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Evaluation of Mobile Health Applications to Track Patient-Reported Outcomes for Oncology Patients: A Systematic Review

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Abstract

Purpose: In response to the COVID-19 pandemic, there has been a rapid growth in the use of telehealth/telemedicine that will likely be sustained in the postpandemic setting. Mobile health applications (apps) can be used as part of the telehealth encounter to monitor patient-reported outcomes (PROs) and enhance patient-provider communication.

Methods and Materials: A systematic review was performed of mobile health apps with symptom trackers. We searched the iOS App Store and Android Google Play using the words *cancer*, *oncology*, and *symptom tracker*. Apps were included if they incorporated a symptom tracking function that could allow patients with cancer to record symptoms and PROs. Apps were evaluated using the mobile apps rating scale, which includes engagement, functionality, aesthetics, information, and app subjective quality.

Results: The initial search yielded 1189 apps, with 101 apps eligible after title and description screening. A total of 41 apps met eligibility criteria and were included in this study. The majority of apps (73%, n = 30) were general health/pain symptom trackers, and 27% (n = 11) were cancer-specific. The app quality mean scores assessed using the mobile apps rating scale ranged from 2.43 to 4.23 (out of 5.00). Only 1 app has been trialed for usability among patients with cancer.

Conclusions: Although various symptom tracking apps are available, cancer-specific apps remain limited. Future collaboration between oncologists, app developers, and patients to optimize PRO assessment and integration with telehealth/telemedicine encounters to increase symptom recognition and enhance patient-provider communication is urgently needed.

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Introduction

In the face of the current COVID-19 pandemic, there has been a significant increase in the utilization of telehealth/telemedicine.[1-3] Although the pandemic has sped up the integration of these services into clinical practice, we believe that the momentum will continue in the postpandemic setting.[4] Thus, we must determine how to best integrate and optimize the use of telehealth in providing high-level oncology care.

Mobile health (mHealth) apps are a component of telehealth and allow for the use of portable devices to perform health-related services. There are many cancer-focused mHealth apps available in the digital marketplace.[5-7] A

prior review performed in 2014 found 166 apps targeted toward patients with cancer,[7] and an update from 2015 to 2017 identified an additional 123 cancer-focused apps.[6] However, nearly 85% of these apps lacked the ability to track symptoms, side effects, and treatments, despite patient-reported outcomes (PROs) being an increasingly important component of defining patient-centered care and value.[6,7] Indeed, determining ways to integrate real-time collection and evaluation of PROs in a user-friendly and easily integrated electronic format is essential for optimal patient-provider communication and accurate symptom tracking. Importantly, mHealth apps may allow patients to track symptoms and side effects in an efficient and meaningful way. In this study, we evaluate the characteristics of mHealth apps with a symptom tracking function relevant to patients with cancer.

Methods and Materials

Search strategy

In May 2020, we conducted a systematic search on both the iOS App Store and the Android Google Play Store using the following terms in the search engine: *cancer, oncology, symptom tracker*. Only these 2 application stores were searched because they comprise the overwhelming majority of the market share.[8]

Inclusion/selection criteria

A flowchart for the systematic app search is shown in Figure 1. Apps were included if they were smartphone apps that provided a function to track symptoms and were available in English. Apps were excluded if they fell into the following categories: educational/informational, astrology/horoscope, lifestyle/support group, targeted toward providers/health care professionals, meetings/events/conferences, online medical services and diagnosis, specific to a particular health care group or practice, medical journals, study/examination materials, patient portal/health information, professional groups, or nonmedical.

Apps with symptom trackers were excluded if the symptom tracker was limited to a narrow scope of symptoms (eg, apps that only record mood or only list asthma symptoms), if the app was designed for a specific clinic, or if it required a given login/invite code.

