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Care maps are an effective tool for optimizing quality of care of infectious diseases in a resource-constrained short-stay ambulatory care setting

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Abstract

Care maps (CMs), which are innovative, comprehensive, educational, and simple medical tools, were developed for 6 common diseases, including heart failure, stroke, hyperglycemia, urinary tract infection, dengue infection, and upper gastrointestinal bleeding, were implemented in a short-stay ambulatory ward. This study aimed to investigate the effectiveness of and level of clinician satisfaction with CMs in an ambulatory care setting.

A retrospective chart review study comparing the quality of care between before and after CM implementation was conducted. The medical records of patients who were admitted to a short-stay ambulatory ward in a tertiary referral center were reviewed. Demographic data, severity of disease, quality of care, length of stay (LOS), admission cost, and CM user satisfaction were collected and recorded.

The medical records of 1116 patients were evaluated. Of those, 589 and 527 patients were from before (non-CM group) and after CM (CM group) implementation, respectively. There were no significant differences between groups for age, gender, or disease-specific severity the median (interquartile range) total and essential quality scores were significantly higher in the CM group than in the non-CM group [total quality score 85.3 (75.0–92.9) vs 61.1 (50.0–75.0); $P < .001$, and essential quality scores 90.0 (75.0–100.0) vs 60.0 (40.6–80.0); $P < .0001$, respectively]. All aspects of quality of care were significantly improved between before and after CM implementation. Overall median LOS was significantly decreased from 3.8 (2.5–5.7) to 3.0 (2.0–4.9) days, but there was no significant decrease for admission cost. However, CMs were able to significantly reduce both LOS and admission cost in the infectious disease-related subgroup. Most CM users reported satisfaction with CMs.

CMs were shown to be an effective tool for improving the quality of care in patients with ambulatory infectious diseases. In that patient subgroup, LOS and admission cost were both significantly reduced compared to pre-CM implementation.

Abbreviations: CHF = congestive heart failure, CMs = care maps, DF = dengue fever, EQS = essential quality score, LOS = length of stay, QoC = quality of care, TQS = total quality score, UGIB = upper gastrointestinal bleeding, UTI = urinary tract infection.

Keywords: ambulatory setting, care maps, effectiveness, infectious disease, user satisfaction

1. Introduction

Several evidence-based guidelines have been introduced to optimize both clinical practices and patient outcomes. Previous study reported that the use of guidelines facilitated improvements in clinical practice by guiding the prescription of appropriate laboratory investigations and by preventing further disease complications.[1] Additionally, guideline non-adherence can lead to incorrect diagnosis, inappropriate treatment, inefficient use of healthcare funding,[2] and unnecessary or potentially harmful outcome.[3–5] However, in routine clinical practice, there are many different levels of care, a wide range of available resources, and variation in the knowledge and experience of healthcare providers. As a result, guideline implementation-related challenges were reported by some studies.[2–10] To improve the success of guideline implementation, many obstacles to successful guideline implementation and strategies for overcoming those obstacles have been considered.[6,11] Factors reported to be associated with guideline implementation include guideline complexity, layout, accessibility, and applicability.[12–16] Therefore, an effective guideline should be short and user-friendly, it should include simple tools, such as checklists and tables,[12,16–18] and it should incorporate organization of care and cultural norms.[11] Protocols, standing orders, and local structures and incorporation have been introduced,[14,19] which demonstrated that order sets could promote more adherence to good evidence-based clinical practices,[20] and reduce medical errors.[21] Moreover, order sets could lead to improvements in medication prescription, administration, and treatment outcomes.[22–24]

