



# Improving Pain Management at Home: Integrating Patient-Reported Outcomes into a Mobile Application

Li-Lu Chang, RN, DNP; Meng-Kuan Chiang, RN, MSN

Center for Advancement of Nursing Education, Koo Foundation Sun Yat-Sen Cancer Center, Taipei, Taiwan

## Introduction

Cancer-related pain is a prevalent and often undertreated issue in outpatient settings, with 30–60% of patients reporting inadequate pain management (Jacobsen et al., 2010; Liang et al., 2011; Valeberg et al., 2008). Patient-Reported Outcomes (PROs) offer an effective way to assess pain in real time, supporting timely clinical decisions (Zhi et al., 2021; Kotronoulas et al., 2014).

To address these challenges, the Pain App was developed as a smartphone-based tool designed to empower cancer patients in self-reporting their pain levels, tracking medication usage, and distant monitoring side effects. The app incorporates four key modules: pain assessment, medication reminders, patient education, and visualization of PRO results (Figure 1).

Although mobile applications for pain management have demonstrated potential, there is limited evidence regarding their long-term effectiveness and patient acceptance in clinical practice (Jibb et al., 2017; Yang et al., 2019). This study aimed to assess the feasibility and impact of using institution-developed Pain App to improve outpatients' cancer pain management.

## Methods

This time-series study was conducted from January to September 2022 at a cancer hospital in Taiwan. A custom App was developed to allow patients to record and track their pain severity and functional scores at home, generating longitudinal reports accessible to healthcare providers. Participants were followed for 8 weeks, until pain issues were resolved or until they withdrew from the study. Nurses monitored entries and followed up as needed. Outcomes were analyzed using McNemar, and Proportion Z tests to evaluate pain trends and App usability.

## Results

Out of 143 patients screened and 84 enrolled completed data collection across all five time points (T1–T5). The average age was  $54.7 \pm 9.17$  years. Most had metastatic cancer (87.3%) and were undergoing active treatment—chemotherapy (50.8%) and targeted therapy (34.9%) being the most common. Pain medications included weak opioids (49.2%) and strong opioids (46.0%). The pain scores were collected at five time points: T1 (Day 1), T2 (Days 5–9), T3 (Days 12–16), T4 (Days 19–23), and T5 (Days 26–30). Mean pain scores were  $2.79 \pm 1.62$  (T1),  $2.92 \pm 1.57$  (T2),  $2.87 \pm 1.57$  (T3),  $2.98 \pm 1.56$  (T4), and  $2.60 \pm 1.52$  (T5). Although McNemar tests showed no significant changes between baseline and T2–T5 when comparing “better” vs. “worse” statuses, the Z-test findings suggest a meaningful shift in the overall pain experience, with more participants maintaining or reaching pain relief over time (Table 1).

- The proportion of patients classified as “better” increased by +6.3% ( $p < 0.001$ )
- The “same bad” group decreased by –6.0% ( $p < 0.001$ )
- The “same good” group increased by +4.7% ( $p < 0.001$ )

Participants reported that the app was user-friendly and appreciated its real-time feedback and educational content. Among its features, the most valued was the daily self-reporting of pain, which effectively prompted timely responses from nurses or physicians to address patients' pain-related concerns.

Table 1. A comparison between the percentage of patients with pain at baseline ( $\Delta T2$ ) and other time periods ( $\Delta T3$ ,  $\Delta T4$ ,  $\Delta T5$ ).

variables	better D (Z <sup>a</sup> ,p)	worse D (Z <sup>a</sup> ,p)	same good D (Z <sup>a</sup> ,p)	same bad D (Z <sup>a</sup> ,p)
$\Delta T3\text{-}\Delta T2$	-4%(7.15,p<0.001)	-1%(2.14,p=0.032)	1.5%(1.24,p=0.215)	4.7%(3.01,p=0.003)
$\Delta T4\text{-}\Delta T2$	3.1%(3.74,p<0.001)	6.3%(6.93,p<0.001)	-6%(5.51,p<0.001)	-3%(2.04,p=0.041)
$\Delta T5\text{-}\Delta T2$	6.3%(6.93,p<0.001)	-4%(7.15,p<0.001)	4.7%(3.61,p<0.001)	-6%(4.12,p<0.001)

<sup>a</sup> Proportion z-test. \* $p < 0.05$ . \*\* $p < 0.01$ .

