

Telehealth with Comprehensive Live-Fed Real-World Data as a Patient Care Platform for Lung Cancer: An Implementation & Evaluation Study

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Abstract

Background: Telehealth has emerged as an effective channel providing outpatient services in many countries. However, majority telehealth systems focus on operational functions offering sectional patient journey at the most. Experience of incorporating longitudinal real-world medical record data by taking advantage of telehealth is valuable but has not been widely shared. The benefits of such a telehealth platform with comprehensive live-fed real-world data for cancer patient care are yet to be studied.

Objective: The primary purpose of this study is to understand the feasibility and benefits of cancer patient care using a telehealth platform with live-fed longitudinal real-world data supplemental to hospital electronic medical records systems, specifically from physician's perspective.

Methods: A telehealth platform was built and launched for physician and patient registration. Real-world data was collected and curated using a comprehensive data model. Physician activities using the telehealth platform are recorded as system logs and analyzed. A survey was conducted in February 2023 among the registered physicians to assess the qualitative effectiveness of patient care, and quantitative benefits of their before and after experience including number of patients managed, time spent, dropout rate, visits rate, followup data. Descriptive and inferential statistics are performed on the datasets.

Results: Over a period of 15 months, 16 035 unique users (13 888 patients, 1 539 friends and family members, 174 physician

groups with 608 individuals) were registered. More than 382 000 messages including text, reminders, pictures, etc. were generated by physicians in communicating with patients. 78 group leaders (45% of the groups) participated the survey. 84%(65.6/78, SD: 8.7) of the participants reported positive experience of efficient communication, remote supervision, quicker response to questions, adverse event prevention, more complete followup data, patient risk reduction, cross-organization collaboration and in-person visits reduction. Majority of them (76% - 97.4%) estimated improvements in time spending, number of patients managed, drop off rate and access to medical history, average ranging from 57% to 105%. When comparing to prior platforms, responses from those physicians indicate better experience in time spending, drop off rate and medical history while number of patients managed does not show significance.

Conclusions: This study indicates that a telehealth platform with comprehensive live-fed real-world data for cancer patient care is feasible and effective inpatient management with improved time spending, drop off rate and access to medical history and positive experience in physician-patient interaction.

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Original Manuscript

Telehealth with Comprehensive Live-Fed Real-World Data as a Patient Care Platform for Lung Cancer: An Implementation & Evaluation Study

Abstract

Background: Telehealth has emerged as a popular channel for providing outpatient services in many countries. However, majority of the telehealth systems focus on operational functions offering only sectional patient journey at the most. Experience of incorporating longitudinal real-world medical record data by taking advantage of telehealth is valuable but it has not been widely shared. The feasibility and usability of such a telehealth platform, with comprehensive live-fed real-world data for cancer patient care, are yet to be studied.

Objective: The primary purpose of this study is to understand the feasibility and usability of cancer patient care using a telehealth platform with live-fed longitudinal real-world data as a supplement to hospital electronic medical records systems, specifically from physician's perspective.

Methods: A telehealth platform was constructed and launched for the registration of physician and patient. Real-world data were collected and curated using a comprehensive data model. Physician activities on the platform were recorded as system logs and analyzed. In February 2023, a survey was conducted among the registered physicians to assess the specific areas of patient care and to quantify their before and after experiences including number of patients managed, time spent, dropout rate, visits rate, followup data. Descriptive and inferential statistics were performed on the datasets.

Results: Over a period of 15 months, 16,035 unique users (13,888 patients, 1,539 friends and family members, 174 physician groups with 608 individuals) registered. More than 382,000 messages including text, reminders, pictures, etc. were generated by physicians in communicating with patients. 78 group leaders (45% of the groups) participated in the survey. Eighty-four percent (65.6/78, SD: 8.7) of the participants reported positive experience of efficient communication, remote supervision, quicker response to questions, adverse event prevention, more complete followup data, patient risk reduction, cross-organization collaboration and in-person visits reduction. The majority of them (76% - 97.4%) estimated improvements in time spent, number of patients managed, drop off rate and access to medical history, average ranging from 57% to 105%. When compared to prior platforms, responses from those physicians indicated better experience in time spent, drop off rate and medical history while the number of patients managed did not show significant change.

Conclusions: This study suggests that a telehealth platform, equipped with comprehensive live-fed real-world data, is feasible and effective for cancer patient care. It enhances inpatient management by improving time efficiency, reducing drop-off rates, and providing easy access to medical history. Moreover, it fosters a positive experience in physician-patient interactions.