Congestive heart failure (CHF),[25] hyperglycemia,[26–29] stroke,[30] urinary tract infection (UTI),[31–34] dengue fever (DF),[35] and upper gastrointestinal bleeding (UGIB)[23,36] are common problems encountered, and these conditions lead to high healthcare costs and increased morbidity and mortality in ambulatory service settings. Similar to a primary care hospital setting, short-stay ambulatory wards were established to care for all non-critical in-hospital patients, including the aforementioned 6 common diseases. The main objectives of the ambulatory ward are to provide care that will facilitate early discharge within 1 week, and to provide knowledge and experience regarding common diseases encountered in primary care setting for both medical students and medicine trainees. The current standard of care in our hospital complies with international and some local standard guidelines. However, guideline implementation-related challenges include guideline non-adherence due to lack of experience, knowledge, and efficiency of disease management in a resource- and budget- constrained setting. In order to achieve these objectives of ambulatory care, to improve guideline implementation-related challenges, and to enhance the efficiency of disease management in the context of our resource- and budget- constrained setting, care maps (CMs), which are innovative, educational, comprehensive, and simple medical tools with their implementation strategies, were implemented. Therefore, the aim of this study was to investigate the effectiveness of CM implementation, the level of clinician satisfaction, and the appropriate disease spectrum for which CMs can be used in an ambulatory setting.

2. Methods

2.1. Participants and medical records

A retrospective structured chart review was conducted in patients that were admitted to the ambulatory ward of Siriraj Hospital, which is a national tertiary referral center that is located in Bangkok, Thailand during the January 2010 to December 2014 study period. CMs, which are medical management tools, were implemented in the ambulatory ward of our center in the year 2012. The medical records of patients that were admitted during 2010–2011, which is 2-year period before the implementation of CMs, were included in the non-CM group, and the medical data from patients admitted after January 2012 until December 2014 were included in the CM group. All patients' medical records were identified with an International Classification of Diseases, 10th ed. (ICD-10) code for stoke, dengue infection, heart failure, diabetes, UTI, and UBGI at the ambulatory short-stay ward. Medical records for each disease were recruited in chronological order until up to 100 or the number available for each disease before and after CM implementation. After recruitment, each patient's record was manually reviewed to confirm the diagnosis of the target disease according to standard disease definition. Patient medical record, admission notes, doctor's order sheet, nursing notes, monitoring charts, and laboratory results were reviewed to identify demographics, clinical, comorbidities, disease severity, medication, and management. Data from pregnant participants and incomplete medical records were excluded from the study. This study was approved by the Siriraj Institutional Review Board (SIRB) (COA no. SI 685/2013).

2.2. Procedure and measurement

CMs are innovative tools that were designed to increase quality of patient care (QoC), decrease length of hospital stay (LOS), decrease admission cost, and improve learning for medical students and residents. CMs are generated by summarizing several current guidelines, and they are adapted for patient management in an ambulatory care setting by all ambulatory medical staff and related healthcare personnel. After extensive review and discussion, draft CMs were created by the consensus with all panels. Pre-implementation phase consisted of providing education to CM users and pilot use in at least 10 patients within a 1- to 2-month period. Following the pre-implementation phase, CMs were modified according to feedback, problems, and concerns from CM users, and the revised versions were approved by consensus meeting. Provider education was presented as in-service training to all medical staff, nurse practitioners, and related healthcare personnel actively practicing in our ambulatory ward. After provider training, CMs were officially launched and implemented. All 6 CMs consist of the following 5 component parts: essential patient history, appropriate physical examinations, core treatments and necessary laboratory tests, follow-up details, and discharge planning. The CMs that we created and implemented at our center are limited to 2 pages, and the information is delivered in a simple, "just in-time" knowledge, and easy to understand format that includes guided checklists, tables, and brief passages. The CMs for each common ambulatory disease are shown in Appendix 1, http://links.lww.com/MD/F464.

