ORIGINAL ARTICLE

Readmission Rate and Percentage of Drug used as Guideline-Directed Medical Therapy Before and After Checklist (QR Code) Implement in Heart Failure Treatment

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Background: Congestive heart failure (CHF) is a common cardiac syndrome that produces high morbidity, mortality, and rehospitalization. Nowadays, heart failure reduced ejection fraction (HFrEF) treatment as guideline directed medical therapy (GDMT) following by Thai Heart Failure Guideline 2019 has proven benefits. The authors recognized that many patients were readmitted because of improper medications. Implementing checklist before discharge might improve drug adherence and decrease hospitalization rate.

Objective: Compared rehospitalization rate of CHF among patients using checklist and non-using checklist, as the primary outcome. Drug use as GDMT were also evaluated among both groups, as the secondary outcome.

Materials and Methods: The present study used a retrospective cohort and compared HFrEF patients who used checklist, as intervention group, with non-using checklist, as control group. Intervention group patients were admitted between December 2020 and December 2021, whereas control group patients were admitted between December 2019 and November 2020 in Vajira Hospital. The medical records of the intervention and control groups were retrospectively reviewed at the first admission. The rehospitalization rate at one and three months were compared. The prescribed medications including angiotensin-converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB)/angiotensin receptor-neprilysin inhibitor (ARNI), beta-blockers, spironolactone, and diuretics, as GDMT, before discharge were compared between groups.

Results: One hundred forty-six patients were included, 56 patients in the checklist group and 90 patients in the control group. Prescription of beta-blockers was significantly higher in the checklist group compared to control group at 96.4% versus 83.3% (p=0.016). However, ACEI/ARB/ARNI prescribed was significantly lower in checklist group at 62.5% versus 84.4% (p=0.003). Spironolactone and diuretics used was not different between the groups. The 3-month readmission rate due to CHF was significantly lower in checklist group at 17.3 persons-3-months versus 37.9 persons-3-months (p=0.035).

Conclusion: The checklist, or using QR code, implementation before discharge in HFrEF patients decreased the rate of rehospitalization at three months for CHF. Checklist using increased adherence to beta-blockers but decreased prescription of ACEI/ARB/ARNI drugs.

Keywords: Check list; Guideline directed medical therapy (GDMT); Discharge; Heart failure reduce ejection fraction (HFrEF)

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Congestive heart failure (CHF) is a common cardiac syndrome that produces high morbidity, mortality, rehospitalization, and economic burden. The prevalence of heart failure in Southeast Asia is 1% to 3%, which is similar in Europe[1]. In addition, the mortality of heart failure in Thailand is 10% per year, and approximately 50% of heart failure patients expire within five years after diagnosis[2]. Using the THAI ADHERE registry, it was found that mortality rate from heart failure in hospital is 5.5%[3]. Furthermore, the national readmission database reveals the trend of heart failure rehospitalization rate at one month and three months were 18.2% and 31.2%, respectively[4]. The overall annual heart failure cost per patient was $3,513, and hospitalized heart failure care costs were $7,181[5].

Over the last three decades, understanding of heart failure, and strategies for diagnosis and treatment of heart failure have dramatically improved. Guideline directed medical therapy (GDMT) such as angiotensin-converting enzyme inhibitor (ACEI), angiotensin receptor blockers (ARBs), beta-blockers, angiotensin receptor-neprilysin inhibitor (ARNI),

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or spironolactone for treatment heart failure with reduced ejection fraction (HFrEF) have been developed and shown benefit on decrease mortality, morbidity, and hospitalization[6,7]. However, many patients are still not prescribed optimal drugs for treatment of heart failure[8-10]. For example, THAI ADHERE registry found that in 2,014 admission events from CHF, 43.6% are HFrEF patients that are defined as left ventricular ejection fraction (LVEF) of less than 40%. However, only 35.3%, 12.4%, 25.2%, and 17.1%, received prescription of ACEI, ARBs, beta-blocker, and spironolactone before discharge, respectively. Therefore, the Thai Heart Failure Guideline 2019 recommends using checklist before discharge in heart failure patient. However, the data of this checklist are lacking in Thai people.