Data extraction

Apps were initially screened by app name and description in Google Play and iOS App Store. Apps that met selection criteria were downloaded using either a Samsung s10+ for Google Play apps or an Apple iPhone X for Apple Store apps and further screened. Two co-authors with iPhones conducted the Apple Store app
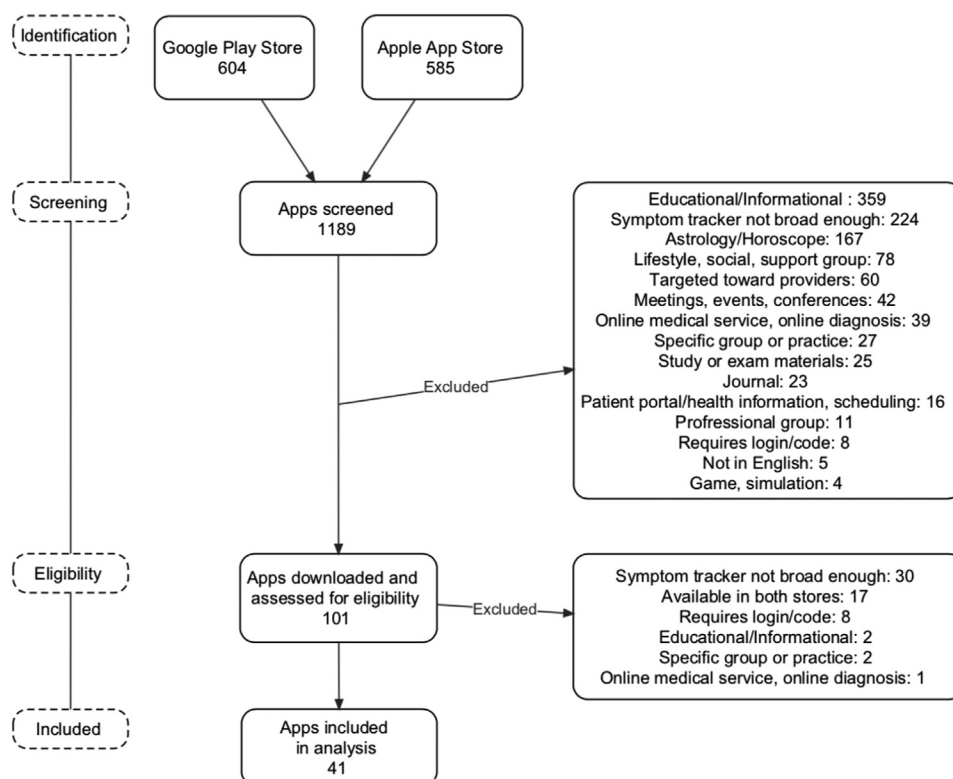
Figure 1   Flowchart for systematic app search in Google Play and iOS app stores.

search and 2 coauthors with Samsung phones conducted the Google Play app search to screen apps for inclusion. Apps available on both platforms were downloaded on both devices, and app characteristics were listed from iOS. Both free and paid apps were included, and free apps with premium features were downloaded to evaluate full functionality of the app.

App evaluation

Apps were analyzed using the mobile apps rating scale (MARS),[9,10] a tool to assess the quality of mHealth apps using an objective and reliable method, which includes the following categories: engagement, functionality, aesthetics, information, and assessment of subjective quality. Apps only available on iOS App Store were reviewed by 2 coauthors with iPhones, and apps only available on Google Play were reviewed by 2 coauthors with Android phones. Apps available on both platforms were reviewed by 3 coauthors (2 with iPhones and 1 with a Samsung phone). A mean score was then derived for each MARS category. Before conducting the MARS evaluation, reviewers developed a shared understanding of the target group for the apps, discussed each MARS item, and piloted a review of a few apps to ensure an appropriate level of interrater consensus ratings. The MARS rating process was overseen by the principal investigator, who has received formal training in digital health as a part of a master's degree in Health Delivery Sciences.

Results

Our initial search identified 1189 total apps (604 apps from the Google Play Store and 585 apps from the Apple App Store). After screening of app name and description, 1088 apps were excluded. The remaining 101 apps were downloaded and assessed for eligibility. After further evaluation of the apps, 60 apps were excluded. A total of 41 apps were included in our study (Fig 1), of which 18 were available in the Apple App Store only, 6 were available in the Google Play App Store only, and 17 were available in both.