Keywords: telehealth; real-world data; patient engagement; lung cancer

Introduction

According to GLOBOCAN 2020 report, the cancer mortality rate is higher in China than that in developed countries. Lung cancer remains the most common and deadliest type of cancer, with estimated 0.82 million new cases and 0.72 million deaths in 2020 in China [1]. In contrast to the rapidly declined mortality rate of lung cancer in developed countries between 2000 and 2012 [2], the trend for the lung cancer mortality rate was stable in China from 2000 to 2016 [3]. Despite favorable survival outcome data for Chinese patients in international randomized clinical trials, these do not reflect the real-world situation for the general population. The less-than-optimal progress in cancer control, especially in terms of the mortality rate, may be attributed to healthcare disparities between different regions, particularly urban and rural areas [4,5]. Clinical trial data from inadequately represented cancer patient populations could be complemented with real-world evidence to better inform healthcare practice and policy decisions [6].

The rapid development and adoption of new treatment regimens have made post-treatment care a critical factor in extending cancer survival rate and improving patients' quality of life [7]. Concurrently, telehealth has quickly become a major care delivery mechanism in recent years, a trend accelerated by the COVID-19 pandemic. One of the ongoing efforts to sustain and scale digital health involves enabling data sharing and integration across different health systems [8]. Consequently, most telehealth systems today rely on point-in-time medical records which do not contain historical records or data from other institutes. To overcome this data barrier, the platform implemented in this study has the capability to acquire medical records directly from patients.

Though there are perceivable benefits to having comprehensive medical records for telehealth, enabling comprehensive and longitudinal data for each patient involves tremendous efforts. Such data is also critical for deriving conclusive real-world evidence [9]. From a data acquisition perspective, it must be inclusive, especially the vitals related to patients' daily health status throughout the entire treatment period, in addition to diagnosis and treatment information [10]. While this is achievable nowadays with the adoption of wearables and mobile devices, there are still tremendous challenges in compiling patients' journeys longitudinally as there are no unified nation-wide platforms that can consolidate all relevant data from all healthcare institutions in China [11, 12]. The ever-increasing mobility of patients across the country has exacerbated the data segmentation issue. Presumably, due to the improvement of annual income per household in recently years, and the deployment of inter-state healthcare systems, many patients opt for top-tier hospitals regardless of the travel distances from their hometowns. It is quite common for one patient to receive treatments from different hospitals at various stage while the hospital systems are disconnected. The lack of longitudinal data from such fragmented health services may also contribute to subpar care and survival outcomes [13,14].

The distinct feature of telehealth that this study is interested in is its use as an adjunct to traditional physical visits and face-to-face consultations, particularly for post-treatment care and continuity of care from a physician's perspective. Much of the study on telehealth usage has been focused on patients as the user population. Williams and Shang examined the use among

low-income minority population in the US and found the use of telehealth varies between race, employment status, identified gender, education level, and age[15]. Acoba et al. studied racial disparities in cancer patients during telehealth visits and confirmed satisfaction is different between race groups [16]. Turner et al. evaluated the experiences of healthcare providers and professionals during the COVID-19 pandemic, and concluded the need of implementation strategies and necessary policies [17]. In the area specific to cancer patient, teledermatology has emerged as a popular mechanism [18]. Lama et al. found more half of cancer survivors use internet or telehealth by providers using cross-sectional study [19].

One of the specific aspects being assessed is follow-up, a unique challenge for cancer care in China, primarily due to the substantial patient-to-physician ratio [20]. Follow-ups based on patient-reported outcomes (PROs) can improve the overall survival (OS) rate due to early relapse detection and better performance status at relapse. A study published in 2017 found that patients who reported their symptoms via the online tool survived seven months longer than those who received usual care through regular screenings [21]. A previous meta-analysis incorporating 21 studies also demonstrated that the reporting of PROs, including quality of life and disease symptoms, were significantly associated with tumor response to anti-cancer therapies such as chemotherapy, targeted therapy, and radiotherapy [22].

The platform used for this study, named WeDoc, is cloud-based and currently focuses on lung cancer. It consists of a mobile app for physicians, a WeChat mini-program for patients, and a cloud-based data and analytical component serving as the backend. The platform contains comprehensive longitudinal medical records sourced from all relevant hospitals, supplemented with third party test results, patient-reported outcomes, follow-up data, and more. The underlying data model is highly customizable to individual physician's needs and contains curated fields commonly used for cancer clinical research.

Methods

Overview

A cloud-based telehealth platform was built and launched for licensed oncologists and their patients. Patient medical records were collected and curated into a proprietary lung cancer data model. Physician and patient activities are recorded on the platform. A survey containing qualitative and quantitative questions was conducted 20 months after launch. Descriptive statistics and regression analysis were conducted on the survey data.

Analysis is conducted on two sets of data: activities recorded on the platform and results from a usage survey. Both sets of data are gathered from the perspective of physician, as the first-stage goal of this platform is to function as an assistant for physicians.

Platform implementation and user activity recording

The backend of the platform features a data processing pipeline, data and process management interfaces, and cloud repositories for raw, curated, and research data. Original data is de-identified, masking all personal details. This data is then abstracted and reviewed by trained personnel, and the abstracted data is consolidated, checked for quality, and committed to the Real-World Data repository.

