback that contributed to treatment fidelity and acceptability of the web-based format [29]. In an informal postsession feedback conversation, the couples provided suggestions, including (1) visual format changes (ie, reduce the slide size) in order to make the presenter's face more prominent to facilitate a personal connection, (2) offer participants a choice between receiving the printed session handouts by mail or digitally via email, and (3) purposefully enhance and monitor group cohesion. Methods to enhance group cohesion online have been suggested recently [35].

Lessons Learned From the Pilot Sessions

The most helpful step, of those outlined by Hom and colleagues [26], was pilot-testing the intervention to staff and previous HHT participants. Facilitators learned that to maximize group cohesion, maximize flow of conversation, and allow participants to contribute substantially to meaningful discussions, limiting the group to a maximum of 5 couples was required. During the sessions themselves, facilitators found it easier to manage the group dynamics by disabling the chat feature—except with the hosts—and by requesting that the participants use their mute function during the didactic and presentation portion of the session to minimize distraction and hearing difficulties. Finally, facilitators realized that it will be important to seek ongoing feedback from all the participants regarding IT issues or anything related to the web-based format; to that end, they employed a brief questionnaire for participants to fill out after the completion of the HHT program (see [Multimedia Appendix 2](#) for the HHT Client Satisfaction Survey). With the pilot sessions completed, the new web-based HHT program was ready to launch (see [Figure 2](#) for a comparison of the original in-person HHT program and the web-based HHT program).

Figure 2. A comparison of the original in-person Healing Hearts Together (HHT) program and the web-based HHT program.

ORIGINAL HHT IN-PERSON PROGRAM **NEW WEB-BASED HHT PROGRAM**



Stage V: Launch of the Web-Based HHT Intervention and Research Protocol

Baseline Assessment

The baseline assessment visit is conducted at the hospital. Participants scheduled for the assessment are now screened for COVID-19 over the phone within 24 hours of their visit. Once they arrive at the hospital, they are rescreened at the hospital

entrance and provided with a mask. Research staff wear appropriate personal protective equipment. Physical distancing regulations are respected, except when completing measurements such as heart rate variability, blood pressure, height, weight, waist circumference, carbon monoxide concentration, and saliva. Proper hygiene procedures are used at every stage of assessment. Questionnaires are completed by participants at home via a secure web application for building and managing web-based surveys and databases (eg, REDCap).

If participants decline an on-site appointment, questionnaires can still be completed online and physiological measures are not completed.

Allocation to Treatment

The randomization process has not changed with the new web-based format. Participants are randomized to the HHT program or to usual care using a computer-generated program at our cardiovascular methods center. Sequences are placed in sealed, numbered, opaque envelopes to ensure concealment of treatment allocation until after baseline data collection. The research coordinator allocates the next available number on study entry, logs all randomizations, and notifies participants of their allocated group immediately by phone. The research coordinator and participants are aware of group allocation. Research assistants, blinded to the participants' treatment allocation, conduct both follow-up assessments.

Intervention

The participants who are randomly assigned to the experimental intervention participate in the new web-based HHT group program. The research coordinator informs participants of their program start date, provides each couple with a brief tutorial of how to access the videoconferencing software, and sends them the intervention materials (eg, book and handouts) via email and/or post before the group start date. For extra technical support, participants receive an email with the prepared tip sheets to help them navigate the web-based format. The number (eight sessions) and duration (2 hours) of sessions remain the same in the web-based format. In this format, couples continue to benefit from the same didactic presentations, videos, and group and couple discussions that were offered in the traditional in-person format. After each web-based session, participants are asked to fill out a very brief feedback questionnaire.

End-of-Treatment and Follow-Up Assessment

As with the baseline assessment, participants will be permitted to go in person to the hospital for their 8-week follow-up assessments. Nevertheless, it was necessary to create a contingency plan that allows for a more flexible approach. Should more strict hospital restrictions emerge, the research staff has prepared alternative means of gathering assessment data, (eg, recording the conflict resolution task via the videoconferencing platform, using self-reported unstandardized height and weight readings, and using self-reported blood pressure readings).