2.3. Quality assessments

All data specific to QoC, LOS, and cost of admission were collected. The QoC assessment was divided into the 2 following QoC parameters: total quality score (TQS) and essential quality score (EQS). These 2 quality scores were determined using a TQS evaluation form and an EQS evaluation form that were

completed by the 3 members of an expert panel for this project who were not involved in the development and implementation of the CMs. Regarding the TQS evaluation form development process, the indications for appropriate care for each common disease from widely accepted Joint Commission International Accreditation Standard, and international and local guidelines were considered and selected by consensus among 10 independent medical specialists for each disease in the context of ambulatory short-stay inpatient service. Concerning EQS evaluation form development, because we required 100% consensus agreement among all experts to develop the essential quality indicators, only items that were rated the most important items as a 5 out of a 5-point scale by all specialists on the panel were selected. The total of all selected and of the essential quality indicators were defined as TQS and EQS (Appendix 2, http://links.lww.com/MD/F465), respectively. The total score was divided into 4 aspects of care, including:

1) history and physical examination assessment;
2) prescription: pharmacological aspects;
3) prescription: non-pharmacological aspects; and,
4) discharge planning and patient education, which were defined as the score of all items elicited from history taking and from physical examination, from the prescription of medications, from the prescription of non-pharmacologic care (rehabilitation, monitoring and evaluation), and from aspects related to discharge planning (follow-up, patient education, and family support), respectively.

2.4. Case definitions

Severe cases were defined as patients who had more pronounced symptoms and/or who were at high risk for developing complications or serious problems. Each CM defined "severe case" according to different criteria. For the CHF CM, a severe case was defined as a patient who had left ventricular ejection fraction less than 40% by echocardiography or who had heart failure class IV by New York Heart Association classification. For the hyperglycemia CM, patients who had initial capillary blood glucose greater than 250 mg/dL at admission were classified as severe cases. For the stroke CM, a case was defined as severe if a patient had a National Institute of Health Stroke Scale score greater than 15 at admission. For the DF CM, we used the criteria for severe dengue infection from the World Health Organization guideline 2009.[37] For the UTI CM, patients with complicated UTI who were male, immunocompromised, and diagnosed with diabetes or cancer were defined as severe cases. For the UGIB CM, patients who had a pre-endoscopy Rockall Score of 3 or higher were classified as high-risk or severe cases.

2.5. Satisfaction assessment

Questionnaires designed to elicit the level of CM user satisfaction were sent to clinicians in the ambulatory ward that used CMs, including nurses, medical residents, and medical students. Scoring of each question was based on a 5-point Likert scale, with a 1 indicating strong disagreement and a 5 indicating strong agreement. CM users that returned a completed questionnaire are referred to as responders in this report. CM users were asked to describe their position and gender. CM users were also asked to rate CMs relative to their value as an educational tool, their value for improving the QoC, their ability to improve the efficiency of

the patient care process, the feasibility of their use in an ambulatory setting, and the users' overall level of satisfaction with CMs. Only questionnaires that were fully completed were included in our analysis.

2.6. CM implementation

In this study, we applied CMs using several potentially effective implementation strategies. CMs were created in short form format consisting of 1 sheet of paper with checklists. They were designed to be a time-saving and user-friendly tool for clinicians. Peer pressure within and among all of stakeholders, and quality supervision by ward attending staff are effective strategies for influencing the continuous use of CMs. All attending staff were requested to always ask for and about CMs and to mention medical information from CMs with medical residents and students. Medical students, medicine specialist trainees, and healthcare staff learned together under the guidance of ambulatory ward attending physicians. Moreover, CMs were provided as "just-in-time" or "ready-for-use" medical knowledge that trainees could directly apply with their patients. All these strategies helped to successfully promote the increased and sustained use of of CMs.