A summary of key characteristics of included apps is shown in Table 1. Details regarding characteristics of each app are described in Table E1. The majority of symptom tracking apps (35/41, 85%) were free to download. Three apps had a free trial period ranging from 7 to 30 days, after which a paid subscription was needed, ranging from USD $19.99 to $85.99 annually. Three apps required payment, with costs ranging from USD $2.99 to $4.99. Of the 35 free apps, 9 (26%) had in-app purchases to upgrade to premium or to unlock more app features, such as exporting data or adding additional symptoms. Most apps (30/41, 73%) that met inclusion criteria were general health/pain symptom trackers, and 11 of 41 (27%)

Table 1   Summary of apps

Characteristics	n = 41
Platform	
iOS store only	18 (43.9%)
Google Play only	6 (14.6%)
Both iOS and Google	17 (41.5%)
Cost	
Free	35 (85.4%)
Free for full access	24 (58.5%)
One-time payment for premium	4 (9.8%)
Subscription for premium (monthly or annual)	7 (17.1%)
One-time pay	3 (7.3%)
Subscription required (monthly or annual)	3 (7.3%)
Size of app	
Median	28.65 MB
Range	0.807–101.4 MB

were cancer-specific apps. Of the cancer-specific apps, 5 of 11 (46%) were nonspecific, whereas the remaining 6 included 1 each (1/11, 9%) for blood, lymphoma, head and neck, breast, pancreatic, and ovarian cancers, respectively.

The availability of various symptom tracking functions is outlined in Table 2. The majority of apps allowed for the inclusion of additional symptoms (33/41, 80%), symptom severity rating (39/41, 95%), ability to annotate notes to symptoms (31/41, 76%), and graphical depiction of symptoms over time (24/41, 61%), and had the capability to export/send data (34/41, 83%). Nearly half of the apps (18/41, 44%) had all evaluated app functions available. For apps that included symptom severity scales, Common Terminology Criteria for Adverse Events were not detailed and ratings reflected a patient's subjective symptom severity.

Table 3 summarizes the app quality mean scores from MARS evaluation by highest mean MARS score. The average overall quality MARS score ranged from 2.43 to 4.23, with an average of 3.50. The average scores for the 4 MARS categories were engagement (3.47), functionality (3.70), aesthetics (3.48), and information (3.26). The highest scoring apps were Wave: Your health tracker (4.23), Bearable – Mood & Symptoms (4.20), and Cancer.Net Mobile (4.09). Bearable – Mood & Symptoms and Cancer.Net Mobile are free. Wave: Your health tracker is free, but requires an upgrade (USD $8.99 per month or $26.99 for 6 months) to generate weekly reports. These 3 apps had all evaluated symptom tracking functions available, were easy to navigate, and generated a graph of symptoms over time that could be easily exported and sent to a provider. Health Storylines was the only app (1/41, 2.4%) found to have been trialed for usability and satisfaction ratings.[11]

Table 2   Evaluation checklist for symptom-tracking functions

App name	Symptom tracking function					
	Symptoms listed	Can add symptoms if not listed	Records symptom severity	Can add additional notes	Graphical summary	Can export/ send data
Act React − Personal Diary & Activity Tracker	X	X	X		X	
Bearable − Mood & Symptoms	X	X	X	X	X	X
Blood Cancer Storylines	X	X	X		X	X
Cancer Treatment Calendar	X		X	X		X*
Cancer.Net Mobile	X	X	X	X	X	X
CancerAid	X	X	X	X		
chemoWave	X	X	X	X	X	X*
Chronicle: Chronic Symptom & Pain Tracker	X	X	X	X	X	X
Crystal	X	X	X	X	X	X
Flaredown for Chronic Illness	X	X	X	X	X	X
Focus on Lymphoma	X	X	X	X		X
Head & Neck Cancer Manager	X		X	X		X†
Health Log	X	X	X		X	X
Health Storylines	X	X	X	X	X	X
Living With Cancer	X‡		X	X	X	X†
Manage My Pain	X	X	X	X	X	X
MDHealthTrak - Symptoms Tracker	X	X	X	X	X	X†
My Pain Diary & Symptom Tracker	X	X	X	X	X	X
My Pain Log	X§		X	X	X	X*
myMedDiary	X		X	X	X	
OpenCare - Track Symptoms	X	X	X	X	X	X
Outcomes4Me - Breast Cancer Care	X	X	X			
Pain Log − Pain Tracker			X			X
Pain Tracker & Diary	X§		X	X	X	X
Pancreatic Cancer Action − Symptom Tracker	X	X	X	X	X	X
ReX	X	X	X			X
Sprout Care - Health Tracker	X	X		X		X
Symdir - symptom diary		X	X	X	X	X
Symple Journal	X	X	X	X	X	X
Symple Symptoms Tracker	X	X	X	X		X
Symptom Journal		X	X	X		
Symptom Tracker & Health Diary	X	X	X	X	X	X
Symptom Tracker by NearField		X	X	X		
Symptom Tracker by TracknShare	X	X	X			X
Symptom Tracker: Healthmate	X	X	X			X†
Symptom Tracker: Pain History	X	X*	X			X*
Target Ovarian Cancer Symptoms Diary	X					
Updoc: Health Diary	X	X	X	X	X	X
Wanngi Health Tracker		X	X	X		X
Wave: Your health tracker	X	X	X	X	X	X
Wellth Health Tracker	X	X	X	X	X	X