CONSORT Reporting

The research coordinator updated the CONSORT data to include patients who were no longer eligible due to surpassing the eligibility window as well as patients who were unable to complete follow-up assessments due to the pandemic. In addition, revisions were made to the inclusion and exclusion criteria (eg, technology requirements and broader catchment area).

Data Management and Analysis

As COVID-19 restrictions lift, a choice for the in-person versus the web-based HHT program may be provided to participants. However, this creates a new and potentially confounding variable that will need to be included in the database and explored in statistical analyses. A dichotomous variable indicating participation in the web-based or in-person HHT program will then be used as a covariate to control for the mode of delivery. Exploratory analyses can be used to investigate whether the delivery mode made a difference by using an interaction term between delivery mode and the intervention. Advice from the study statistician regarding the above procedures was sought. Researchers should consult with appropriate statistics advisors when interim analyses are conducted and changes to the data analysis plan are considered.

Advantages of the New Web-Based Format

As we updated our protocol, several advantages of the web-based program became evident, both from a clinical and research perspective. These included the following:

1. **Broader recruitment.** With the necessity of weekly travel removed, the potential recruitment of patients living outside of a 1-hour radius from the hospital could now be included. Prior to the pandemic, participants who lived longer than an hour's drive from the hospital were excluded, as it was seldom feasible for couples to drive an hour or more for eight weekly group sessions, in addition to the three assessment appointments, especially in the winter months. However, with the web-based format, participants are required to attend only three assessments on site. As such, from a research perspective, it is important to note that the reduced travel burden permits potential recruitment from rural areas, which will enrich the diversity of our sample.
2. **Flexible scheduling.** Flexibility in scheduling both participants and facilitators for the group sessions and assessments emerged as another benefit of the HHT web-based intervention. With no need to reserve group rooms or to arrange for parking at our busy hospital, finding mutually convenient times for the web-based sessions and for the in-person assessments has been optimized. In addition, all group facilitators can be trained online at their convenience individually or as a group by the research coordinator, a process that allows for streamlined, efficient training and ongoing support for the HHT facilitators [27].
3. **Flexible methodology.** For several years, the gold standard for the informed consent process has involved face-to-face interactions with potential participants. With the recent increase in web-based surveys and interventions, there has been more openness to online consent forms. However, hospital-based clinical trials have always favored the traditional in-person model for obtaining consent. The COVID-19 pandemic has required hospitals and research institutions to adopt more flexible means to obtain informed consent, while assuring high ethical standards. This flexibility toward informed consent and other aspects of

methodology (eg, recruitment and web-based measures) will provide opportunities for researchers who would like to reach a broader population.

Conclusions

When the principal investigators conceptualized and created the HHT program, they envisioned an in-person group program that would help couples grow closer and work well together to improve cardiac health. The COVID-19 pandemic forced hospitals to rethink the mode of delivery for their services. While these drastic changes undoubtedly prompt stress and invoke challenges, there are opportunities for clinical research

to extend the reach of recruitment to hard-to-access populations (eg, patients with chronic conditions or mobility issues and patients who have family and work obligations that do not allow them to leave their homes) and, ultimately, promote patient-centered care. It is understood that researchers around the world will also have to take into consideration the subject matter of their research, as well as the cultural, environmental, occupational, and economic factors in their home countries. Despite the diverse nature of global research, this tutorial aims to serve as a brief, yet comprehensive, framework for clinical researchers facing the challenge to offer flexible and innovative web-based interventions.

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Conflicts of Interest

HT, SJ, and PG are coauthors of the Healing Hearts Together Relationship Program and receive royalties from its sales.

Multimedia Appendix 1

Checklist for clinical researchers transitioning their research and intervention to a web-based platform.

[\[PDF File \(Adobe PDF File\), 28 KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

Healing Hearts Together (HHT) Client Satisfaction Survey.