2.7. Statistical analysis

Baseline characteristics, disease severity, quality scores, LOS, and admission cost for each disease were compared between the CM and non-CM groups. Moreover, in order to evaluate the overall effectiveness of CMs, the summary effect of these parameters was compared between pre- and post-implementation. Descriptive statistics were used to summarize evaluated factors. Continuous normally-distributed variables are presented as mean and standard deviation, continuous skewed distribution variables are given as median and interquartile range, and categorical variables are shown as number and percentage. The TQS and EQS were calculated by obtaining the percentage of completeness of each CM and then calculating its median to represent the effect of CM implementation compared to pre-CM implementation. Significant variation between the CM and non-CM groups was identified for normally-distributed continuous variables by unpaired t test, for non-normally-distributed variables by Mann–Whitney U test, and for categorical variables by Chi-squared test. All statistical analyses were performed using IBM SPSS Statistics version 18 (SPSS, Inc., Chicago, IL), and a P-value less than .05 was regarded as being statistically significant for all tests.

3. Results

One thousand one hundred sixteen medical records were recruited for the present analysis. Of those, the medical records of 527 patients and 589 patients were included in the CM group and the non-CM group, respectively. The average age was 58.4 ± 20.6 years and 60.3 ± 19.4 years, and 57% and 51% were male in the CM and non-CM groups, respectively. Except for the mean age of participants with CHF and DF, and the proportion of severe cases among participants with UGIB, there was no significant difference in mean age, proportion of male gender, or the proportion of severe cases between the CM and non-CM groups. Baseline demographic characteristics and disease severity were compared between groups, and those results are shown in Table 1.

Table 1

Baseline demographic and case severity characteristics compared among the evaluated ambulatory diseases.

Characteristics	CHF	Hyperglycemia	Stroke	UTI	DF	UGIB	Total
Patients, n							
Care map group	80	100	100	50	97	100	527
Non-care map group	100	100	89	100	100	100	589
Age (yr), (mean ± SD)							
Care map group	72.1 ± 15.3[*]	64.6 ± 12.2	64.5 ± 13.8	65.9 ± 18.0	28.6 ± 12.8[*]	60.3 ± 16.6	58.4 ± 20.6
Non-care map group	66.6 ± 15.4	66.8 ± 11.8	64.7 ± 12.1	68.1 ± 18.4	33.3 ± 15.4	62.8 ± 15.6	60.3 ± 19.4
Male gender, (%)							
Care map group	74%	48%	54%	38%	52%	74%	57%
Non-care map group	59%	46%	65%	22%	47%	67%	51%
Severe cases[**], n (%)							
Care map group	29 (36.0%)	32 (32.0%)	1 (1.2%)	40 (80.0%)	48 (49.5%)	59 (59.0%)[*]	209 (39.7%)
Non-care map group	44 (44.0%)	20 (23.0%)	1 (2.7%)	77 (77.0%)	51 (51.0%)	42 (42.0%)	235 (39.9%)

[*] Indicates statistical significance at a level of *P* < .05.
[**] Severe cases were defined as patients who had more pronounced symptoms and/or who were at high risk for developing complications or serious problems.
CHF = congestive heart failure, DF = dengue fever, SD = standard deviation, UGIB = upper gastrointestinal bleeding, UTI = urinary tract infection.

The TQS and the EQS significantly improved after CM implementation the median (interquartile range) TQS. In the CM group and the non-CM group was 85.3 (75.0–92.2) and 61.1 (50.0–75.0), respectively; *P* < .001. Similarly, the median EQS markedly increased in the CM group compared to the non-CM group [90.0 (75.0–100.0) *vs* 60.0 (40.6–80.9); *P* < .001]. Except for the UGIB CM, significant improvement in the EQS domain for all other disease CMs was observed after CM implementation. Several aspects of care were analyzed as part of the total quality care score. The median history-taking and physical assessment score significantly increased from 66.7 (37.5–100.0) in the non-CM group to 100.0 (85.7–100.0) in the CM group, especially in the hyperglycemia CM group [33.3 (16.7–50.0) to 100.0 (100.0–100.0); *P* < .0001, respectively]. Regarding prescription quality divided into pharmacologic-related and non-pharmacologic-related subdomains, the implementation of CMs increased the prescription quality score in both subdomains [66.7 (54.5–100.0) *vs* 66.7 (40.0–75.0); *P* < .001, and 83.3 (66.7–100.0) *vs* 66.7 (33.3–100.0), *P* < .001 – both respectively]. A statistically significant improvement was observed in the CM groups regarding the prescription medical-related score, especially in the CHF and UTI CMs. However, implementation of the CHF and UGIB CMs did not significantly improve the prescription non-pharmacologic-related score. CMs also improved the discharge planning and patient education score. Overall, the median discharge planning and patient education score increased from 57.1 (33.3–75.0) in the non-CM group to 75.0 (50.0–100.0) in CM group (*P* < .001). There was significant difference in this score in the CHF, stroke, UTI, and DF CMs, but not in the hyperglycemia and UGIB CMs.

