Use of a Smartphone Medical App Improves Complications and Quality of Life in Patients with Nasopharyngeal Carcinoma Who Underwent Radiotherapy and Chemotherapy

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Background: We explored the intervention effect of a smartphone medical app on complications and quality of life of patients with nasopharyngeal carcinoma who underwent radiotherapy and chemotherapy.

Material/Methods: We divided 132 patients with nasopharyngeal carcinoma who received radiotherapy and chemotherapy for the first time, in accordance with the random number table method, into a control group (67 patients) and an intervention group (65 patients). Patients in control group were discharged with standard care and patients in the intervention group used a smartphone medical app after discharge. Data on adverse effects of radiotherapy and chemotherapy, complications, and quality of life were collected and analyzed.

Results: There was no difference between the complications of radiotherapy and chemotherapy and quality of life between the 2 groups at discharge (P>0.05). The incidence of oral mucositis, xerostomia, mouth-opening difficulties, and nasal congestion in the intervention group was significantly lower than in the control group at 6 months after discharge and quality of life was significantly higher than in the control group (P<0.05).

Conclusions: Reasonable use of this smartphone app can improve the exercise compliance of discharged patients with nasopharyngeal carcinoma who underwent radiotherapy and chemotherapy, reduce the adverse reactions and complications of radiotherapy and chemotherapy, and improve quality of life and satisfaction of patients after discharge.

MeSH Keywords: Mobile Applications • Nasopharyngeal Neoplasms • Postoperative Complications • Quality of Life

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Background

Nasopharyngeal carcinoma (NPC) is a malignant tumor that occurs in the nasopharyngeal mucosa epithelium [1,2] and is generally treated with radiation therapy [3,4]. However, the complications and adverse reactions after radiotherapy and chemotherapy cannot be ignored [5], such as oral mucosal lesions, mouth-opening difficulties, xerostomia, hearing loss, and nasal congestion [6,7], but most patients with NPC only receive conventional discharge health education after their radiotherapy and chemotherapy treatment in the hospital. Because of their poor self-management ability, it not only affects the treatment effect, but also seriously affects their quality of life.

A smartphone medical application (app) can play a positive role in the self-management of patients and improve the compliance behavior of patients. In 2011, a survey in the United States showed that 84% of respondents have a smartphone, and that 53% of people with smartphones already use apps in clinical practice. The use of smartphones and apps is prevalent among orthopedic care providers in academic centers [8]. Another survey revealed patient behavior patterns that would be useful in future app development. Being able to record, analyze, seamlessly share, and obtain feedback on the SMBG data using an iPhone/iTouch app might benefit patients [9]. GM Turner-mc-grievy reported the potential benefits of mobile monitoring methods during behavioral weight loss trials. Future studies should examine ways to predict which self-monitoring method works best for an individual to increase adherence [10]. However, the current research on the use of mobile medical apps for discharged NPC patients who underwent concurrent radiotherapy and chemotherapy has not been further studied. Therefore, in the present study we used a smartphone medical app as an intervention method for discharged NPC patients who underwent radiotherapy and chemotherapy to share information about NPC disease, such as observation and treatment of complications of radiotherapy and chemotherapy, as well as regular re-examination, to improve the self-management ability of discharged patients so that they can effectively deal with complications of radiotherapy and chemotherapy and improve their quality of life.

Material and Methods

Patients

We randomly divided 132 patients admitted to the Rhinology Department of our hospital from March 2015 to March 2017 into 2 groups: 65 patients were assigned to the intervention group and 67 patients were assigned to the control group. Inclusion criteria were: (1) patients with NPC confirmed by histopathology and received radiotherapy and chemotherapy for the first time, (2) had the ability to take care of themselves, (3) had reading ability, (4) provided informed consent. Exclusion criteria were: (1) severe cardiovascular and cerebrovascular complications, (2) severe cognitive, mental, and language disorders. All patients provided signed informed consent. This research was approved by the Institutional Ethics Committee of First Affiliated Hospital of Zhengzhou University.