[\[PDF File \(Adobe PDF File\), 35 KB-Multimedia Appendix 2\]](#)

References

1. Greenman P, Tassé V, Tulloch H. Straight to the Heart: Romantic relationships, attachment, and the management of cardiac disease. In: Rennolds A, editor. *Psychology of Interpersonal Perception and Relationships*. Hauppauge, NY: Nova Science Publishers; 2015:157-174.
2. King KB, Reis HT. Marriage and long-term survival after coronary artery bypass grafting. *Health Psychol* 2012 Jan;31(1):55-62. [doi: [10.1037/a0025061](https://doi.org/10.1037/a0025061)] [Medline: [21859213](https://pubmed.ncbi.nlm.nih.gov/21859213/)]
3. Liu H, Waite L. Bad marriage, broken heart? Age and gender differences in the link between marital quality and cardiovascular risks among older adults. *J Health Soc Behav* 2014 Dec;55(4):403-423 [FREE Full text] [doi: [10.1177/0022146514556893](https://doi.org/10.1177/0022146514556893)] [Medline: [25413802](https://pubmed.ncbi.nlm.nih.gov/25413802/)]
4. Dhindsa DS, Khambhati J, Schultz WM, Tahhan AS, Quyyumi AA. Marital status and outcomes in patients with cardiovascular disease. *Trends Cardiovasc Med* 2020 May;30(4):215-220 [FREE Full text] [doi: [10.1016/j.tcm.2019.05.012](https://doi.org/10.1016/j.tcm.2019.05.012)] [Medline: [31204239](https://pubmed.ncbi.nlm.nih.gov/31204239/)]
5. Robles TF, Slatcher RB, Trombello JM, McGinn MM. Marital quality and health: A meta-analytic review. *Psychol Bull* 2014 Jan;140(1):140-187 [FREE Full text] [doi: [10.1037/a0031859](https://doi.org/10.1037/a0031859)] [Medline: [23527470](https://pubmed.ncbi.nlm.nih.gov/23527470/)]
6. Baucom BRW, Baucom KJW, Hogan JN, Crenshaw AO, Bourne SV, Crowell SE, et al. Cardiovascular reactivity during marital conflict in laboratory and naturalistic settings: Differential associations with relationship and individual functioning across contexts. *Fam Process* 2018 Sep;57(3):662-678. [doi: [10.1111/famp.12353](https://doi.org/10.1111/famp.12353)] [Medline: [29577270](https://pubmed.ncbi.nlm.nih.gov/29577270/)]
7. Donoho CJ, Seeman TE, Sloan RP, Crimmins EM. Marital status, marital quality, and heart rate variability in the MIDUS cohort. *J Fam Psychol* 2015 Apr;29(2):290-295 [FREE Full text] [doi: [10.1037/fam0000068](https://doi.org/10.1037/fam0000068)] [Medline: [25844496](https://pubmed.ncbi.nlm.nih.gov/25844496/)]
8. Cundiff JM, Birmingham WC, Uchino BN, Smith TW. Marital quality buffers the association between socioeconomic status and ambulatory blood pressure. *Ann Behav Med* 2016 Apr;50(2):330-335. [doi: [10.1007/s12160-015-9742-z](https://doi.org/10.1007/s12160-015-9742-z)] [Medline: [26442917](https://pubmed.ncbi.nlm.nih.gov/26442917/)]
9. DiMatteo MR. Social support and patient adherence to medical treatment: A meta-analysis. *Health Psychol* 2004 Mar;23(2):207-218. [doi: [10.1037/0278-6133.23.2.207](https://doi.org/10.1037/0278-6133.23.2.207)] [Medline: [15008666](https://pubmed.ncbi.nlm.nih.gov/15008666/)]