Overall, the median LOS in the non-CM group and the CM group was 3.8 (2.5–5.7) days and 3.0 (2.0–4.9) days, respectively (*P* = .04). The median LOS when using the UTI CM significantly decreased from 5.0 (4.0–7.0) days to 4.0 (3.0–5.0) days (*P* < .001). None of the other CMs were able to significantly reduce LOS. The median admission cost of UTI significantly decreased after the implementation of CMs [295.0 (194.7–495.6) *vs* 415.9 (256.6–678.5) US dollars; *P* = .006], while the use of the UGIB CM tended to increase admission cost [557.5 (365.8–1044.2) *vs* 448.4 (262.5–778.8) US dollars; *P* = .008]. Quality, LOS, and admission cost in the CM and non-CM groups were compared among diseases, and those results are given in Table 2.

Table 2

Quality, length of stay, and cost of care among the evaluated ambulatory diseases compared between the care map and non-care map groups.

	Care map group	Non-care map group	*P*-value
1. Total quality score[*]			
- Overall	85.3 (75.0–92.2)	61.1 (50.0–75.0)	<.001
- CHF	60.0 (60.0–70.0)	60.0 (50.0–70.0)	.001
- Hyperglycemia	90.0 (82.0–95.0)	52.2 (46.8–59.8)	<.001
- Stroke	85.7 (85.7–92.9)	67.9 (57.1–76.8)	<.001
- UTI	76.6 (73.0–82.0)	52.1 (45.8–62.4)	<.001
- DF	82.8 (73.0–89.5)	64.3 (51.1–72.5)	<.001
- UGIB	89.3 (85.7–92.9)	85.7 (82.1–92.9)	.02
2. Essential quality score[*]			
- Overall	90.0 (75.0–100.0)	60.0 (40.6–80.0)	<.001
- CHF	50.0 (50.0–70.0)	50.0 (25.0–50.0)	.21
- Hyperglycemia	100.0 (100.0–100.0)	40.6 (40.6–60.7)	<.001
- Stroke	100.0 (80.0–100.0)	80.0 (60.0–80.0)	<.001
- UTI	90.0 (80.0–90.0)	50.0 (30.0–60.0)	<.001
- DF	78.9 (69.3–90.4)	60.1 (48.6–78.9)	<.001
- UGIB	90.0 (80.0–100.0)	90.0 (80.0–100.0)	.26
3. Length of stay (d)			
- Overall	3.0 (2.0–4.9)	3.8 (2.5–5.7)	.04
- CHF	4.4 (2.8–5.7)	4.7 (3.6–6.2)	.19
- Hyperglycemia	3.9 (2.0–5.0)	3.9 (2.7–5.7)	.74
- Stroke	3.0 (2.0–4.0)	3.0 (2.0–6.0)	.50
- UTI	4.0 (3.0–5.0)	5.0 (4.0–7.0)	<.001
- DF	2.7 (1.9–3.6)	2.6 (1.8–2.9)	.09
- UGIB	3.0 (3.0–5.0)	3.0 (2.0–4.0)	.07
4. Admission cost (US dollars)			
- Overall	286.1 (162.2–522.1)	312.7 (174.0–542.8)	.10
- CHF	339.2 (221.2–536.9)	368.7 (274.3–654.9)	.11
- Hyperglycemia	330.4 (215.3–584.1)	351.0 (188.8–531.0)	.98
- Stroke	224.2 (165.2–374.6)	265.5 (159.3–513.3)	.18
- UTI	295.0 (194.7–495.6)	415.9 (256.6–678.5)	.002
- DF	129.8 (100.3–165.2)	129.8 (103.2–177.0)	.54
- UGIB	557.5 (365.8–1044.2)	448.4 (262.5–778.8)	.008