Intervention method

Control group: Patients in the control group received a conventional follow-up visit after hospital discharge, in which patients were informed after discharge about relevant issues by their physician, including diet, exercise, and rehabilitation exercise, and were told that they should attend re-examinations at 3 and 6 months after discharge.

In the intervention group, when patients were discharged, they were asked to download the smartphone medical app and complete rehabilitation after discharge according to the app guidelines. The smartphone medical app intervention manager asked patients about their use of the app by telephone follow-up every month. According to characteristics of NPC, the app includes 3 special modules: a re-examination reminder, a knowledge base, and an online expert. With the re-examination reminder, 3 days before the re-examination, the app administrator notifies the patients to review. The knowledge base informs patients consists of text, pictures, and videos, including a rehabilitation exercise video, assessment and treatment of adverse reactions and complications, medication, diet, activities and rest, and psychological guidelines. With the online expert, every Wednesday and Saturday, a doctor is scheduled to answer patients’ questions online to help doctors know about recovery after discharge. Patients can also interact with other patients, share information about rehabilitation after discharge, and upload rehabilitation pictures.

Data collection and processing

We collected and evaluated data on complications after radiotherapy and chemotherapy, rehabilitation exercise compliance, and quality of life at discharge and at 3 months and 6 months after discharge. Patients were asked to complete a questionnaire and report on their condition according to uniform instructions, and this process was completed by the patients themselves. Patients were contacted by telephone to remind them about follow-up at 3 and 6 months, and at the same time complete the patient condition form. Patients who could not go to the hospital for re-examination were followed-up by mail or telephone.

Statistical analysis

SPSS17.0 software was used for statistical analysis. Enumeration data were checked by chi-square test, and the
independent-samples t test was used to assess the data. Rank data were tested by rank sum test method, and the level of test was 0.05 (α=0.05).

**Results**

**Basic information**

We divided the 132 patients with NPC who received radiotherapy and chemotherapy for the first time, in accordance with the random number table method, into a control group (67 patients) and an intervention group (65 patients) (Table 1). There was no significant difference between the 2 groups in gender, age, course of disease, or chemotherapy and radiotherapy regimens (P>0.05).

**Comparison of radiotherapy and chemotherapy complications**

Table 2 compares complications in the 2 groups, including xerostomia, oral mucositis, hearing loss, mouth-opening difficulties, and nasal congestion. Patients had varying degrees of xerostomia, oral mucositis, hearing loss, mouth-opening difficulties, and nasal congestion at discharge. There was no significant difference in the incidence of these complications between the 2 groups (P>0.05). Xerostomia was the most common complication, and the incidence rates in the 2 groups were 89% and 92%, respectively.

At 6 months after discharge, the incidence and severity of oral mucositis, mouth-opening difficulties, xerostomia, and nasal obstruction in the intervention group was significantly lower than that in the control group, and there was a significant difference between the 2 groups (P<0.05). This indicated that the intervention had positive effects on improving xerostomia and oral mucositis for discharged patients. The app knowledge base includes measures to improve the incidence of these complications, such as encouraging patients to rinse with dilute saline and use sodium bicarbonate mouthwash, keep the mouth clean, increase intake of liquids, jointly present nasal irrigation content in the form of pictures and videos, and help patients improve cognitive level and compliance, so as to improve the symptoms of nasal congestion.

**Comparison of compliance of rehabilitation exercise between 3 and 6 months after discharge**

Taking mouth-opening exercises and nasal irrigation compliance as examples, the results of rehabilitation training compliance are shown in Table 3. Results showed that the compliance of mouth-opening exercises and nasal irrigation in the intervention group was higher than that in the control group at 3 and 6 months after discharge (P<0.05). The incidence of mouth-opening difficulties and nasal congestion was significantly lower than in control group at 6 months after discharge, indicating that the smartphone app can effectively improve the symptoms of mouth-opening difficulties and nasal congestion.

