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Effectiveness of Clinical Management of COVID-19 Based on Structured Clinical Knowledge and Process Paths

Satoko TSURU[a,1], Tetsuro TAMAMOTO[b], Akihiro NAKAO[c], Yutaka MACHIDA[d], Kouichi TANIZAKI[a] and Naohisa YAHAGI[a,e]
[a] *The University of Tokyo, Japan*
[b] *Nara Medical University, Japan*
[c] *DoctorsMobile Corp, Japan*
[d] *Tokyo Rinkai Hospital, Japan*
[e] *Keio University, Japan*

Abstract. This study examined the effectiveness of a systematic approach to the clinical management of COVID-19, focusing on nursing turnover. METHODS: Between 2017 and 2019, a clinical process support system based on structured clinical knowledge (Team Compass with the Patient Condition Adaptive Path System; TC-PCAPS) was developed, and implemented in hospitals. In 2020, the COVID-19 clinical management system (COVID-19-CMS) was developed. In this study, the effectiveness of implementing both systems was analyzed. The analysis covered hospitals N, T, and B, where TC-PCAPS implementation started in 2019, 2020, and 2022, respectively. Data for the period from 2018 to 2022 were collected and compared. RESULTS: Hospitals N and T implemented TC-PCAPS in the first year and the COVID-19-CMS in the following year. The nurse turnover rates of these hospitals were lower than those of the prefectures in which they were located. There was a trend towards a gradual reduction in nurse turnover. In contrast, hospital B, which had only just started to introduce these systems, saw a gradual increase in nurse turnover. CONCLUSION: The data collected from these three hospitals suggested that this systematic approach has the potential to reduce nurse turnover, in addition to the previously reported ability of TC-PCAPS to reduce nurse overtime. In Japan, there is a need to respond to future pandemics and reform the work styles of physicians and nurses. The abovementioned systematic approach has great potential for contributing to both of these aims.

Keywords. clinical knowledge, clinical process, COVID-19, nurses, turnover

1. Introduction

The COVID-19 pandemic has affected economic activity, daily life, and healthcare delivery around the world. In Japan, from 2020 to 2022, civic and economic activity atrophied, and medical personnel were exhausted by the demands placed on them by the pandemic. To prevent disruption in hospitals caused by COVID-19, measures must be taken to prevent the numbers of newly infected and seriously ill patients increasing and

[1] Corresponding Author, Satoko Tsuru, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656 Japan, email: tsuru@tqm.t.u-tokyo.ac.jp.

maintain or increase the corresponding medical resources. In hospitals, the former measures aim to prevent the occurrence of case clusters, and the latter measures aim to secure medical personnel and the necessary equipment, drugs, and medical supplies. Since it takes time to train medical personnel, it is important to at least prevent existing medical personnel, especially nurses, from leaving their jobs. We have developed a clinical management system based on structured clinical knowledge and process paths, which aims to reduce the levels of disruption and stress pandemics cause in hospitals. The purpose of this study was to analyze the effectiveness of this system. In this paper, the effectiveness of the system was examined after its implementation by focusing on the turnover rate of nursing staff.

2. Methods

2.1. Infrastructure enhancement (2017-2019): development of a clinical process support system using structured clinical knowledge and its implementation in hospitals

Since 2004, Tsuru, Iizuka et al. [1] have been developing a clinical pathway system, incorporating structured clinical knowledge (the Patient Condition Adaptive Path System; PCAPS), with the cooperation of more than 100 physicians.

In 2017, Tsuru, Nakao et al. [2] started developing a clinical support system for managing clinical processes for all hospitalized patients, and in 2018 they developed an IT application for increasing the quality and efficiency of nursing and implemented it in hospital S (350 beds, acute care).

Tsuru, Tamamoto, Nakao et al. [3] subsequently created numerous structured knowledge content groups, a highly functional IT application, and an operational system at a university hospital, with the aim of improving the quality and efficiency of team medicine. The developed system, which was named Team Compass with PCAPS, was implemented in hospital N (900 beds, a university hospital) in May 2019. As a result, 730 process paths were typified at the university hospital. Structured clinical knowledge relating to nursing was incorporated into each of the units that made up the process paths. Physicians applied the most appropriate paths to inpatients via the electronic medical record system. Nurses were able to create nursing plans by selecting individual observations and care actions in the initial unit. Nurses then delivered and recorded their care based on the plan for each patient. The nurses' sequential inputs allowed physicians and other nurses to share information about patients' conditions and any interventions employed. More than 50% of nurses' overtime in Japan is due to record-keeping. In our previous study, hospital N, which implemented Team Compass with PCAPS in 2019, achieved a 27% reduction in nurses' overtime compared with the same month in the previous year, and hospital T, which implemented the system in 2020, achieved a persistent 40-50% reduction in nurses' overtime from the month after the system's implementation [3].