10. Lewis MA, Butterfield RM. Social control in marital relationships: Effect of one's partner on health behaviors. *J Appl Soc Psychol* 2007 Feb;37(2):298-319. [doi: [10.1111/j.0021-9029.2007.00161.x](https://doi.org/10.1111/j.0021-9029.2007.00161.x)]
11. Lewis MA, Rook KS. Social control in personal relationships: Impact on health behaviors and psychological distress. *Health Psychol* 1999;18(1):63-71. [doi: [10.1037/0278-6133.18.1.63](https://doi.org/10.1037/0278-6133.18.1.63)]
12. Trevino DB, Young EH, Groff J, Jono RT. The association between marital adjustment and compliance with antihypertension regimens. *J Am Board Fam Pract* 1990;3(1):17-25. [Medline: [2305637](https://pubmed.ncbi.nlm.nih.gov/2305637/)]
13. Rankin-Esquer LA, Deeter AK, Froeliche E, Taylor CB. Coronary heart disease: Intervention for intimate relationship issues. *Cogn Behav Pract* 2000 Mar;7(2):212-220. [doi: [10.1016/s1077-7229\(00\)80034-6](https://doi.org/10.1016/s1077-7229(00)80034-6)]
14. Valtorta NK, Kanaan M, Gilbody S, Ronzi S, Hanratty B. Loneliness and social isolation as risk factors for coronary heart disease and stroke: Systematic review and meta-analysis of longitudinal observational studies. *Heart* 2016 Jul 01;102(13):1009-1016 [FREE Full text] [doi: [10.1136/heartjnl-2015-308790](https://doi.org/10.1136/heartjnl-2015-308790)] [Medline: [27091846](https://pubmed.ncbi.nlm.nih.gov/27091846/)]
15. Uchino BN, Smith TW, Berg CA. Spousal relationship quality and cardiovascular risk: Dyadic perceptions of relationship ambivalence are associated with coronary-artery calcification. *Psychol Sci* 2014 Apr;25(4):1037-1042 [FREE Full text] [doi: [10.1177/0956797613520015](https://doi.org/10.1177/0956797613520015)] [Medline: [24501110](https://pubmed.ncbi.nlm.nih.gov/24501110/)]
16. Skoyen JA, Kogan AV, Novak SA, Butler EA. Health behavior and emotion regulation in couples. In: Newman ML, Roberts NA, editors. *Health and Social Relationships: The Good, the Bad, and the Complicated*. Washington, DC: American Psychological Association; 2013:121-142.
17. Tulloch H, Greenman P, Demidenko N, Johnson SM. *Healing Hearts Together Relationship Education Program: Facilitator's Guide for Small Groups*. Ottawa, ON: ICEEFT; 2017.
18. Johnson SM. *Facilitator's Guide for Hold Me Tight Groups*. 2nd edition. Ottawa, ON: ICEEFT; 2010.
19. Johnson SM. *The Practice of Emotionally Focused Marital Therapy: Creating Connection*. Philadelphia, PA: Brunner/Mazel; 1996.
20. Wiebe SA, Johnson SM. A review of the research in emotionally focused therapy for couples. *Fam Process* 2016 Sep;55(3):390-407. [doi: [10.1111/famp.12229](https://doi.org/10.1111/famp.12229)] [Medline: [27273169](https://pubmed.ncbi.nlm.nih.gov/27273169/)]
21. Johnson S. *Hold Me Tight: Seven Conversations for a Lifetime of Love*. New York, NY: Little, Brown and Company; 2008.
22. Dalgleish TL, Johnson SM, Burgess Moser M, Lafontaine M, Wiebe SA, Tasca GA. Predicting change in marital satisfaction throughout emotionally focused couple therapy. *J Marital Fam Ther* 2015 Jul;41(3):276-291. [doi: [10.1111/jmft.12077](https://doi.org/10.1111/jmft.12077)] [Medline: [24910261](https://pubmed.ncbi.nlm.nih.gov/24910261/)]
23. Feeney BC. The dependency paradox in close relationships: Accepting dependence promotes independence. *J Pers Soc Psychol* 2007 Feb;92(2):268-285. [doi: [10.1037/0022-3514.92.2.268](https://doi.org/10.1037/0022-3514.92.2.268)] [Medline: [17279849](https://pubmed.ncbi.nlm.nih.gov/17279849/)]
