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Conflict of Interest

The authors declare that they have no conflict of interest.

Permissions

Permission to use the Medication Adherence Questionnaire, the Adherence to Refills and Medications Scale, the Belief about Medicine Questionnaire, the Medication Adherence Self-Efficacy Scale-Revised, Medication Specific Social Support and table 4 has been granted.

Abstract

Adherence to cardiac medications makes a significant contribution to avoidance of morbidity and premature mortality in patients with cardiovascular disease. This quantitative study employed cross-sectional survey design to evaluate medication adherence and contributing factors among patients with cardiovascular disease, comparing patients who were admitted to a cardiac ward (n=89) and those attending outpatient cardiac rehabilitation (n=31) in Australia. Data collection was completed between October 2016 and December 2017. Descriptive and regression analyses were conducted to identify medication adherence and determine factors independently predictive of medication adherence. Participants from cardiac rehabilitation had significantly lower adherence to cardiac medications than those recruited from the cardiac ward (58.1% vs. 64.0% respectively). Self-efficacy was significantly associated with participants' medication adherence in both groups. The ability to refill medications and beliefs about cardiac medications were independently significantly predictive of cardiac medication adherence. These findings indicate areas where clinical nurses could expand their role to improve cardiac patients' medication self-management.

Keywords: Beliefs, medication adherence, cardiovascular disease, cardiac rehabilitation, predictive factors, medication refill, nursing, self-efficacy.

1. Introduction

Cardiovascular disease (CVD) is a major cause of mortality and disability worldwide, and was the main cause of mortality in 2017 in Australia, accounting for 10,514 (13%) and 8,076 (10%) deaths among male and female, respectively (Australian Institute of Health and Welfare, 2019). Adherence to cardio-protective medications is critical for primary and secondary prevention of CVD, but it is estimated that up to 50% of medications are not taken as prescribed by patients with chronic disease, increasing rehospitalization rates and premature mortality (Burnier & Egan, 2019).

The World Health Organization defines adherence to medications as "taking more than eighty percent of medicines as prescribed" (Sabaté, 2003, p. 3). Medication adherence typically decreases over time; this is a major challenge in all chronic diseases (Usherwood, 2017). For instance, a Canadian study found that only thirty-six percent of elderly patients with CVD adhered to their cholesterol-related treatments two years after diagnosis (Jackevicius, Mamdani, & Tu, 2002). An American study found that 10% -25% of patients newly diagnosed with cardiac disease had stopped taking their medications by their 24 week follow-up (Sokol, McGuigan, Verbrugge, & Epstein, 2005). In Australia, cardiovascular medication non-adherence rates ranged between 14% and 43% from 2010 to 2014 (McKenzie, McLaughlin, Clark, & Doi, 2015). Despite the increasing potential for cardiac medications to impact patients' health, the level of medication adherence in patients with CVD remains problematic (Leslie, Pell, & Mccowan, 2018). For example, a recent RCT conducted in Australia showed medication adherence among patients with CVD ranging from only 18.8% to 29.4% for intervention and control groups, respectively (Santo et al., 2019). Poor adherence to medication regimens in patients with CVD is associated with frequent rehospitalization and mortality (Al-Ganmi, Perry, Gholizadeh, & Alotaibi, 2016). Given that medication adherence is an important health behavior world-wide, at all points in the treatment of CVD, it is essential to determine

adherence to cardio-protective medications and potential predictive factors to initiate behavioral changes as needed.

1.1 Literature review

Adherence to medication prescriptions is necessary to receive the full benefits of medications, but is a complex and dynamic process. This is particularly challenging for patients with CVD who are predominantly discharged from hospital with long-term polypharmacy (Pandey, Clarus, & Choudhry, 2018). Multiple factors may be influential, including patient-related behaviors that are difficult to objectively measure and monitor (Boudreaux, Baumann, Camargo, O'Hea, & Ziedonis, 2007). Patient knowledge or understanding of a medication regimen, perceived adherence barriers or facilitators, low self-efficacy, and lack of belief in the necessity of medicines may influence medication adherence (Morrison et al., 2015).