**Comparison of quality of life between the 2 groups at 6 months after discharge**

Quality of life in the 2 groups after discharge was investigated using the Quality of Life Questionnaire (QLQ-C30) [11], which was designed by the European Cancer Treatment Research
At 6 months after discharge, quality of life scores of control and intervention groups were better than at discharge, indicating that most patients had improved quality of life. In the functional and overall quality of life field, scores of the intervention group were higher than in the control group at 6 months after discharge (P<0.05). In the area of symptoms, scores of fatigue and pain in the intervention group were lower than those in the control group (P<0.05). In the single area, such as sleep loss, appetite loss, and constipation, the scores of the intervention group was lower than that of the control group (P<0.05). The results indicated that the app can further improve fatigue, pain, sleep loss, appetite loss, constipation, and other symptoms, which is helpful to further improve the overall quality of life of patients.

### Table 2. Comparison of side effects and complications of radiotherapy and chemotherapy in two groups [N (%)].

| Items                          | Grade | At discharge       | Z/χ² | P    | 6 months after discharge | Z/χ² | P     |
|-------------------------------|-------|-------------------|------|------|--------------------------|------|-------|
|                               |       | Group C N1=65     | Group I N2=67 |      |                          |      |       |
| Oral mucositis                | 0     | 8 (12)            | 13 (19) |      | 34 (52)                  | 52 (78) |      |
|                               | I–II  | 40 (61)           | 40 (59) | -0.757 | 29 (45)                  | 12 (19) | -2.138 | 0.033 |
|                               | III–IV| 17 (27)           | 14 (22) |      | 2 (3)                    | 3 (3)  |      |      |
| Mouth opening difficulties    | 0     | 16 (24)           | 15 (22) |      | 23 (36)                  | 45 (68) |      |
|                               | I–II  | 38 (58)           | 42 (63) | 0.000 | 31 (48)                  | 14 (22) | -2.397 | 0.017 |
|                               | III–IV| 11 (18)           | 10 (15) |      | 11 (16)                  | 8 (10)  |      |      |
| Xerostomia                    | 0–I   | 39 (60)           | 43 (64) | -0.503 | 42 (65)                  | 51 (76) | -2.335 | 0.020 |
|                               | II–III| 26 (40)           | 24 (36) | 0.615 | 23 (35)                  | 16 (24) |      |      |
| Hearing loss                  | Without| 20 (31)          | 19 (29) |      | 22 (34)                  | 24 (36) | 0.545 | 0.460 |
|                               | Exist | 45 (69)           | 46 (71) | 0.010 | 43 (66)                  | 43 (64) |      |      |
| Nasal congestion              | 0     | 12 (18)           | 17 (25) |      | 25 (39)                  | 37 (56) |      |
|                               | I–II  | 29 (45)           | 35 (53) | 1.220 | 25 (39)                  | 25 (38) | -2.084 | 0.037 |
|                               | II–III| 24 (37)           | 15 (22) |      | 15 (22)                  | 5 (6)   |      |      |

Group C is control group, and Group I is intervention group.

### Table 3. Comparison of rehabilitation exercise compliance between two groups of patients after discharge [N (%)].

| Items                          | 3 months after discharge       | 6 months after discharge       |
|-------------------------------|-------------------------------|-------------------------------|
|                               | Group C N1=65 | Group I N2=67 | Z/χ² | P      | Group C N1=65 | Group I N2=67 | Z/χ² | P      |
| Compliance of mouth opening exercise | Full compliance | 8 (12) | 20 (19) |      | 5 (12) | 8 (19) |      |      |
|                               | Partial compliance | 40 (61) | 36 (59) | 6.610 | 0.037 | 23 (6) | 33 (59) | 7.369 | 0.013 |
|                               | Non-compliance | 17 (27) | 11 (22) |      | 37 (2) | 26 (22) |      |      |      |
| Compliance of nasal irrigation | Full compliance | 12 (12) | 24 (19) |      | 8 (12) | 16 (19) |      |      |      |
|                               | Partial compliance | 20 (61) | 16 (59) | 3.685 | 0.048 | 34 (61) | 19 (59) | 8.356 | 0.015 |
|                               | Non-compliance | 33 (27) | 27 (22) |      | 23 (27) | 32 (22) |      |      |      |

Group C is control group, and Group I is intervention group.