24. Li T, Chan DK. How anxious and avoidant attachment affect romantic relationship quality differently: A meta-analytic review. *Eur J Soc Psychol* 2012 Jan 20;42(4):406-419. [doi: [10.1002/ejsp.1842](https://doi.org/10.1002/ejsp.1842)]
25. Tulloch H, Johnson S, Demidenko N, Clyde M, Bouchard K, Greenman PS. An attachment-based intervention for patients with cardiovascular disease and their partners: A proof-of-concept study. *Health Psychol* 2020 Dec 21:1. [doi: [10.1037/hea0001034](https://doi.org/10.1037/hea0001034)] [Medline: [33346674](https://pubmed.ncbi.nlm.nih.gov/33346674/)]
26. Hom MA, Weiss RB, Millman ZB, Christensen K, Lewis EJ, Cho S, et al. Development of a virtual partial hospital program for an acute psychiatric population: Lessons learned and future directions for telepsychotherapy. *J Psychother Integr* 2020 Jun;30(2):366-382. [doi: [10.1037/int0000212](https://doi.org/10.1037/int0000212)]
27. Inchausti F, MacBeth A, Hasson-Ohayon I, Dimaggio G. Telepsychotherapy in the age of COVID-19: A commentary. *J Psychother Integr* 2020 Jun;30(2):394-405. [doi: [10.1037/int0000222](https://doi.org/10.1037/int0000222)]
28. Banbury A, Nancarrow S, Dart J, Gray L, Parkinson L. Telehealth interventions delivering home-based support group videoconferencing: Systematic review. *J Med Internet Res* 2018 Feb 02;20(2):e25 [FREE Full text] [doi: [10.2196/jmir.8090](https://doi.org/10.2196/jmir.8090)] [Medline: [29396387](https://pubmed.ncbi.nlm.nih.gov/29396387/)]
29. Van Daele T, Karekla M, Kassianos AP, Compare A, Haddouk L, Salgado J, et al. Recommendations for policy and practice of telepsychotherapy and e-mental health in Europe and beyond. *J Psychother Integr* 2020 Jun;30(2):160-173. [doi: [10.1037/int0000218](https://doi.org/10.1037/int0000218)]
30. Lawlor-Savage L, Prentice JL. Digital cognitive behaviour therapy (CBT) in Canada: Ethical considerations. *Can Psychol* 2014;55(4):231-239. [doi: [10.1037/a0037861](https://doi.org/10.1037/a0037861)]
31. McDonald A, Eccles JA, Fallahkhair S, Critchley HD. Online psychotherapy: Trailblazing digital healthcare. *BJPsych Bull* 2020 Apr;44(2):60-66 [FREE Full text] [doi: [10.1192/bjb.2019.66](https://doi.org/10.1192/bjb.2019.66)] [Medline: [31685068](https://pubmed.ncbi.nlm.nih.gov/31685068/)]
32. Békés V, Aafjes-van Doorn K. Psychotherapists' attitudes toward online therapy during the COVID-19 pandemic. *J Psychother Integr* 2020 Jun;30(2):238-247. [doi: [10.1037/int0000214](https://doi.org/10.1037/int0000214)]
33. Watts S, Marchand A, Bouchard S, Gosselin P, Langlois F, Belleville G, et al. Telepsychotherapy for generalized anxiety disorder: Impact on the working alliance. *J Psychother Integr* 2020 Jun;30(2):208-225. [doi: [10.1037/int0000223](https://doi.org/10.1037/int0000223)]
34. Joint Task Force for the Development of Telepsychology Guidelines for Psychologists. Guidelines for the practice of telepsychology. *Am Psychol* 2013 Dec;68(9):791-800. [doi: [10.1037/a0035001](https://doi.org/10.1037/a0035001)] [Medline: [24341643](https://pubmed.ncbi.nlm.nih.gov/24341643/)]
35. Weinberg H. Online group psychotherapy: Challenges and possibilities during COVID-19—A practice review. *Group Dyn* 2020 Sep;24(3):201-211. [doi: [10.1037/gdn0000140](https://doi.org/10.1037/gdn0000140)]

Abbreviations

EFT: emotionally focused therapy
HHT: Healing Hearts Together
HMT: Hold Me Tight: Conversations for Connection
IT: information technology
RCT: randomized controlled trial
REDCap: Research Electronic Data Capture

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