Patients on the platform are invited by their oncologists and can form a user group with family members or friends. Oncologists can invite physicians and caregivers to create a treatment group, facilitating remote collaboration and simplifying hospital transfers. Patient reminders, assessments, and symptom feedback are gathered, and any potential adverse events are escalated to the primary oncologist.

The system's data model incorporates the schema of electronic medical records, patient outcome reports, and periodic progression assessments by physicians, with a primarily focus on lung cancer data. Data abstraction and data quality assurance involve both manual processes and regularly executed algorithms.

Survey design and questionnaire

The platform records the number of registered users and their activities. In March 2023, about 20 months post launch, an online usage survey was carried out using a WeChat survey mini program. The program was pushed to all registered users as a study advertisement. The survey consisted of both qualitative and quantitative questions. Instead of individual physicians, each treatment group leader was asked to compile the group's experience and provide responses. This approach was taken because the group leader dictates the use of the platform, and each group member may only utilize a subset of its functions.

The survey questions were designed to evaluate physician's patient care experience using the platform. This includes basic functions and follow-up, their estimation of promptness in answering patient questions, patient risk reduction, cross-organization collaboration, and handling out-of-town patients. Quantitative questions asked for the number of patients managed, both outpatient and in-patient, the reduction in physical visits, patient drop-off rate, and time spent on collecting medical history during each visit. All identifiable information about participants was removed, and each individual was assigned a unique participant ID.

Table 1 Survey question categories, description and answer options.

Question Category	Question Description	Answer Options
Patient care functions	A1 – (Efficient communication) The platform serves as a communication channel for physicians to provide online notification of important matters.	Single choice selection of binary options (Agree or Disagree) for each statement as a Checkbox selection.
	A2 – (Remote supervision) The platform enables physicians to engage continuous supervision and remote interaction.	
	A3 – (Medical history retrieval) The platform offers patients' medical history and communication records for physicians to review.	
	A4 – (Patient administrative processes) The platform helps hospital appointment scheduling for both outpatient and inpatient procedures.	
	A5 – (Response to patient question on time) The platform enables physicians to promptly answer patients' questions without in-person visits.	
	A6 – (Adverse event prevention) The platform enables physicians to timely capture potential adverse reactions from patient feedbacks.	
Follow up	B1 – (Treatment status availability) Before: it was hard to acquire patient status. After: Patient status is easy to gather from the	

	platform.	
	B2 – (Survival status availability) Before: it was hard to acquire survival status. After: survival status is provided on the platform.	
	B3 – (Data comprehensiveness) Before: records were incomplete. After: multi-dimensional comprehensive data is available on the platform.	
	B4 – No differences between before and after using the platform.	
Response promptness	C – With the platform, are you able to respond to patient inquiries quicker than before?	Single choice selection of 3 options (Yes, No or Unknown) for each question as a Radio button selection.
Patient risk reduction	D – After using the platform, do you feel that your patients have lower risk in getting adverse reactions?	
Cross-org collaboration	E – Have you established collaborations across different departments, hospitals, or even regions through the platform?	
Manage remote patients	F – Is managing out-of-town patients more convenient for you by using the platform?	Single choice selection of 5 quantitative ranges: 1: 10-20% 2: 20-50% 3: 50-100% 4: > 100% 5: 0%
More patients managed per unit time	G –With the platform, how many more patients can you manager within the same amount of time?	
In-person visits saved	H –After using the platform, what is your estimation of the average number of in-person visit reduction per patient per year?	Single choice selection of 5 quantitative ranges: 1: 1-3, 2: 4-6, 3: 7-10, 4: > 11, 5: 0
Prior telehealth experience	I – Before using WeDoc, did you use any other telehealth platforms for patient management?	Single choice selection of Yes or No
Patient management specifics	How many minutes per day do you spend on managing patients?	Quantitative values entered by participants
	What is the total number of patients you manage?	
Outpatient management	How many outpatient visits in total do your lung cancer patients have per month?	
	What percentage of your lung cancer patients are likely to miss their outpatient visits each month?"	
In-patient management	How many lung cancer patients do you have for inpatient treatment per month?	
	What percentage of your inpatient patients discontinue their treatment each month?	
Medical history collection	How many minutes do you spend on collecting medical history for each patient visit?	

Statistical analysis

Descriptive statistics and regression analysis were conducted using Python program. For descriptive analysis, we calculate means, medians, standard deviation, and ranges. For quantitative questions regarding usage before and after, we used the Shapiro-Wilk test to

assess the normal distribution of the data. Subsequently, we employed a Wilcoxon Rank Sum test to evaluation the significance of the datasets. We used G*Power analysis [23] for difference between two dependent means (matched pairs), setting $\alpha = 0.05$, $\beta = 0.2$, and $d_z = 0.5$, assuming a medium difference between the before and after groups, a sample size of 27 is sufficient for the tests.