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Table 4. QLQ-C30 questionnaire of two groups at discharge and 6 months after discharge.

| Field        | Group C | Group I | t  | P     | Group C | Group I | t  | P     |
|--------------|---------|---------|----|-------|---------|---------|----|-------|
| Functional   |         |         |    |       |         |         |    |       |
| Field        |         |         |    |       |         |         |    |       |
| PF           | 59.62±12.18 | 58.79±10.58 | 0.293 | 0.771 | 80.22±11.35 | 91.36±8.63 | 4.444 | <0.001 |
| RF           | 55.86±16.53 | 56.33±14.69 | 0.121 | 0.904 | 63.54±14.23 | 72.18±10.13 | 2.812 | 0.007 |
| EF           | 53.29±12.36 | 54.18±12.68 | 0.287 | 0.775 | 62.53±11.34 | 73.62±10.21 | 4.139 | <0.001 |
| CF           | 73.22±13.25 | 74.37±14.76 | 0.331 | 0.742 | 77.63±12.31 | 83.14±10.64 | 1.928 | 0.049 |
| SF           | 57.89±17.46 | 56.37±16.35 | 0.362 | 0.719 | 70.54±15.14 | 76.91±12.19 | 1.572 | 0.121 |
| Symptom      |         |         |    |       |         |         |    |       |
| Field        |         |         |    |       |         |         |    |       |
| FA           | 52.09±16.49 | 53.82±18.32 | 0.400 | 0.690 | 38.64±13.32 | 22.14±12.54 | 5.139 | <0.001 |
| NV           | 20.98±12.69 | 21.56±11.02 | 0.196 | 0.845 | 2.54±5.61 | 2.13±4.96 | 0.311 | 0.756 |
| PA           | 55.46±20.41 | 57.21±21.35 | 0.338 | 0.737 | 8.24±11.75 | 3.12±8.36 | 2.018 | 0.048 |
| DY           | 10.21±14.56 | 12.84±13.24 | 0.761 | 0.449 | 2.34±9.63 | 2.11±8.54 | 0.102 | 0.919 |
| SL           | 61.02±22.12 | 59.74±21.36 | 0.237 | 0.813 | 13.14±20.11 | 6.13±16.58 | 1.531 | 0.131 |
| AP           | 73.82±23.12 | 71.21±21.58 | 0.481 | 0.632 | 9.62±10.54 | 3.28±8.56 | 2.657 | 0.009 |
| CO           | 15.34±16.57 | 16.40±15.80 | 0.264 | 0.792 | 8.11±12.33 | 3.82±9.22 | 1.585 | 0.118 |
| DI           | 5.39±10.50 | 6.10±9.44 | 0.286 | 0.776 | 5.10±8.51 | 5.86±4.47 | 0.361 | 0.719 |
| FI           | 43.85±34.17 | 41.28±35.11 | 1.867 | 0.067 | 39.66±30.12 | 38.22±31.01 | 0.190 | 0.850 |
| Overall      |         |         |    |       |         |         |    |       |
| quality of   |         |         |    |       |         |         |    |       |
| life field   |         |         |    |       |         |         |    |       |
| QL           | 34.15±10.31 | 32.14±9.65 | 0.811 | 0.420 | 62.15±11.17 | 72.03±9.07 | 3.908 | <0.001 |

Group C is control group, and Group I is intervention group. PF – physical functioning; RF – role functioning; EF – emotional functioning; CF – cognitive functioning; SF – social functioning; FA – fatigue; NV – nausea and vomiting; PA – pain; DY – dyspnoea; SL – sleep loss; AP – appetite loss; CO – constipation; DI – diarrhoea; FI – financial difficulties; QL – quality of life.