* Need to upgrade for function.
† Recipient/provider must have app and be registered in the system.
‡ Only tracks mood and pain.
§ Specific to pain.

Table 3   The MARS mean scores of included apps

App name	Engagement (A)	Functionality (B)	Esthetics (C)	Information (D)	Subjective quality (E)	App quality mean score (A + B + C + D)/4
Wave: Your health tracker	4.30	4.50	4.47	3.65	4.10	4.23
Bearable — Mood & Symptoms	4.30	4.63	4.30	3.55	4.28	4.20
Cancer.Net Mobile	4.16	4.13	3.98	4.08	4.13	4.09
Symptom Tracker: Pain History	3.80	4.50	4.33	3.50	4.50	4.03
Head & Neck Cancer Manager	4.30	4.25	4.00	3.50	4.50	4.01
Updoc: Health Diary	3.87	4.25	4.20	3.25	4.38	3.89
Wellth Health Tracker	4.20	3.75	4.00	3.50	4.25	3.86
Sprout Care - Health Tracker	4.00	3.75	4.00	3.50	3.75	3.81
Symple Symptoms Tracker	3.80	4.25	3.67	3.50	3.50	3.81
Symptom Tracker & Health Diary	3.73	3.92	3.89	3.45	3.69	3.75
chemoWave	4.00	3.75	3.83	3.33	3.75	3.73
ReX	3.80	3.75	3.67	3.50	2.50	3.68
Flaredown for Chronic Illness	3.60	3.88	3.67	3.50	3.50	3.66
Crystal	3.78	4.13	3.67	3.00	3.75	3.65
Symptom Tracker by TracknShare	4.00	3.75	3.33	3.50	3.50	3.65
Outcomes4Me - Breast Cancer Care	3.73	3.83	3.63	3.34	4.25	3.63
myMedDiary	3.60	3.75	3.67	3.50	2.50	3.63
OpenCare - Track Symptoms	3.80	4.00	3.67	3.00	3.75	3.62
Wanngi Health Tracker	4.00	3.50	3.33	3.50	2.50	3.58
Focus on Lymphoma	3.80	3.50	3.17	3.80	3.38	3.57
Manage My Pain	3.20	3.83	3.87	3.33	3.31	3.56
Symptom Tracker: Healthmate	3.80	3.50	3.33	3.50	3.00	3.53
My Pain Log	3.60	3.75	3.67	3.00	2.50	3.51
Pain Tracker & Diary	3.67	3.75	3.34	3.25	3.83	3.50
My Pain Diary & Symptom Tracker	3.60	4.00	3.33	3.00	3.00	3.48
MDHealthTrak - Symptoms Tracker	3.27	3.67	3.89	3.00	3.13	3.46
Act React — Personal Diary & Activity Tracker	3.70	3.67	3.33	3.00	4.25	3.43
Cancer Treatment Calendar	3.80	3.50	3.33	3.00	2.50	3.41
CancerAid	3.20	3.13	3.67	3.58	2.63	3.40
Health Storylines	3.20	3.25	3.33	3.50	2.50	3.32
LivingWith: Cancer Support	3.33	3.17	3.45	3.22	2.83	3.29
Blood Cancer Storylines	3.40	3.63	2.83	2.83	1.88	3.17
Chronicle: Chronic Symptom & Pain Tracker	3.30	3.63	2.66	3.00	3.00	3.15
Pancreatic Cancer Action — Symptom Tracker	3.00	3.13	3.17	3.17	3.13	3.11
Health Log	3.10	3.13	3.00	3.00	3.00	3.06
Symdir - symptom diary	3.40	3.25	2.67	2.83	2.25	3.04
Symple Journal	2.86	3.25	2.87	3.05	2.25	3.01
Target Ovarian Cancer Symptoms Diary	2.70	3.13	3.17	3.00	3.13	3.00
Symptom Journal	2.60	3.50	2.30	3.00	1.50	2.85
Pain Log — Pain Tracker	2.30	3.00	2.50	2.75	1.50	2.64
Symptom Tracker by NearField	2.50	3.00	2.00	2.24	1.25	2.43

Abbreviation: MARS = Mobile App Rating Scale.