Ethical considerations

This study was reviewed and approved by Yinchuan Ningfei Internet Hospital under approval number HLWYJ-2022-016. Participants were not compensated for their participation.

Results

Activities recorded on the platform

Over a period of 15 months, 608 physicians from 153 hospitals have registered on the platform. The hospitals are from 21 out of the 34 total provinces in China. 93% of the physicians are from hospitals rated as Grade III, Level A which is the highest rating according to the latest statistics [24]. From a department perspective, 46% of the physicians are from the Oncology Department, 42% from the Department of Respiratory and Critical Care Medicine, and 12% from other departments.

Table 2. Physician and patient profiles registered in the system including number of hospitals, departments, physicians, treatment groups, and patients.

Characteristics	Counts, n (%)
Total Hospitals	153
Grade III Level A	142 (93%)
Others	11 (7%)
Total Departments	270
Oncology	125 (46%)
Respiratory and Critical Care Medicine	113 (42%)
Others	32 (12%)
Total Physicians	608
Treatment group leader	174 (28.6%)
Total treatment groups	211
Total patients & family members	15,427
Total patients	13,888
Non-resident patients	7,826 (56.3%)

One of the platform's features is for physicians to create treatment groups by including other physicians. Among the 608 physicians, 174 of them have one or more groups. There are a total of 211 groups, with most physicians managing between one to three groups. A patient may be part of multiple groups, depending on the group's purpose and the stage of the treatment period. For instance, a patient undergoing inpatient chemotherapy might initially be in a group with radiologist in the hospital, but later transferred to a follow-up group consisting only of the

lead oncologist and the follow-up assistant. Table 2 describes profiles of physicians and treatment groups.

Besides physicians and caregivers, there are 15,427 users including patients and family members on the platform. Within those users, about 10% are family members or friends.

Table 3. Activity log of message types and quantities from physicians.

Message type	Typical usage	Message counts
Text	Chats between patient and physician	222,012
Reminder	Appointments and preparation items for appointment	66,985
Picture	Pictures in chat with patient	32,548
PatientEducation	Articles, videos, URL links etc. for general patient education	27,538
TeamMessage	Messages between physicians within the same group	19,779
ScaledAssessment	Patient self-assessment of various aspects	8,005
Voice	Voice messages for patient	5,884

Survey questionnaire responses

Participants Characteristics

A total of 78 group leaders participated in the survey, representing about 45% (78/174) of the total treatment groups. All the groups are associated with Group III, Level A hospitals. Of these participants, 42% (33/78) are from the three mega-cities: Beijing/Shanghai/Guangzhou (BSG). The gender distribution shows that 54% (42/78) are male. In terms of departmental affiliation, 59% (46/78) are from the Oncology Department, 33% (26/78) from the Respiratory Department, and the remaining participants are from other departments. As for the age distribution of the leaders, 42% (33/78) are between 40-50 years old, 31% (24/78) are between 50-60 years old, 19% (15/78) are between 30-40 years old, 5% (4/78) are between 20-30 years old, and 2 out of 78 are above 60 years old. While 53 had prior experience with telehealth platforms, 25 are the first-time user of telehealth. Participant characteristics are summarized in Table 4.

Table 4. Profiles of participants in this study (N=78)

Characteristics	Participants, n (%)
City location	
Beijing/Shanghai/Guangzhou	33 (42%)
Others	45 (58%)
Gender	
Female	36 (46%)
Male	42 (54%)
Departments	

Oncology	46 (59%)
Respiratory	26 (33%)
Others	6 (8%)
Age group (years)	
20-30	4 (5%)
30-40	15 (19%)
40-50	33 (42%)
50-60	24 (31%)
60+	2 (3%)
Prior telehealth usage	
No	25 (32.1%)
Yes	53 (67.9%)

Qualitative question results

For the questions from A1 to F, which include topics of communication efficiency, remote supervision, response time to questions, adverse event prevention, followup data completeness, patient risk reduction, cross-organization collaboration and remote patient management, participants provided qualitative answers to each question. The results are shown in Table 5. Positive answer indicates an agreement to the statement or yes to the question. Negative answer indicates a disagreement to the statement or no to the question. Most of the questions received positive answers except the topic of cross-organization collaboration which shows nearly neutral feedback, 53.8% positive vs. 46.2% negative. The questions of treatment status availability, survival status availability and data comprehensiveness (B1, B2 and B3) contain both before and after statements. A negative answer may indicate that the participant only disagrees to part of the statement. Therefore, the final results of these questions evaluate less in favor of the WeDoc tool.

On the question of the number of patients managed using the tool, 35.9% of the participants estimated 20-50% more patients with the same amount of the time spent. While 6 of the participants estimated 0 increase. Similarly, on the question of the number of in-person patient visits reduction, 38.5% estimated 4-6 visits saved per year and 6 of them did not see any saving.