Discussion

With the progress of society and the change of medical mode, evaluation of the effect of cancer treatment focuses more on improvement of quality of life after treatment [12]. After receiving radiotherapy and chemotherapy, patients with NPC have varying degrees of complications and adverse reactions, physical damage, and reduction of social function, which puts patients under great pressure, and quality of life can be seriously affected.

Patients and their families lack understanding of the disease system and pay great attention to treatment in the hospital, but they despise the rehabilitation exercise treatment and follow-up visit after the operation and discharge [13]. Studies have shown that the quality of life of cancer patients is related to their optimistic attitudes towards life [14]. Use of an app can enhance the communication between doctors and patients, and it can be fast and convenient for doctors to provide health information to patients and develop some appropriate measures and methods to relieve nervousness and anxiety of patients as well as help them actively carry out functional exercises [15,16]. Moreover, the app allows physicians to keep abreast of the patient’s condition and quickly provide comprehensive and systematic treatment, care, and rehabilitation and carry out a timely follow-up [17].

Patients may suffer from mouth-opening difficulties, nasal congestion, and other symptoms after their discharge, among which mouth-opening difficulties are the more severe complication [18], the incidence of which first decreased and then increased. At 1–2 months after discharge, the incidence of mouth-opening difficulties was the highest, and then gradually decreased as oral mucosa injuries healed. At about 6 months after discharge, mouth-opening difficulties occurred again. It is an effective method to prevent and reduce the incidence and severity of mouth-opening difficulties by early opening mouth exercises and keeping on doing the exercise [19–21]. In the app, there are mouth-opening exercises videos, and it is necessary to encourage patients to follow the video every day and do it; patients should adhere to exercise even if early oral mucositis and xerostomia occur after radiotherapy.
Due to the sustained rehabilitation exercise of the intervention group, the incidence and severity of mouth-opening difficulties were lower than in control group (P<0.05).

In addition, nasal lavage can alleviate nasal mucosa swelling, dryness, nasal congestion, and other adverse reactions. There are pictures and videos co-presented about nasal irrigation and other operations in the app, so that patients can easily understand and master the correct methods. The pictures and videos can be watched repeatedly, which can improve cognitive level and compliance.

Nasal irrigation can reduce the nasal swelling, dryness, nasal obstruction, and other adverse reactions of NPC patients after radiotherapy. It can also promote normal mucosal repair and reduce the incidence of complications [22]. After the patient is discharged, it is necessary to improve the compliances using nasal lavage. All these activities can be performed with the help of the relevant videos to improve patient compliance. Consistent and correct performance of exercises can effectively improve patient symptoms.

Conclusions

This study shows that rational use of a smartphone app can improve exercise compliance of patients with NPC after radiotherapy and chemotherapy, reduce adverse reactions and complications due to radiotherapy and chemotherapy, and improve quality of life and satisfaction after discharge.

Conflict of interest

None.

References:

1. Saba NF, Salama JK, Beitler JJ et al: ACR Appropriateness criteria® for nasopharyngeal carcinoma. Head Neck, 2016; 38: 979–86
2. Liebowitz D: Nasopharyngeal carcinoma: The Epstein-Barr virus association. Semin Oncol, 1994; 21: 376–81
3. Al-Sarraf M, LeBlanc M, Giri PG et al: Chemoradiotherapy versus radiotherapy in patients with advanced nasopharyngeal cancer: Phase III randomized intergroup study 0099. J Clin Oncol, 1998; 16: 1310–17
4. Ghiemire BR, Lin LP, Guo Y, Zhang L: The role of concurrent chemo-radiotherapy to radiotherapy alone in the treatment of locally advanced nasopharyngeal carcinoma: A meta-analysis of the phase III randomized trials. The Journal of Evidence-Based Medicine 2007; 7
5. Bajaj B, Audry H, Bourhis J et al: Chemotherapy in locally advanced nasopharyngeal carcinoma: an individual patient data-metanalysis of eight randomized trials and 1753 patients. Int J Radiat Oncol Biol Phys, 2006; 64: 47–56
6. Chen HY, Ma XM, Ye M et al: Effectiveness and toxicities of intensity-modulated radiotherapy for patients with locally recurrent nasopharyngeal carcinoma. PLoS One, 2013; 8: e73918
7. Yeh SA, Tang Y, Lui CC et al: Treatment outcomes and late complications of 849 patients with nasopharyngeal carcinoma treated with radiotherapy alone. Int J Radiat Oncol Biol Phys, 2005; 62: 672–79
8. Franko OI: Smartphone apps for orthopaedic surgeons. Clin Orthop Relat Res, 2011; 469: 2042–48
9. Rao A, Hou P, Golink T et al: Evolution of data management tools for managing self-monitoring of blood glucose results: A survey of iPhone applications. J Diabetes Sci Technol, 2010; 4: 949–57
10. Turner-McGrievy GM, Beets MW, Moore JB et al: Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program. J Am Med Inform Assoc, 2013; 20: 513–18
11. Olszewski M, Schulgen G, Schumacher M, Altman DG: Quality of life assessment in clinical cancer research. Br J Cancer, 1994; 70: 1–5
12. Lim SY, Yuzhalin AE, Gordon-Weeks AN, Muschel RJ: Tumor-infiltrating monocytes[isolated macrophages promote tumor invasion and migration by upregulating S100A8 and S100A9 expression in cancer cells. Oncogene, 2016; 35: 5735–45
13. Guy R, Hocking J, Wand H et al: How effective are short message service reminders at increasing clinic attendance? A meta-analysis and systematic review. Health Serv Res, 2012; 47: 614–32
14. Li LR, Lin MG, Liang J et al: Effects of intrinsic and extrinsic factors on the level of hope and psychological health status of patients with cervical cancer during radiotherapy. Med Sci Monit, 2017; 23: 3508–17
15. Riley WT, Rivera DE, Atienza AA et al: Health behavior models in the age of mobile interventions: are our theories up to the task? Transl Behav Med, 2011; 1: 53–71
16. Bopp JM, Miklowitz DJ, Goodwin GM et al: The longitudinal course of bipolar disorder as revealed through weekly text messaging: a feasibility study. Bipolar Disorder, 2010; 12: 327–34
17. Brendryen H, Drozd F, Kraft P: A digital smoking cessation program delivered through internet and cell phone without nicotine replacement [happy ending]. Randomized controlled trial. J Med Internet Res, 2008; 10: e51
18. Xinghong WL, Radiotherapy DO, Hospitalamp HC, Hospital TK: Effect of evidence-based nursing on treatment of nasopharyngeal carcinoma patients with radiotherapy.] Journal of Clinical Medicine in Practice, 2013 [in Chinese]
19. Wang XM, Yang DH, Chen Y et al: [Development and application of management program for the rehabilitation training of mouth opening.] Journal of Nursing Administration, 2015; 15: 667–69 [in Chinese]
20. Kamstra JL, van Leeuwen M, Roodenburg JL, Dijkstra PJ: Exercise therapy for trismus secondary to head and neck cancer: A systematic review. Exercise therapy for trismus. Head Neck, 2017; 39: 160–39
21. Liang KL, Kao TC, Lin JC et al: Nasal irrigation reduces postirradiation rhinosinusitis in patients with nasopharyngeal carcinoma. Am J Rhinol, 2008; 22: 258–62
22. Xiang L, Fa-ya L, Ping H et al: Management of radiation-induced early nasal adhesion after radiotherapy for nasopharyngeal carcinoma. Am J Rhinol Allergy, 2013; 27: EB2–84