T1: day 1. T2: days 5-9. T3: days 12-16. T4: days 19-23. T5: days 26-30.  $\Delta Tn$  denotes the comparison between T1 and Tn.

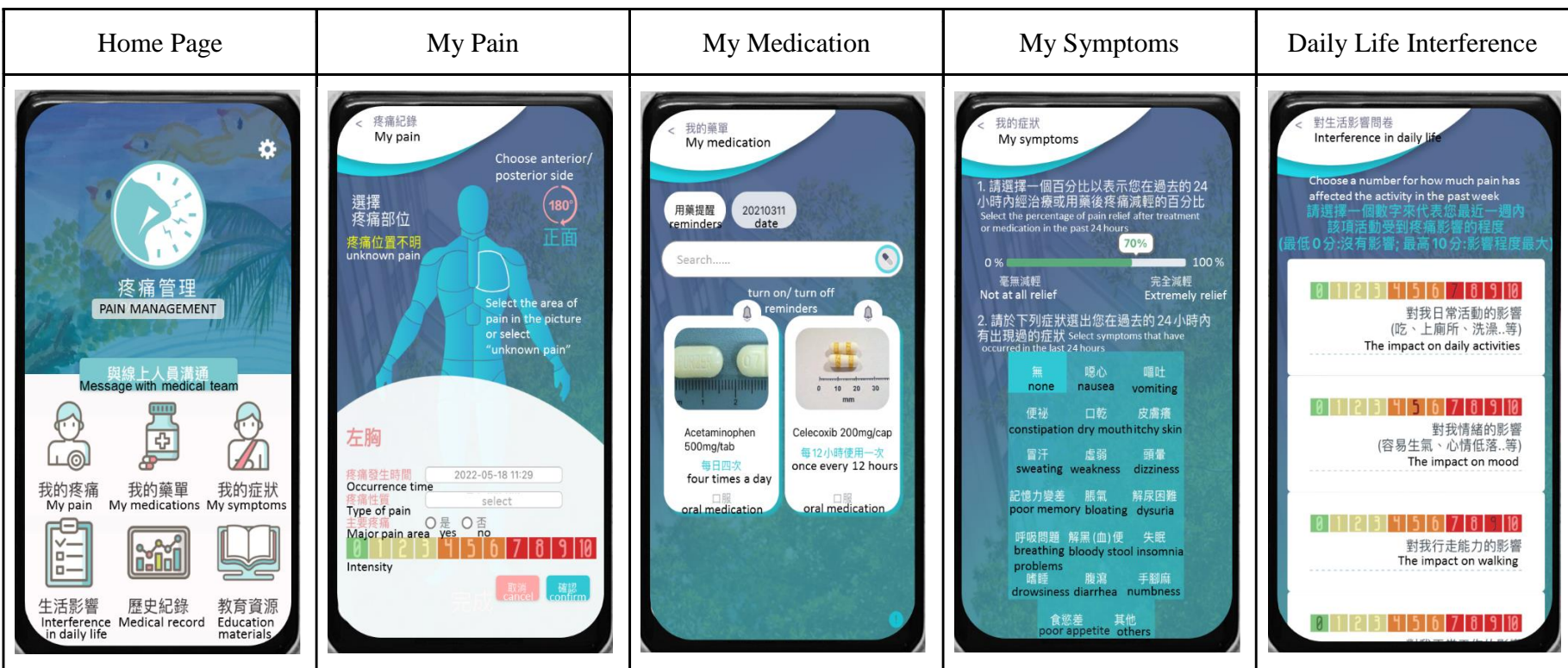


Figure 1. The user interface of the App includes Home Page, My Pain, My Medication, My Symptoms and Daily Life Interference.

## Conclusions

This study demonstrated that integrating a mobile application for patient-reported outcomes into cancer pain management is both feasible and well-received by patients. While average pain scores remained relatively stable, a statistically significant increase in the proportion of patients reporting pain improvement over time was observed.

The Pain App enabled real-time symptom tracking and nurse-initiated support, contributing to enhanced patient engagement and satisfaction. These findings support the clinical implementation of the App as a supportive tool for outpatient cancer pain management.

Future work should focus on routine clinical integration of the app and conducting larger-scale studies or randomized controlled trials to evaluate further its long-term impact on pain score reduction and self-management efficacy in diverse patient populations.

## References

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