Among the 78 participants, 53 (67.9%) of them had prior telehealth usage experience, while it is the first time for the remaining group to use a telehealth tool. We divide the participants to two groups, with and without telehealth usage experience for some of the further analysis.

Table 5. Results of qualitative survey questions (N=78)

Question Description	Survey Result, n (%)	
	Positive	Negative
A1: Efficient communication	76 (97.4%)	2 (2.6%)

A2: Remote supervision	73 (93.6%)	5 (6.4%)
A3: Medical history retrieval	69 (88.5%)	9 (11.5%)
A4: Patient administrative processes	58 (74.4%)	20 (25.6%)
A5: Response to patient question on time	69 (88.5%)	9 (11.5%)
A6: Adverse event prevention	67 (85.9%)	11 (14.1%)
B1: Treatment status availability	68 (87.2%)	10 (12.8%)
B2: Survival status availability	58 (74.4%)	20 (25.6%)
B3: Data comprehensiveness	68 (87.2%)	10 (12.8%)
B4: No difference	8 (10.3%)	70 (89.7%)
C: Response promptness	70 (89.7)	8 (10.3%)
D: Patient risk reduction	70 (89.7)	8 (10.3%)
E: Cross-organization collaboration	42 (53.8%)	36 (46.2%)
F: Manage remote patients	78 (100%)	0 (0%)
I: Prior telehealth experience	53 (67.9%)	25 (32.1%)
G: More patients managed per unit time		
0%	6 (7.7%)	
10-20%	20 (25.6%)	
20-50%	28 (35.9%)	
50-100%	7 (9.0%)	
>100%	17 (21.8%)	
H: In-person visits saved per year		
0	6 (7.7%)	
1-3	12 (15.4%)	
4-6	30 (38.5%)	
7-10	21 (26.9%)	
>11	9 (11.5%)	

Quantitative question results

For questions from J to P, participants were asked to provide quantitative values for their experiences of both before and after using the tool. Table 6 summaries the descriptive characteristics of the values for each question. The 'Unknown' category indicates null values in the survey, and they were omitted in the analysis. The highest unknown answer we received was for the question of the number of patients managed before using the tool. We use G*Power analysis for the remaining nonnull before and after pairs to ensure that there are sufficient samples for analysis. With an assumption of medium differences between the before and after groups, at least 27 samples must present in the group.

Table 6. Results of quantitative survey questions (N=78).

Question Description	Quantitative value received					Unknown N (%)
	Min	Median	Max	Mean	SD	

Time spent managing patients (minutes)						
J1: Before	10	30	180	50.5	45.1	18 (23.1%)
J2: After	3	20	120	25.5	22.7	10 (12.8%)
Number of patients managed (N)						
K1: Before	0	40	800	105.7	177.4	20 (25.6%)
K2: After	1	100	1606	324.3	428.8	13 (16.7%)
Monthly outpatient lung cancer patients (N)						
L1: Before	0	85	2000	221.8	352.2	8 (10.3%)
L2: After	0	80	2000	237.1	369.6	8 (10.3%)
Outpatient patients drop off rate (%)						
M1: Before	0	25	80	26.8	21.1	11 (14.1%)
M2: After	0	10	50	13.1	11.4	11 (14.1%)
Monthly inpatient lung cancer patients (N)						
N1: Before	0	60	350	110.1	93.5	2 (2.6%)
N2: After	0	70	350	116.2	94.8	2 (2.6%)
Inpatient patients drop off rate (%)						
O1: Before	0	10	50	14.9	12.1	5 (6.4%)
O2: After	0	5	100	9.2	16.2	5 (6.4%)
Time collecting medical history (minutes)						
P1: Before	2	10	180	14.0	28.8	5 (6.4%)
P2: After	1	3	120	8.8	19.2	3 (3.8%)

To better understand the differences between the Before and After results, we use Shapiro algorithm to test whether the values fall in normal distribution. For normally distributed data series, t-Test can be used to compare the pair. Otherwise, Wilcoxon Test is a more suitable method. Since the P values of Shapiro Test are much less than the common hypothesis threshold of 0.05, we conclude that none of the pairs is normally distributed. Therefore, Wilcoxon tests are used to perform the Before and After pairs. Table 7 shows the Shapiro Test and Wilcoxon Test results for the 7 quantitative question pairs. The Wilcoxon results suggest that there are two questions without significant difference between the Before and After pairs: the number of monthly outpatient patients admitted, and the number of monthly inpatient patients admitted. This result is quite explainable as the telehealth tool itself is not aimed to recruit new patients, so that monthly patients almost kept the same. For the topics with significant change, we calculate the improvement based on the mean value collected by the survey, which is also shown in Table 7.