2.2. Development of a "COVID-19 clinical management system" (2020)

A COVID-19 clinical management system, consisting of PCAPS contents, monitoring tools, and an operational system, was developed.

(1) PCAPS contents (COVID-19) : The Ministry of Health, Labor and Welfare (MHLW) created the "COVID-19 Clinical Practice Guide for New-type Coronavirus Infections,

version 2.2", which standardized the classification of the severity of COVID-19 into four types (mild, moderate I, moderate II, and severe). We developed a process path based on this guide, consisting of 4 units for suspected COVID-19 patients and 4 units for definitively diagnosed COVID-19 patients.
(2) Monitoring tools (a COVID-19 symptom observation tool and a dashboard for all hospitalized patients) : The "COVID-19 Symptom Observation Enhancement Items" were developed. When they were applied to all inpatients, eight observation items were automatically incorporated into the nursing plan and implemented. A dashboard was developed to collect and monitor the entered data.
(3) Operational system : Using the monitoring tools described in (2), nurses in the infection control room narrowed down the list of suspected COVID-19 patients and wards where cluster outbreaks may have occurred and reported the results to a physician in the infection control department. Based on this data, the physician decided whether to move patients to a different ward. Then, the PCAPS content outlined in (1) was applied, and testing and treatment of suspected and definitively diagnosed COVID-19 patients were initiated. If a suspected COVID-19 patient was PCR-positive, they were transferred from the suspected ward to the COVID-19 ward. All nursing plans for both wards were standardized based on the PCAPS content (COVID-19). The nurses assigned to both wards rotated at regular intervals, but this did not cause any confusion. As the number of infected patients changed, the numbers of beds allocated to the suspected COVID-19 and COVID-19 wards were also altered, resulting in the repeated reorganization of general wards and the reassignment of nurses. In hospitals that implemented this system, when nurses were assigned to other wards they were immediately able to provide appropriate clinical care based on each patient's nursing care plan. In July 2020, the COVID-19 clinical management system was implemented at hospital N. In hospital N, physicians from all departments were assigned to the COVID-19 wards in rotation. They were able to perform their duties without confusion. Hospital T implemented Team Compass with PCAPS in October 2020. In the following year, the COVID-19 clinical management system was implemented. In 2021, overtime in the COVID-19 wards was minimal. In contrast, the staff on the general wards had to work overtime to accommodate new patients and their families.

2.3. Analysis of the Effectiveness of COVID-19 Clinical Management Based on Structured Clinical Knowledge and Process Paths

The nurse turnover rate was used as an effectiveness indicator. Nurse turnover is a problem in both developed and developing countries, and many countries are experiencing replacement-cost issues associated with nurse turnover [4,5,6]. In a 2021 hospital survey conducted by an American firm, the registered nurse turnover rate was 27.1%, a significant increase from the figure of 18.7% seen in 2020 [7]. In 2020, Japan's turnover rate was 10.6% for all nurses and 8.2% for new nurses. The nurse turnover rates for each prefecture in Japan were quite different [8]. We extracted the nurse turnover rates (for 2019 and 2020) for the prefectures in which hospitals N and T were located from the latter study and compared them with the nurse turnover rates for the two hospitals. We also added nurse turnover data for hospital B, which had not yet implemented the COVID-19 clinical management system.

3. Results

Each hospital in Japan was required to have a number of beds for COVID-19 patients. Both hospitals N and T were significant contributors to the provision of COVID-19 beds in their prefectures, providing up to 17% and 18% of the total number of COVID-19 beds in their prefectures, respectively. The bed occupancy rate was reduced to 57-77% at hospital N and 53-69% at hospital T to reduce the workload of the nurses on the general wards. Both hospitals implemented Team Compass with PCAPS in the first year and the COVID-19 clinical management system the following year. The nurse turnover rates of both hospitals during the COVID-19 pandemic were lower than those seen in the prefectures in which the hospitals were located. In addition, there was a gradual reduction in nurse turnover after the implementation of the COVID-19 clinical management system. In comparison, we can see that nurse turnover at hospital B, which had not yet implemented the system, gradually increased during the study period (Fig. 1).