CHF = congestive heart failure, DF = dengue fever, IQR = interquartile range, UGIB = upper gastrointestinal bleeding, UTI = urinary tract infection.
Score data presented as median (IQR)
A *P*-value < .05 indicates statistical significance
[*] The total quality score and essential quality score were calculated by obtaining the percentage of completeness of each care map and then calculating its median to demonstrate the effect of care map implementation compared to pre-care map implemenation.

Table 3

Evaluated parameter scores in the care map and non-care map groups compared between the infectious disease and non-infectious disease subgroups.

Parameters	Infectious disease Median (IQR)	Non-infectious disease Median (IQR)
Total quality score		
- Care map group	80.3 (73.1–86.4)[**]	85.7 (78.6–92.9)[**]
- Non-care map group	58.4 (47.8–66.9)	64.3 (52.8–78.6)
Essential quality score		
- Care map group	80.0 (70.0–90.0)[**]	90.0 (75.0–100.0)[**]
- Non-care map group	50.9 (39.5–70.0)	60.7 (40.6–80.0)
History and physical examination assessment score		
- Care map group	100.0 (100.0–100.0)[**]	100.0 (85.7–100.0)[**]
- Non-care map group	62.5 (50.0–83.3)	71.4 (33.3–100.0)
Prescription pharmacologic-related score		
- Care map group	100.0 (0.00–100.0)[*]	66.7 (54.5–75.0)[*]
- Non-care map group	66.7 (0.0–100.0)	66.7 (50.0–75.0)
Prescription non-pharmacologic-related score		
- Care map group	83.3 (50.0–100.0)[**]	80.0 (66.7–100.0)[**]
- Non-care map group	50.0 (28.6–75.0)	66.7 (50.0–100.0)
Discharge planning and patient education score		
- Care map group	66.7 (60.0–100.0)[**]	75.0 (50.0–100–0)[**]
- Non-care map group	60.0 (33.3–66.7)	57.1 (25.0–100.0)
Length of stay (days)		
- Care map group	3.0 (2.0–4.0)[*]	3.7 (2.1–5.0)
- Non-care map group	3.1 (2.5–6.0)	3.9 (2.4–5.7)
Admission cost (US dollars)		
- Care map group	179.7 (125.4–288.2)[*]	400.0 (250.9–718.7)
- Non-care map group	230.5 (145.8–481.4)	410.2 (250.9–732.2)

[*] Indicates statistical significance at a level of $P<.05$.
[**] Indicates statistical significance at a level of $P<.0001$.
IQR = interquartile range.

For subgroup analysis, we classified patients into the 2 following subgroups: infectious disease and non-infectious disease. Patients with DF or UTI were included in the infectious disease group, while patients with stroke, CHF, hyperglycemia, or UGIB were in the non-infectious disease group. Our analysis revealed that implementation of CMs was able to improve the TQS and the EQS in both groups ($P < .001$). Moreover, the use of CMs increased the prescription score significantly in both the pharmacologic ($P = .002$ for infectious disease, and $P = .037$ for non-infectious disease) and non-pharmacologic-related subdomains ($P < .001$ for both the infectious and non-infectious disease groups). Concerning the discharge planning and patient education score, a significant increase was observed in both groups ($P < .001$). Surprisingly, CMs were able to significantly reduce both LOS and admission cost only in the infectious disease-related group. Median LOS reduced from 3.1 (2.5–6.0) days to 3.0 (2.0–4.0) days ($P = .003$), and the admission cost decreased from 230.5 (145.8–481.4) to 179.7 (125.4–288.2) US dollars ($P = .001$). In contrast, no significant difference in LOS or admission cost was observed in the non-infectious disease group after CM implementation. Evaluated parameter scores in the CM and non-CM groups were compared between the infectious disease and non-infectious disease subgroups, and those results are presented in Table 3.