So, the present study aimed to evaluate the usefulness of the checklist before discharge to evaluate if it might improve prescribing optimal medical treatment as GDMT and reduce rehospitalization rate.

Methods and Materials

Patient population

The present study was a retrospective cohort comparing HFrEF patients who used checklist, or QR code, as intervention group, with non-using checklist, as control group. Intervention group patients were admitted between December 2020 and December 2021, whereas control group patients were admitted between December 2019 and November 2020 in Vajira Hospital. Both groups received routine care. The medical records of the intervention and control groups were retrospectively reviewed at the first admission. The data were collected by using ICD-10-CM as CHF as primary diagnosis.

Inclusion criteria were all patients aged older than 15 years old, Heart failure reduced ventricular ejection fraction, or LVEF of less than 40%, and hospitalized patients in internal medicine wards with functional class II to IV. All Heart failure participants were diagnosed by cardiologist. Exclusion criteria were end-stage malignancy, pregnancy, end stage renal disease (ESRD), and patient who did not used the checklist. The study was approved by the Ethics Committee of the Faculty of Medicine, Vajira Hospital, Navamindradhiraj University (COA194/2564).

Checklist

The authors developed a checklist as QR code for HFrEF patient based on the Thai Heart Failure Guideline 2019[2]. Checklists were used before discharging patients and included age, gender, body weight, blood pressure, heart rate, creatinine (Cr), LVEF, cause of CHF, precipitating factors, drug used as GDMT such as ACEI, ARB, ARNI, beta-blockers, spironolactone, loop diuretics, and causes of no GDMT used, Instruction checklist before discharge is shown in Figure 1.

The heart failure checklist was introduced in the medical record forms. When the patient is scheduled for discharge, the resident medicine will scan and complete the checklist by QR code before prescribing medication. In addition, the nurse and pharmacist will complete their part of the checklist during the education period.

Endpoints and definition

The primary endpoint was the comparison between intervention and control group in the rehospitalization rate at 3-months due to CHF. The secondary endpoints were the comparison between the groups of the 1-month rehospitalization, mortality, and prescribed medications as GDMT before discharge.

Statistical analysis

Based on a previous study[11], the present study estimated sample size was done using two proportions with independent sample formula that estimated 134 participants to achieve a power of 80%. Quantitative variables were described as mean ± standard deviation and compared using Student's t-test. Qualitative variables were described as number and percentage and were compared using Fisher's exact test or chi-square test. Differences between groups in rate of rehospitalization due to CHF at three months were tested using Poisson regression analysis. A p-value less than 0.05 was considered significant. All statistical analyses were performed by IBM SPSS Statistics for Windows, version 28.0 (IBM Corp., Armonk, NY, USA).

Results

One hundred forty-six patients were included, 56 patients were in the checklist group and 90 patients were in the control group. Baseline demographic data are shown in Table 1. The demographic data showed that 66% were men. The mean age was 63 years and LVEF for 30% to 39%. Hypertension and dyslipidemia were the majority of the co-morbidities. Common causes of CHF in checklists