There was a small wave of COVID-19 infections in Japan in FY2020 (Fiscal Year 2020 ran from April 2020 to March 2021), whereas there was a moderate wave in FY2021 and a large wave in FY2022, which continued to stress medical personnel, especially nurses. In the spring of 2020, when the number of infected patients in Japan started to increase, acute care hospitals were required by the government to secure enough beds for COVID-19 patients. They were also required to separate COVID-19 wards, which required large numbers of nurses, from general wards, whose nursing requirements are set out in law. Recruiting new nurses was difficult. The nurses assigned to the COVID-19 wards experienced physical and mental fatigue from dealing with patients under special circumstances. The nurses who were forced to move to new departments were highly stressed and fatigued by unfamiliar tasks, unfamiliar disease responses, and changes in the teams they worked with. As a result, a vicious cycle of increased turnover among nurses who were strongly affected by the spread of COVID-19 and a shortage of nurses in the field occurred.

In the infection situations encountered in FY2020 and FY2021, the use of the COVID-19 clinical management system, which was implemented using Team Compass with PCAPS, may have helped to prevent the occurrence of hospital clusters. However, in FY2022 case clusters occurred frequently in all three hospitals. Even in hospitals T and N, where the infection situation was controlled by Team Compass, the infection situation exceeded the limits of the healthcare delivery system in FY2022.

		Hospital B (477beds, acute & general hospital, Private hospital)							Hospital T (400beds, acute & general hospital, Semi-public hospital)							Hospital N (900beds, university hospital)						
Fiscal Year	COVID-19 outbreaks (wave)	COVID-19 Clinical Management System	Team Compass with PCAPS	Turnover rate(all RN)	Turnover rate (new RN)	Turnover rate(O-prefecture) according to Japan Nurses Association	Bed occupancy rate	Number of clusters	COVID-19 Clinical Management System	Team Compass with PCAPS	Turnover rate(all RN)	Turnover rate (new RN)	Turnover rate(T-prefecture) according to Japan Nurses Association	Bed occupancy rate	Number of clusters	COVID-19 Clinical Management System	Team Compass with PCAPS	Turnover rate(All RN)	Turnover rate (new RN)	Turnover rate(N-prefecture) according to Japan Nurses Association	Bed occupancy rate	Number of clusters
FY2018				13%	7%		96%				12.90%	20%		79%			in preparation	8.30%	8.70%		92%	
FY2019				9%	9%	13.50%	95%			in preparation	10.60%	18%	14.90%	80%			+	11.30%	1.20%	11.10%	90%	
FY2020	First wave : small Second wave : small Third wave : middle			10%	13%	12.30%	92%	3		+	10.10%	9%	13.40%	69%	0	+	+	10%	9.90%	10.80%	77%	0
FY2021	Fouth wave : middle Fifth wave : middle			12%	14%		93%	0	+	+	11.5% Occurrence of turnover due to covid-19	18%		65%	1	+	+	7.50%	6.90%		68%	3
FY2022	Sixth wave : large Seventh wave : large	in preparation	in preparation				94%	6	+	+				53%	7	+	+				57%	7

Fig. 1. Comparison among the three hospitals RN: Registered nurses

4. Discussion

Both hospitals T and N accepted COVID-19 patients. In such hospitals, nurses were generally exhausted. However, compared with the nurse turnover rates seen in the surrounding prefectures, the nurse turnover rates of both hospitals were low. In FY2019, hospital N implemented its first electronic health record update in 10 years and adopted Team Compass with PCAPS at the same time, suggesting that nurses who had difficulty coping with this digital transformation may have left the hospital in FY2019. Hospital T had zero nurse turnover due to COVID-19 in FY2020. However, in FY2021, there was a rapid increase in the number of infected patients in prefecture T, and some nurses left the hospital due to COVID-19 at the end of the fiscal year. Both hospitals had significantly lower turnover among new nurses in the year in which Team Compass with PCAPS was implemented. Therefore, this system may be attractive to newcomers. However, the rapid increase in the number of infections in the following year suggests that the situation was intolerable for new nurses. It is suggested that the turnover of new graduate nurses after the spread of COVID-19 subsided could be used as an evaluation measure for assessing the value of this system. In comparison with hospitals T and N, the nurse turnover of hospital B, which had not yet implemented the COVID-19 clinical management system, gradually increased during the study period.

5. Conclusions

The effectiveness of the implementation of the developed systems was analyzed using the nurse turnover rate. We collected and compared relevant data from three hospitals. The results suggest that these systems have the potential to reduce nurse turnover in addition to the previously reported ability of Team Compass with PCAPS to reduce overtime hours [3]. In Japan, there is a need to respond to future pandemics and to reform the work styles of physicians and nurses. The abovementioned systematic approach has great potential to contribute to both of these aims.

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