Table 7. Quantitative results of Before and After questions using Wilcoxon Test

Question Description	Shapiro Test (P-value)	Wilcoxon P-value	Mean Improvement
Time spent managing patients (J1, J2)	$P<.001$	$P<.001$	88%
Number of patients managed (K1, K2)	$P<.001$	$P=.01$	63%
Monthly outpatient patients admitted (L1, L2)	$P<.001$	$P=.66$	-
Outpatient patients drop off rate (M1, M2)	$P<.001$	$P<.001$	105%

Monthly inpatient patients admitted (N1, N2)	$P<.001$	$P=.59$	-
Inpatient patients drop off rate (O1, O2)	$P<.001$	$P<.001$	62%
Time collecting medical history (P1, P2)	$P<.001$	$P<.001$	57%

Although the survey was not specifically designed to evaluate the group which has prior telehealth platform experience vs. the group which does not have, we discover that 67.9% of the participants had used telehealth tools before. In order to understand the experience by this group, we carried out a Wilcoxon Test for the Before and After questions answered by these participants. Table 8 shows the P value of Wilcoxon Test and the improvements of their mean values. The numbers of monthly admitted outpatient and inpatient lung cancer patients still did not change significantly. However, there is no significant change of the number of patients managed either. This result suggests that physicians may not manage more patients using WeDoc than other telehealth platforms, the differences are within the areas of time spent managing patients, drop off rate of outpatient and inpatient patients, and time collecting medical history.

Table 8. Quantitative results of Before and After questions by those who had prior telehealth platform experience using Wilcoxon Test

Question Description	Shapiro Test (P-value)	Wilcoxon (P-value)	Mean Improvement
Time spent managing patients (J1, J2)	$P<.001$	$P<.001$	77%
Number of patients managed (J3, J4)	$P<.001$	$P=.06$	-
Monthly outpatient patients admitted (K1, K2)	$P<.001$	$P=.75$	-
Outpatient patients drop off rate (K3, K4)	$P<.001$	$P<.001$	102%
Monthly inpatient patients admitted (L1, L2)	$P<.001$	$P=.65$	-
Inpatient patients drop off rate (L3, L4)	$P<.001$	$P<.001$	159%
Time collecting medical history (M1, M2)	$P<.001$	$P<.001$	63%

Discussion

Principal Findings

Specific Feedbacks of the Platform

Results from activity logs and survey responses demonstrate the feasibility of cancer patient care using telehealth with live-fed, real-world database. Specifically, 84% (65.6/78, SD: 8.7) of participants responded positively to Question A1 through F. The lowest scores were for patient administrative processes and survival status. Patient administrative processes in China are complex and not the primary focus of this platform, while obtaining updated survival status during follow-up is clearly an area of improvement. Another area which did not stand out was cross-organization collaboration, presumably due to the deployment of other specialized platforms such as Multidisciplinary Team (MDT), which is popular in China. 92.3% of participants believe that they can manage more patients with the same amount of time, and an equal number of physicians agree that the platform saves at least one or more instances of in-person visits.

The same population conducted a quantitative estimation of before and after experience. Our analysis shows that 5 out of the 7 categories are significantly different between the before and after

experiences, as determined by the Wilcoxon Signed Rank test. The two categories which did not show significant differences were the monthly outpatient and inpatient patient admissions. These two factors are unaffected by the use of any patient management tool; thus, they are indeed irrelevant to our telehealth platform.

Perception from Those with Prior Telehealth Usage

Given that 67.9% of the participants had prior experience of telehealth platforms, analyzing this population alone yielded similar results, except that the number of patients managed did not meet our significance value assumption of 0.05. This implies that while managing more patients is a benefit of telehealth platforms, it may not be unique to ours. The strengths of a telehealth platform with real-world data, are manifested in the categories of time efficiency, drop-off rate and access to patient's medical history.

Remote Patient Management

The adoption of remote patient management is manifested in patient profiles, which show that more than half of the patients, about 56.3%, appear to be none-resident patients. 941 patients have experienced a transfer from one hospital to another, and almost 1,500 patients had prior diagnoses or treatments from hospitals other than their current ones. Taking hospitals in Shanghai as an example, the platform shows that about 35% of patients are from cities other than Shanghai. Although more than half of them are from adjacent provinces such as Jiangsu and Zhejiang, some travel thousands of miles from places like Heilongjiang, Sichuan, Liaoning etc. Because of the unbalanced healthcare condition in China, it is quite common for patients to be diagnosed in one hospital and receive treatments from another. Despite significant improvements over the past decades, the best oncologists and medical facilities are still heavily concentrated in top cities.

Text as the Dominant Message Type

Activity log indicates that text is the most commonly used message type for communicating to patients. The use of pictures and voices messages is significantly less than that of texts. Reminders are also quite popular, followed by educational materials. Preliminary analysis did not reveal significant differences in usage patterns among physicians, so this study does not present usage data by physician profile.