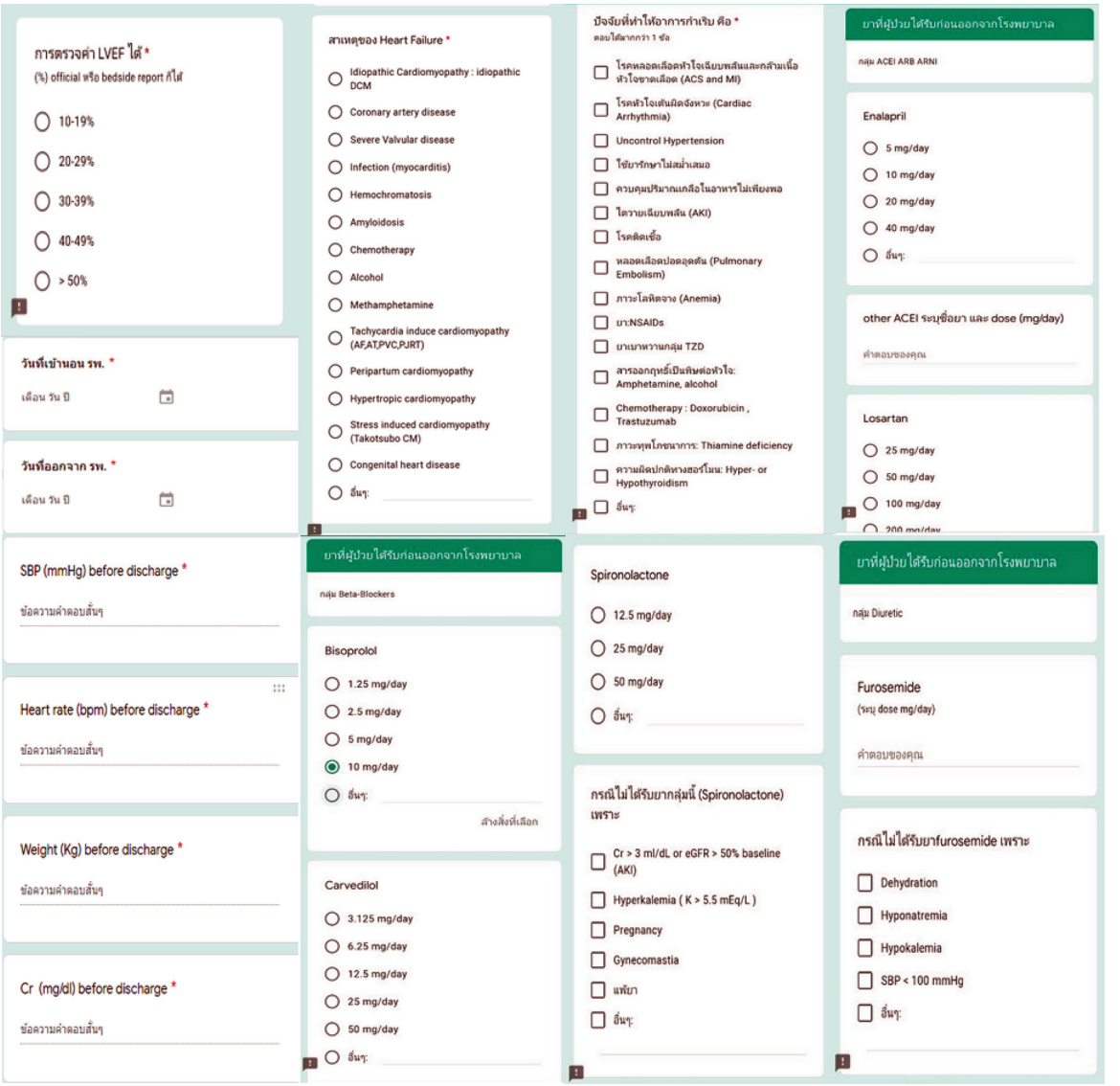

Figure 1. Checklist (QR code) for HFrEF patient.

group were coronary heart disease at 55.3%, idiopathic dilated cardiomyopathy (DCM) at 17.8%, and tachycardia induced cardiomyopathy at 16%. Common precipitating causes were acute coronary syndrome (ACS) at 39.2%, non-compliance with dietary at 32.1%, and poor drug compliance at 19.6% (Table 2, 3).

Prescription of beta-blockers was much higher in the checklist group compared to the control group at 96.4% versus 83.3% (p=0.016). However, ACEI/ARB/ARNI prescribed was significantly lower in the checklist group at 62.5% versus 84.4% (p=0.003). Spironolactone and diuretics used was not different between the groups, as shown in Table 4. In addition, worsening of renal function was the most common cause of cessation of the renin-angiotensin-aldosterone system (RAAS) drugs and the spironolactone, which were 71% and 14%, respectively. The other causes of unprescribed drugs as GDMT in the checklist group are described in Table 5.

The 1-month readmission rate due to CHF was not different between the groups with 9.15 person-month versus 11.63 person-month (p=0.50) (Table 4). However, the 3-month readmission rate due to CHF was significantly lower in checklist group at 17.3 person-3-month versus 37.9 person-3-month (p=0.035) (shown as Figure 2).