Two hundred ninety-eight questionnaires were sent to CM users. Two hundred sixty-nine questionnaires were collected at the end of study for a 90.3% response rate. Forty-two (15.6%), 210 (78.1%), and 17 (6.3%) respondents were doctors, medical students, and nurses, respectively. Regarding respondents' views concerning the educational value of CMs, 88.1% of medical doctors, 89.5% of medical students, and 70.6% of nurses rated CMs as being highly educational tools. Moreover, most respondents were in agreement or in strong agreement that CMs were able to improve the QoC and improve the efficiency of the patient care process (Table 4). Approximately 80% of internal medicine residents and medical students, and 65% of nurses reported overall satisfaction with the use of CMs in clinical practice.

4. Discussion

In this study of 1116 patients with common ambulatory diseases, almost all baseline characteristics and disease severity were similar between the CM and the non-CM groups. Our primary

Table 4

Proportion and percentage of care map users that reported agreement or strong agreement for each measured domain compared among medical residents, medical students, and nurses.

Domains	Medical residents (n = 42)	Medical students (n = 210)	Nurses (n = 17)
Educational tool	37 (88.1%)	188 (89.5%)	12 (70.6%)
Improving care quality	38 (90.5%)	183 (87.1%)	11 (64.7%)
Time effectiveness	30 (71.4%)	173 (82.4%)	10 (58.8%)
Overall satisfaction	35 (83.3%)	184 (87.6%)	11 (64.7%)
Feasibility	30 (71.4%)	153 (72.9%)	13 (76.5%)

concern was to determine the effectiveness and the level of clinician satisfaction with CMs in a medical school environment. We found the implementation and utilization of CMs with peer pressure and quality supervision strategies was able to improve all TQS, almost all EQS, clinician satisfaction, and reduce median LOS. However, the reduction in both LOS and admission cost was dominant in the infectious disease subgroup. Both quality scores were improved significantly in all diseases after implementing the use of CMs. This result correlated with those from previous studies that employed the use of medical checklist tools, standing orders, or order sets to manage patients with heart failure and diabetes.[38,39] However, the one exception was the EQS for the UGIB CM, which may be explained by the fact that our center provides a high standard of care in patients with UGIB, with 24-hour on-call availability of specially trained staff to administer emergency treatment. Accordingly, we found a high EQS for UGIB in both groups.

CMs also significantly improved the effectiveness of patient history taking and physical examination. Overall, the quality score for these topics increased approximately 43% after CM implementation. Completion in patient history taking and physical examination could promote accurate diagnosis and appropriate management.[40,41] All CMs provide users with checklists highlighting the important aspects of history taking and the essential aspects of physical examination. Thus, the quality in history taking and physical examination assessment significantly improved in CM group.