Discussion

With increasing utilization of telehealth/telemedicine during the COVID-19 pandemic and high likelihood of continued utilization in the postpandemic setting, identification of mHealth apps that can facilitate efficient and enhanced patient-provider communication is critical. Evaluation of PROs enhances patient-provider communication, improves patient satisfaction, and improves health outcomes and survival.[12] Integrating alternatives to traditional paper and pencil questionnaires or nonintegrated electronic questionnaires is important to facilitate the ease of data input for the patient as well as efficient and timely interpretation by the physician. We found that the majority of apps were general symptom or pain trackers and a minority were designed specifically for patients with cancer. None of the apps were specific for radiation oncology patients.

With the rise in virtual visits, it is important that subtle changes in a patient's clinical status not be missed. We found that 95% of the apps in our study allowed patients to rate symptom severity and 61% provided a graphical summary of symptoms over time, which provides insight into the trend of a patient's symptoms and could inform clinical management.

In addition, data collected via mHealth apps need to be readily shared with providers before visits to facilitate meaningful discussions. One trial found that the use of health-related quality-of-life assessments by patients before their clinic visits, which were transformed into a graphic summary and given to the physician before the visit, increased the frequency of discussion of health-related quality-of-life issues and allowed the physician to identify patients with moderate-to-severe health problems in several domains.[13] In our study, the majority of apps (83%) had the capability to export data, but it is not clear whether these data can be imported directly into various electronic health records. Exported data are in the form of a pdf or Excel document and may be saved, printed, and/or emailed. The advertised intended purpose of exporting data included preparing for an upcoming appointment with a health care provider and sharing health trends with care team and family members by viewing, emailing, or printing health reports. The apps reviewed were not described as being intended to serve as an official PRO health record, but as a tool to improve the accuracy of PRO assessments. Finding a way to integrate data collected through the apps with an official PRO health record would help further optimize these apps and enhance their role in telemedicine.

Despite the availability of symptom tracking apps in the digital health market, there are many challenges with using them in routine care. There are concerns regarding disparities of mHealth app use by socioeconomic status,[14] data protection,[15,16] and evidence-based app validation. It is difficult to determine which mHealth apps are Health Insurance Portability and Accountability Act (HIPAA) compliant; this is not provided in the app description, and there is no certification process for HIPAA. Better evaluation and documentation of HIPAA compliance are important to ensure protection of patient data. Future development of successful apps requires collaboration between app developers, health care providers, and patients.[17]

Our study had several limitations. First, we used 3 keywords (*cancer, oncology, symptom tracker*) in our search of the mobile app store, but this may not have identified other apps with symptoms trackers relevant to patients with cancer. Second, we confined our search to the mobile app store because our focus was on mHealth apps, but this excluded website-based programs and applications that may also provide symptom tracking functions. Third, mobile apps were initially screened for a symptom tracking function by reviewing their app descriptions, which could have excluded some apps that actually have symptom tracking features. Fourth, apps with too narrow a scope of symptoms were excluded. Although some of these symptoms are important to patients with cancer, such as mood tracking, we felt that these apps were not broad enough to capture the scope of side effects patients with cancer may experience. Finally, we excluded apps that were tied to a patient portal or medical practice or required a login because we did not have access to these apps. We recognize that these apps may have the ability to collect PROs with improved data protection; however, our goal was to evaluate the readily accessible symptom tracking mobile apps. This should be an area of future exploration.

Conclusions

mHealth apps can be used as an efficient method to track PROs during and after treatment. Although various symptom tracking apps are available in the mobile health market, the number of apps targeted toward patients with cancer remains limited. Further collaboration between oncologists, patients, and app developers to optimize mHealth apps to enhance PRO assessment and integration with telehealth/telemedicine encounters to increase symptom recognition and enhance patient-provider communication is urgently needed.

Supplementary Materials

Supplementary material for this article can be found at https://doi.org/10.1016/j.adro.2020.09.016.

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