Security & privacy

With the adoption of the Personal Information Protection Law (PIPL) [25] on November 01, 2021, in China, all systems handling data of Chinese citizens must be compliant with the law. This law is widely seen as China's equivalent of the GDPR [26]. The system in question acts as both a data handler and a data processor. It controls the scope of data usage based on the level of consent obtained from users, making user consent a mandatory prerequisite for successful user registration. By separating raw data and identifiers from curated, de-identified data, the system ensures the proper implementation of data protection policies.

From an operation perspective, privacy protection remains one of the most significant challenges in building such a platform. The challenge is less technical, as there are rich sets of mechanisms available, such as data anonymization, encryption, access control, audit etc. The main challenge comes from the perceptions and cooperation of patients. Ideally, patients and their relatives should also have access to real-world data, enabling them to participate in making treatment decisions. Apart from patient perception, potential malpractice concerns

also hinder data sharing, preventing people from gaining strategic insights. Healthcare policymakers and scientific researchers need to collaborate with data analysts to promote a proper data-sharing process.

Limitations

Although this study is based on a live system with real-world data and experiences, the findings remain preliminary. At present, the platform only provides services to the lung cancer population, and the results of this study are derived from physicians from a subset of the treatment. Although the user base of the platform encompasses both physicians and patients, future research involving a broader population, including more physicians and direct patient experiences, may yield new, insightful findings. It would also be interesting to expand to other disease. Given the large quantity of chat messages accumulated on the platform, a detailed examination of these messages paired with language processing models, would be a fascinating next step.

Conclusion

This study demonstrates the feasibility of using telehealth for patient management. As the focus of cancer treatment shifts towards patient care, telehealth in the form either of mobile apps, web-based interfaces, or other formats, will play an increasingly critical role in enabling physicians to maintain close contacts with patients, regardless of physical location. We advocate for the integration of telehealth with comprehensive real-world medical record data, so that such a platform can provide patient management capabilities. This could eventually lead to improved quality of life and survival rates of cancer patients.

Authors' Contributions

DZ, YS, YP and LJ contributed to the conception and the design of the study. JN, LP, XT, ZD, YZ, AG, JW, XL, JZ refined the research questions and provided feedback to the study design. WH, CZ, CL, HL, YD, JX, DW, XC, RM, XD assisted with platform function review, usability test and helped on participant recruitment. YS, SL designed the survey questions and provided data analysis. DZ, LP, XT, YD, XD, YR, LJ drafted the manuscript.

Data Availability

The data sets analyzed during this study are available from the corresponding author on reasonable request.

Conflicts of Interest

YP and SL are co-founders of Metafame Technologies Inc. that developed the system. However, the system is not marketed as a paid service.

Abbreviations

JMIR: Journal of Medical Internet Research

EMR: Electronic Medical Record

PRO: Patient Reported Outcomes

RWD: Real-World Data
RWE: Real-World Evidence
OS: Overall Survival
PFS: Progression-Free Survival
DFS: Disease-Free Survival
DICOM: Digital Imaging and Communications in Medicine
OCR: Optical Character Recognition
CTCAE: Common Terminology Criteria for Adverse Events
RECIST: Response Evaluation Criteria in Solid Tumors
GDPR: General Data Protection Regulation

References

1. Wei Cao, Hong-Da Chen, Yi-Wen Yu, Ni Li, and Wan-Qing Chen. Changing profiles of cancer burden worldwide and in China: a secondary analysis of the global cancer statistics 2020. *Chinese Medical Journal*, 134(07):783-791, 2021.
2. Rui-Mei Feng, Yi-Nan Zong, Su-Mei Cao, and Rui-Hua Xu. Current cancer situation in China: good or bad news from the 2018 global cancer statistics? *Cancer communications*, 39(1):1-12, 2019.
3. Wanqing Chen, Rongshou Zheng, Peter D Baade, Siwei Zhang, Hongmei Zeng, Freddie Bray, Ahmedin Jemal, Xue Qin Yu, and Jie He. Cancer statistics in china, 2015. *CA: a cancer journal for clinicians*, 66(2):115-132, 2016.
4. Qi Wang and Jie Jiao. Health disparity and cancer health disparity in China. *Asia-Pacific Journal of Oncology Nursing*, 3(4):335-343, 2016.
5. Anli Leng, Jun Jing, Stephen Nicholas, and Jian Wang. Geographical disparities in treatment and health care costs for end-of-life cancer patients in China: a retrospective study. *BMC cancer*, 19(1):1- 14, 2019.
6. CY Yuen, A Bergamasco, and Y Moride. Mapping of existing data sources for the conduct of real-world studies on lung cancer in China. *Value in Health*, 19(7):A851, 2016.
7. Linda A Jacobs and Lawrence N Shulman. Follow-up care of cancer survivors: challenges and solutions. *The Lancet Oncology*, 18(1):e19-e29, 2017.
8. Burbury, Kate, Zee-Wan Wong, Desmond Yip, Huw Thomas, Peter Brooks, Leslie Gilham, Amanda Piper, Ilana Solo, and Craig Underhill. "Telehealth in cancer care: during and beyond the COVID-19 pandemic." *Internal Medicine Journal* 51, no. 1 (2021): 125-133.
9. Beth Schurman. The framework for FDA's real-world evidence program. 2019.
10. Xin Sun. Real-world data and real-world evidence. In *Advanced Statistics in Regulatory Critical Clinical Initiatives*, pages 105-132. Chapman and Hall/CRC, 2022.
11. Jia Zhong, Jun Zhang, Honghao Fang, Larry Liu, Jipan Xie, and Eric Wu. Advancing the development of real-world data for healthcare research in China: challenges and opportunities. *BMJ open*, 12(7):e063139, 2022.