The quality score for pharmacological prescription also improved after the implementation of CMs, especially in patients with UTI. The median prescription medical-related score increased from approximately 65% in the non-CM group to 100% in the CM group due to the fact that there are several presentations of UTI symptoms and many antibiotic options for UTI treatment,[42–44] and CM provided recommended antibiotic information from recent evidence-based guidelines. Moreover, a previous study in order sets relative to UTI demonstrated that the use of an order set could significantly increase the number of cases that received appropriate antimicrobial treatment.[45]

Discharge planning and patient education is an essential combined factor for reducing LOS and the readmission rate.[46,47] In the present study, CMs were found to be effective tools for enhancing the discharge planning and patient education process. The discharge planning and patient education quality scores were higher in the CM group than in the non-CM group for most of the evaluated ambulatory diseases. However, the results were inconsistent in the non-infectious disease group. Interestingly, the quality score was quite high for both UGIB and hyperglycemia in both the CM and non-CM groups. This is likely due to the fact that our center is vigilant about glucose control, and we have a specially trained team standing by to evaluate and treat patients with UGIB. Moreover, most of the non-infectious diseases are chronic diseases. Multiple factors, such as comorbid diseases, can affect LOS and admission cost. As a result, we were unable to identify significant reductions in LOS and admission cost between the CM and non-CM groups in the non-infectious disease subgroup. The observed improvement in the quality of discharge planning and patient education after the implementation of CMs resulted in decreased LOS and decreased admission cost, especially in the infectious disease group because CMs provide antibiotic guidance and switching options to oral antibiotics. These were able to increase physicians' confidence and reduce the time needed to make a decision. Even though CMs take additional time to follow and fill out, the majority of medical residents, medical students, and nurses expressed agreement that CMs are useful, educational, and time-saving tools in an ambulatory ward setting. Previous studies reported the efficacy of order set and medical checklist tools.[20–24] Consistent with that finding, the present study found that CMs that include order sets and medical checklists were able to improve the QoC with a high level of user satisfaction.

This study has some mentionable limitations. First and consistent with the retrospective nature of this study, it is quite difficult to determine with certainty that the observed improvement in care was influenced by the implementation of CMs, and some documents (i.e., discharge planning and patient education) were not fully completed in some cases. However, the main factors/circumstances, including the same team of main providers, ward structures, hospital and data support system, quality assessment, and study population, were equivalent between periods. Second, we did not include mortality or readmission as components of QoC in this study. We proceeded on the assumption that following the appropriate clinical practice guidelines would promote favorable and cost-effective clinical outcomes. Third, this study included data from one center, and our center is a large urban national tertiary referral center that is often referred complicated cases. It is, therefore, possible that our findings may not be generalizable to other ambulatory service settings. Fourth, we did not perform formal validity testing for the items in the quality evaluation form since we selected only those items approved by consensus. Similarly, CM tools were not previously validated and formally performed in feasibility study. However, these CMs were tested for a few months during the pre-implementation phase until there were no further feasibility issue before we officially launched and implemented CMs. Lastly, we encountered some problems with admission cost. The cost of treatment, including medications and medical equipment, was higher in the CM group due to differences in time between the CM and non-CM groups. Compared with the medical cost in 2010 to 2011, the cost of medications and equipment in 2012 to 2014 was higher for same drug and same medical devices. This may explain why no significant reduction in admission cost was observed between the CM and non-CM groups.

5. Conclusion

CMs, which are a simple, "just-in-time" medical management tools, with peer pressure to promote use and quality supervision were found to be an effective way to significantly improve quality, and to significantly reducing LOS in an ambulatory setting – particularly in the infectious disease subgroup in a tertiary medical school care setting. Moreover, the users reported satisfaction with CMs in a medical school environment. Further study should expand the spectrum of diseases encountered in ambulatory or other primary care settings, and investigate the cost-effectiveness of CMs relative to morbidity, mortality, readmission rate, and educational outcomes.

Author contributions

WS, CW, and PP obtained funding. WS, CW, TC, PP, CA, RS, and CC designed the study. WS, CW, PP, TC, CA, TS, RT, CK, RS, and CC were involved in data collection. WS, CW, and CK provided statistical expertise. WS, CW, PP, TC, CA, TS, RT, CK, RS, and CC provided the analysis plan and manuscript design. WS, PP, TC, and CW analyzed the data and wrote the manuscript. All authors contributed to the interpretation of the results and critical revision of the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

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