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Evaluation of mobile health applications to track patient-reported outcomes for oncology patients: A systematic review

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Evaluation of mobile health applications to track patient-reported outcomes for oncology patients: A systematic review

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Summary

In response to the COVID-19 pandemic, there has been an increase in the use of telehealth. mHealth apps can be utilized as part of the telehealth encounter to monitor patient-recorded outcomes and enhance patient-provider communication. We found 41 apps with symptom tracking functions relevant to oncology patients in the digital health market. However, cancer-specific apps remain limited. Future collaboration between oncologists, app developers, and patients is needed to optimize integration of mHealth apps within telehealth.

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Conclusion: While various symptom tracking apps are available, cancer-specific apps remain limited. Future collaboration between oncologists, app developers, and patients to optimize PROs

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Introduction

In the face of the current coronavirus disease 2019 (COVID-19) pandemic, there has been a

significant increase in the utilization of telehealth/telemedicine.[1-3] While the pandemic has sped up

the integration of these services into clinical practice, we believe that the momentum will continue

in the post-pandemic 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 on the digital marketplace.[5-7] A prior review performed in 2014 found 166 apps targeted

toward cancer patients,[7] and an update from 2015-2017 identified an additional 123 cancer-

focused apps.[6] However, nearly 85% of these apps lack 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 cancer patients.

Methods

Search Strategy

On May 15, 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 two 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 included a function to track symptoms and available in English. Apps were excluded if they fell into the following categories: educational/informational, astrology/horoscope, lifestyle/support group, targeted toward providers/healthcare professionals, meetings/events/conferences, online medical services and diagnosis, specific to a particular healthcare group or practice, medical journals, study/exam materials, patient portal/health information, professional groups, or non-medical.

Apps with symptom trackers were excluded if the symptom tracker was limited to a narrow scope of symptoms (e.g., apps that only record mood or only list asthma symptoms), the app was designed for a specific clinic or 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 Samsung s10+ for Google Play apps or Apple iPhone X for Apple Store apps and further screened. Two co-authors with iPhones conducted the Apple Store app search and screened apps for inclusion and two co-authors with Samsung phones conducted the Google Play app search and 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 app 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 the subjective quality. We calculated and reported the mean scores from each category. Apps only available on iOS App Store were reviewed by two co-authors with iPhones and apps only available on Google Play were reviewed by two co-authors with Android phones. Apps available on both platforms were reviewed by three co-authors (two with iPhones and one with Samsung phone). A mean score was then derived. Prior to 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 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 in Health Delivery Sciences.

Results

Our initial search identified 1189 total apps (604 apps from Google Play Store and 585 apps from 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 (**Figure 1**), of which 18 were available in the Apple App Store only, 6 were available in the Google Play App Store only, and 17 apps were available in both.

A summary of key characteristics of included apps is shown in **Table 1**. Details regarding characteristics of each app is described in **Supplementary Table 1.** 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 is needed, ranging from USD $19.99 - $85.99 annually. Three apps required payment, with costs ranging from USD $2.99 - $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, while 11/41 (27%) were cancer-specific apps. Of the cancer-specific apps, 5/11 (46%) were nonspecific, while the remaining 6 included one 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%), graphical depiction of symptoms over time (24/41, 61%), and had the capability to export/send data (34/41, 83%). Nearly half of apps (18/41, 44%) had all evaluated app functions available. For apps that included symptom severity scales, common terminology criteria for adverse events (CTCAE) were not detailed and ratings reflective 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 four 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/month or $26.99/6 months) to generate weekly reports. These three apps

had all evaluated symptom tracking functions available, were easy to navigate, and created a visually appealing 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%) that we identified that has been trialed for usability and satisfaction ratings.[11]

Discussion

With increasing utilization of telehealth/telemedicine during the COVID-19 pandemic and high likelihood of continued utilization in the post-pandemic 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 non-integrated 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 while a minority were designed specifically for cancer patients. None of the apps were specific for radiation oncology patients.

Also, with the rise in virtual visits, it is important that subtle changes to 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% of the apps provided a graphical summary of symptoms over time, which provides insight on the trend of a patient's symptoms and could inform clinical management.

In addition, data collected via mHealth apps needs to be readily shared with providers prior to visits to facilitate meaningful discussions. One trial found that the use of health-related quality-of-life assessments by patients prior to their clinic visits, which were transformed into a graphic summary and given to the physician prior to the visit, increased the frequency that health-related quality-of-life issues were discussed 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's not clear whether this data can be imported directly into various electronic health records. Exported data is in the form of a pdf or excel, and may be saved, printed, and/or emailed. The advertised intended purpose of exporting data included preparing for an upcoming appointment with a health timeline and sharing health trends with care team and family members by viewing, emailing, or printing health reports. The apps reviewed were not described to be intended as an official PRO health record, but 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 its role in telemedicine.

Despite the availability of symptom tracking apps in the digital health market, there are many challenges with utilizing 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, as this is not provided in the app description and there is no certification process for HIPAA. Evaluation and better documentation of HIPAA compliance is important to ensure protection of patient data. Future development of successful apps requires collaboration between app developers, healthcare providers, and patients.[17]

Our study had several limitations. First, we used three 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 cancer patients. We confined our search to the mobile app store since our focus was on mHealth apps, but this excluded website-based programs and applications that may also provide symptom tracking functions. Second, mobile apps were initially screened for a symptom tracking function by their app descriptions, which could have excluded some apps which actually have symptom tracking features. Third, apps with too narrow of a scope of symptoms were excluded. While some of these symptoms are important to cancer patients, such as mood tracking, we felt that it was not broad enough to capture the scope of side effects

cancer patients may experience. Finally, we excluded apps that were tied to a patient portal or medical practice or required a login as 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.

Conclusion

mHealth apps can be used as an efficient method to track PROs during and after treatment. While there are various symptom tracking apps available in the mobile health market, the number of apps targeted toward cancer patients 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.

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Figure Legend

Figure 1: Flowchart for systematic app search from Google Play and iOS App Stores.

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

Table 2. Evaluation checklist for symptoms 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[a]
Cancer.Net Mobile	X	X	X	X	X	X
CancerAid	X	X	X	X		
chemoWave	X	X	X	X	X	X[a]
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[b]
Health Log	X	X	X		X	X
Health Storylines	X	X	X	X	X	X
Living With Cancer	X[c]		X	X	X	X[b]
Manage My Pain	X	X	X	X	X	X
MDHealthTrak - Symptoms Tracker	X	X	X	X	X	X[b]
My Pain Diary & Symptom Tracker	X	X	X	X	X	X
My Pain Log	X[d]		X	X	X	X[a]
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[d]		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[b]
Symptom Tracker: Pain History	X	X[a]	X			X[a]
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

[a] Need to upgrade for function

[b] Recipient/provider must have app and be registered in the system

[c] Only tracks mood and pain

[d] Specific to pain

Table 3. The Mobile App Rating Scale (MARS) mean scores of included apps.

App Name	Engagement (A)	Functionality (B)	Aesthetics (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

Figure

Figure 1. Flowchart for systematic app search from Google Play and iOS App Stores.