Table 1. Patient characteristics

Characteristics	Checklist group (n=56)	Control group (n=90)	p-value
Sex; n (%)			0.831
Male	37 (66.1)	61 (67.8)	
Female	19 (33.9)	29 (32.2)	
Age (years); mean±SD	63.00±15.99	63.37±14.11	0.885
Weight (kg); mean±SD	66.78±15.05	69.01±17.19	0.456
Body mass index (kg/m^2); mean±SD	24.50±4.63	25.22±5.50	0.446
Systolic blood pressure (mmHg); mean±SD	138.09±30.48	142.56±27.58	0.362
Heart rate (bpm); mean±SD	97.14±21.34	99.81±23.83	0.495
Hematocrit (%);mean±SD	39.01±7.51	39.17±6.47	0.892
Creatinine (mg/dl); mean±SD	1.37±0.69	1.24±0.44	0.202
LVEF (%); mean±SD	30.11±7.06	28.70±7.76	0.272
LVEF (range); n (%)			0.389
10% to 19%	3 (5.4)	11 (12.2)	
20% to 29%	24 (42.9)	35 (38.9)	
30% to 39%	29 (51.8)	44 (48.9)	
Comorbidities; n (%)			0.529
DM	25 (44.6)	45 (50.0)	
HT	48 (85.7)	83 (92.2)	0.208
DLP	50 (89.3)	85 (94.4)	0.335
Old CVA	11 (19.6)	16 (17.8)	0.778
CAD	26 (46.4)	58 (64.4)	0.032
CKD	13 (23.2)	20 (22.2)	0.889
AF	9 (16.1)	18 (20.0)	0.552
Hypothyroid	1 (1.8)	1 (1.1)	1.000
Hyperthyroid	2 (3.6)	1 (1.1)	0.559
Anemia	7 (12.5)	15 (16.7)	0.494
Length of stay (days); median (IQR)	7.5 (5 to 11)	7 (5 to 11)	0.700

LVEF=left ventricular ejection fraction; DM=diabetes mellitus; HT=hypertension; DLP=dyslipidemia; CVA=cerebrovascular disease; CAD=coronary artery disease; CKD=chronic kidney disease; AF=atrial fibrillation; SD=standard deviation; IQR=interquartile range

p-value corresponds to Independent samples t-test, Mann-Whitney U test, chi-square test, or Fisher's exact test

Table 2. Etiology of CHF in checklist group (QR code)

Causes	Patient in checklist group (n=56); n (%)
Coronary heart disease	31 (55.3)
Idiopathic DCM	10 (17.8)
Tachycardia induced cardiomyopathy	9 (16.0)
Infection (myocarditis)	2 (3.5)
Methamphetamine induced DCM	2 (3.5)
Peripartum cardiomyopathy	1 (1.7)
Alcoholic induced DCM	1 (1.7)

DCM=dilated cardiomyopathy

Table 3. Precipitating factors of CHF in checklist group (QR code)

Precipitating factors	Patient in checklist group (n=56); n (%)
Coronary artery disease (ACS, MI)	22 (39.2)
Non-compliance with dietary	18 (32.1)
Poor drug compliance	11 (19.6)
Cardiac arrhythmia	7 (12.5)
Uncontrolled hypertension	7 (12.5)
Infection	7 (12.5)
Amphetamine, alcohol used	3 (5.3)
Hyper- or hypothyroidism	2 (3.5)
AKI, volume overload	1 (1.7)
TZDs	1 (1.7)
others	3 (5.3)

ACS=acute coronary syndrome; MI=myocardial infarction; AKI=acute kidney injury; TZD=thiazolidinediones

Discussion

The present observational study shows the advantages of a simple tool, a QR code checklist before discharge that provides benefits for HFrEF patients. The present study revealed a decreased rate of heart failure rehospitalization at three months to 17.3 person-3-months from 37.9 person-3-months (p=0.035). Additionally, the prescription rate of GDMT drugs in the present study was higher than

Table 4. Comparison of clinical outcomes between before and after checklist (QR code) implement in heart failure treatment