12. Feifei Jin, Chen Yao, Xiaoyan Yan, Chongya Dong, Junkai Lai, Li Li, Bin Wang, Yao Tan, and Sainan Zhu. Gap between real-world data and clinical research within hospitals in China: a qualitative study. *BMJ open*, 10(12):e038375, 2020.
13. Xin Sun, Jing Tan, Li Tang, Jeff Jianfei Guo, and Xinling Li. Real world evidence: experience and lessons from China. *Bmj*, 360, 2018.
14. RD Neal, P Tharmanathan, B France, NU Din, S Cotton, J Fallon-Ferguson, W Hamilton, A Hendry, M Hendry, Ruth Lewis, et al. Is increased time to diagnosis and treatment in symptomatic cancer associated with poorer outcomes? systematic review. *British journal of cancer*, 112(1):S92–S107, 2015.
15. Williams, Cynthia, and Di Shang. "Telehealth Usage Among Low-Income Racial and Ethnic Minority Populations During the COVID-19 Pandemic: Retrospective Observational Study." *Journal of Medical Internet Research* 25 (2023): e43604.
16. Acoba, Jared D., Chelsea Yin, Michael Meno, Justin Abe, Ian Pagano, Sharon Tamashiro, Kristy Fujinaga, Christa Braun-Inglis, and Jami Fukui. "Racial Disparities in Patient-Provider Communication During Telehealth Visits Versus Face-to-face Visits Among Asian and Native Hawaiian and Other Pacific Islander Patients With Cancer: Cross-sectional Analysis." *JMIR cancer* 8, no. 4 (2022): e37272.
17. Turner, Kea, Margarita Bobonis Babilonia, Cristina Naso, Oliver Nguyen, Brian D. Gonzalez, Laura B. Oswald, Edmondo Robinson et al. "Health care providers' and professionals' experiences with telehealth oncology implementation during the COVID-19 pandemic: a qualitative study." *Journal of Medical Internet Research* 24, no. 1 (2022): e29635.
18. Leah Kirsten Jones, Amanda Oakley. Store-and-Forward Teledermatology for Assessing Skin Cancer in 2023: Literature Review. *JMIR Dermatol.* 2023 May 17; 2023;6:e43395
19. Lama, Yuki, Amy Davidoff, Robin C. Vanderpool, and Roxanne E. Jensen. "Telehealth Availability and Use of Related Technologies among Medicare-enrolled Cancer Survivors: An Early Snapshot from the COVID-19 Pandemic." *Journal of Medical Internet Research* (2021).
20. Shuxiang Ma, Yan Huang, Yunpeng Yang, Yuxiang Ma, Ting Zhou, Hongyun Zhao, Likun Chen, Ningning Zhou, and Li Zhang. Prevalence of burnout and career satisfaction among oncologists in china: A national survey. *The oncologist*, 24(7):e480–e489, 2019.
21. Fabrice Denis, Claire Lethrosne, Nicolas Pourel, Olivier Molinier, Yoann Pointreau, Julien Domont, Hugues Bourgeois, Hélène Senellart, Pierre Trémolières, Thibaut Lizée, et al. Randomized trial comparing a web-mediated follow-up with routine surveillance in lung cancer patients. *JNCI: Journal of the National Cancer Institute*, 109(9), 2017.
22. David Victorson, Mehul Soni, and David Cella. Metaanalysis of the correlation between radiographic tumor response and patient-reported outcomes. *Cancer: Interdisciplinary International Journal of the American Cancer Society*, 106(3):494–504, 2006.
23. G*Power. URL: <http://www.gpower.hhu.de/> [accessed 2023-05-16]
24. China statistical yearbook 2018. China Statistics Press, Beijing, 2018.
25. Fengying Wu, Lei Wang, and Caicun Zhou. Lung cancer in China: current and prospect. *Current opinion in oncology*, 33(1):40–46, 2021.

26. Daniel Albrecht. Chinese first personal information protection law in contrast to the european gdpr. Computer Law Review International, 23(1):1-5, 2022.



Supplementary Files

Untitled.

URL: <http://asset.jmir.pub/assets/0d24a94b8b694f31be688a1acbce7358.xlsx>

Figures

Patients seeking treatment in Shanghai but from other provinces.