Characteristics	Checklist group (n=56); n (%)	Control group (n=90); n (%)	p-value
Drug used			
ACEI/ARB/ARNI	35 (62.5)	76 (84.4)	0.003
• Enalapril	11 (19.6)	16 (17.8)	0.778
• Losartan	19 (33.9)	46 (51.1)	0.042
• Valsartan	0 (0.0)	3 (3.3)	0.286
• Sacubitril/Valsartan	5 (8.9)	11 (12.2)	0.536
Betablocker	54 (96.4)	75 (83.3)	0.016
• Bisoprolol	40 (71.4)	31 (34.4)	<0.001
• Carvedilol	14 (25.0)	41 (45.6)	0.013
• Nebivolol	0 (0.0)	3 (3.3)	0.286
Spironolactone	25 (44.6)	28 (31.1)	0.098
Furosemide	53 (94.6)	76 (84.4)	0.062
Readmission			
Readmission within 1 month (100 person-month)	5 (9.15)	10 (11.63)	0.500
Readmission within 3 months (100 person-3 month)	9 (17.28)	30 (37.9)	0.035
Mortality			
Mortality within 1 month	1 (1.8)	1 (1.1)	1.000
Mortality within 3 months	2 (3.6)	2 (2.2)	0.638

ACEI=angiotensin-converting enzyme inhibitor; ARB=angiotensin receptor blocker; ARNI=angiotensin receptor-neprilysin inhibitor; HFrEF=heart failure with reduced ejection fraction

p-value corresponds to Independent samples t-test, Mann-Whitney U test, chi-square test, or Fisher's exact test

Table 5. Causes of contraindication of drugs before discharge checklist group (QR code)

Drug	n (%)
No ACEI/ARB/ARNI used (n=21)	
Cr >3 mL/dL or eGFR >50% baseline (AKI)	15 (71.4)
Hypotension	6 (28.5)
Hyperkalemia (K >5.5 mEq/L)	1 (4.7)
No mention	1 (4.7)
No beta-blocker used (n=2)	
Hypotension (SBP <100 mmHg)	1 (50.0)
No mention	1 (50.0)
No spironolactone used (n=32)	
Cr >3 mL/dL or eGFR >50% baseline (AKI)	14 (43.7)
Hypotension	1 (3.1)
No mention	16 (50.0)
No furosemide used (n=3)	
Dehydration	2 (66.7)
Hypotension	1 (33.3)

ACEI=angiotensin-converting enzyme inhibitor; ARB=angiotensin receptor blocker; ARNI=angiotensin receptor-neprilysin inhibitor; AKI=acute kidney injury; Cr=creatinine; eGFR=estimated glomerular filtration rate; SBP=systolic blood pressure

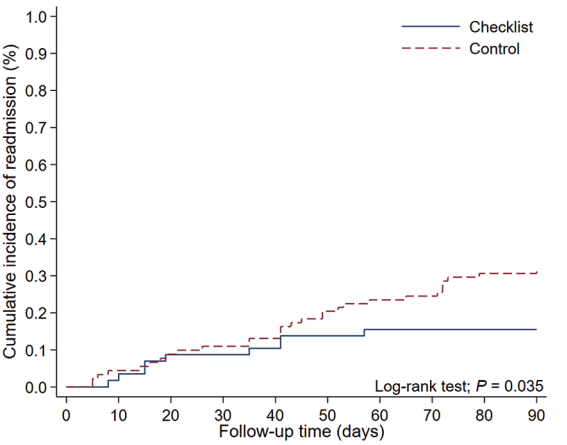

Figure 2. Readmission rate within 3 months compared between checklist (QR code) and control group.

in the Thai registry[3], suggesting that the outcomes might not be due to suboptimal drugs in the control group, but rather from the checklist itself. These results align with previous studies that demonstrate the significant reduction of rehospitalization through checklist usage. For instance, in 2013, Basoor et al.[12] conducted a small, randomized trial. In the checklist group, there was documentation regarding medications, dose recognition, counseling, and follow-up instructions at discharge. Both the 30-day and the 6-month readmissions were lower from 19% to 6% and from 42% to 23%, respectively, in the checklist group. However, the present study shows no significant reduction in the 30-day rehospitalization. This could be explained by the lower rate of 30-day

rehospitalization at 11% in the control group, making the benefits less significant in the intervention group, and the high rate of furosemide prescription in both groups at 94% versus 84% in the present study.

Furthermore, the study demonstrated a significant increase in the prescription of beta-blockers in the checklist group, particularly bisoprolol, compared to the control group with 96.4% versus 83.3% (p=0.016). The results were aligned with a recent observational study in Korea[13] that aimed to improve the quality of care by introducing the checklist to increase the number of GDMT prescriptions before discharge, especially beta-blockers. The checklist group exhibited better clinical outcomes, with significantly reduced readmissions and all-cause mortality within two months after discharge. Even though the number of RAAS drug prescriptions decreased in the checklist group in the present study, there were still benefits in improving rehospitalization, primarily through increased beta-blocker used. One landmark study explains this potential benefit in the CIBIS III trial[14], which indicated that starting with beta-blockers alone, followed by combined therapy with RAAS (enalapril), results in similar rates of combined death and all-cause hospitalization as initial combination therapy.

While there is an increasing trend in the usage percentage of almost all GDMT drugs in the intervention group, the outcome of drug adherence to ACEI/ARB/ARNI was unexpected. Only a small abstract has reported similar results as the present study[11]. The authors suspect that the lower usage of ACEI/ARB/ARNI in the intervention group could be due to various reasons. Firstly, the checklist includes warning boxes such as Cr of more than 3 mL/dL or estimated glomerular filtration rate (eGFR) of more than 50%, or systolic blood pressure (SBP) of less than 100, accounting for 71.4% and 28.5% of contraindication causes in this group, respectively. This makes physicians more cautious about prescribing those drugs. Secondly, the prevalence of acute kidney injury (AKI) in the setting of acute heart failure in the Asian population is higher than anticipated, ranging from 20% to 57%[15]. The present study data highlight the actual renal insufficiency in predischarge of Thai heart failure patients. Therefore, the checklist is a gatekeeper for RAAS drug use to prevent worsening renal function, potentially leading to the cessation of other GDMT drugs in the outpatient setting, resulting in negative consequences.

In contrast, there are differences in outcomes from other checklist studies. A study in France[16] involved 103 heart failure elderly patients aged 70 to 80 years with mildly reduced ejection fraction at 46%, and checklist failures resulted in no benefits from checklist implementation in the 6-month outcome. Additionally, Allain et al.[17] utilized checklists across all classes of heart failure such as HFrEF, heart failure with mildly reduced ejection fraction (HFmrEF), heart failure with preserved ejection fraction (HFpEF), and found no significant benefits as well. This could stem from the abundance of evidence-based data concerning the treatment of patients with heart failure and reduced LVEF, in comparison to HFpEF. This suggests that the checklist might not be as suitable for all classes of heart failure patients.

Limitation

The present study had limitations. Firstly, the intervention group and the control group were not included for the same duration of time. However, the baseline characteristics of the present study were similar in both groups, which may reduce confounding factors. Nonetheless, there might be other confounding factors, such as variations among physicians, their knowledge levels, and new medications available during that time especially a novel drug such as SGLT2 inhibitor and ARNI that may improve the rate of rehospitalization. Secondly, the present study is a single-center observational study with few patients, which was conducted during the COVID-19 pandemic period. Consequently, the results were underpowered to detect significant differences in mortality endpoints within a three-month timeframe. This issue could potentially be resolved by extending the follow-up period. Finally, the usage of a checklist might increase the workload for physicians, as seen in other reports from similar studies. In the authors attempt to address this, they employed a simple QR code checklist to minimize the workload, requiring only minutes to complete. However, it was important to note that long-term adherence to using the checklist by physicians could also present a limitation.

Conclusion

The checklist, using QR code, usage before the HFrEF patients is discharged decreased the rate of rehospitalization at three months from CHF. The checklist increased the adherence to beta-blockers, but decreased ACEI/ARB/ARNI usage.

What is already known on this topic?

Studies had shown the heart failure discharge checklist might improve the rate of prescription, rehospitalization, and mortality.

What does this study add?

The present study confirms that checklist, or QR code, implementation in the heart failure treatment decreased the rate of rehospitalization at three months from CHF and increase the trend in the usage percentage of almost all GDMT drugs.

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Conflicts of interest

The authors declare no conflict of interest.

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