Socio-demographic factors are relevant. Studies of age have returned inconsistent results: while some found those over 65 years particularly non-adherent, possibly because of cognitive impairment, physical disability and lack of social support (Pamboukian et al., 2008), others found older patients more likely to be adherent than younger patients (Park, Howie-Esquivel, Whooley, & Dracup, 2015). Gender may affect medication adherence (Gazmararian et al., 2006), but again findings are contradictory, perhaps because of the potential for error in self reporting, which may produce spurious results. Low medication adherence has been found to occur in more male than female patients with CVD and heart failure (Viana et al., 2014). By contrast, female patients with CVD were shown to be less likely to adhere to cardioprotective regimens than males (Kolandaivelu, Leiden, Gara, & Bhatt, 2014). On the other hand, Doll et al. (2015) found neither age nor gender were linked to medication non-adherence in patients with CVD attending cardiac rehabilitation. Ethnicity has been shown with similarly inconsistent results but has been reported as predictive of medication adherence among patients

with myocardial infarction (Zhang, Baik, Chang, Kaplan, & Lave, 2012). Employment status has also been found to have an effect, with higher medication non-adherence rates from unemployed people, particularly those without healthcare coverage (Lee et al., 2013).

Other influences include health literacy, where poor literacy has been linked to reduced medication adherence (Gazmararian et al., 2006). Social support has generally been linked to better medication adherence, positively affecting CVD outcomes (Wu et al., 2013). One observational study found that 59.2% of patients with CVD attending cardiac rehabilitation with support from family and staff were adherent and better able to refill cardiac medications than those with no support (Molloy, Perkins-Porras, Bhattacharyya, Strike, & Steptoe, 2008). Mood has also been shown to influence patients' self-efficacy, their beliefs about medications, and medication adherence (Cha, Erlen, Kim, Sereika, & Caruthers, 2008).

The problem of medication non-adherence has been repeatedly reported among patients with various chronic diseases, and disease stages (Park, Seo, Yoo, & Lee, 2018). Cardiac patients experience a number of stages in their disease progression and treatment, including acute events and hospital admissions, referrals and attendance at cardiac rehabilitation and community self-management (Doucette, 2017). Admission to hospital for an acute health event has been associated with changes favoring more health-oriented behaviors even in the absence of any specific health behavioral intervention (Boudreaux et al., 2007). Among patients attending cardiac rehabilitation, self-efficacy and beliefs about the benefits of exercise have been associated with medication adherence (Pandey et al., 2018). Few studies consider differences in medication adherence among patients with CVD at different stages of treatment, although such information could be used to develop strategies for different stages. Investigating the dynamics of medication non-adherence may identify specific factors at specific points, offering the potential to enhance medication adherence at different stages (King-Shier et al., 2017). Two such pivotal points in CVD are when an acute event leads to hospitalization, and

subsequent rehabilitation. There has been no evaluation of the factors leading to medication non-adherence at either stage. Overall, poor medication adherence remains a significant challenge in the management of patients with chronic diseases, including those with CVD, with a wide, locally relevant but broadly inconsistent variety of predictive factors. The underlying conceptual framework of medication adherence and factors that affect patients' adherence to their prescribed medications warrant further exploration.

1.2 Study aim

This study aimed to evaluate medication adherence and contributing factors among patients with CVD and to compare these between patients admitted to a cardiac ward and those attending cardiac rehabilitation in Australia.

2. Methods

2.1 Design

This study is part of a larger study exploring medication non-adherence among patients with CVD, part of which has been published (Al-Ganmi, Perry, Gholizadeh, & Alotaibi, 2018). In brief, this quantitative study used cross-sectional survey design to examine self-reported medication adherence and factors potentially predictive of medication adherence in two groups of patients with CVD with a history of prescribed cardiac medications. One group had been admitted to hospital for acute conditions such as acute coronary syndrome and revascularization interventions; the other was attending cardiac rehabilitation after discharge from hospital following similar acute cardiac conditions. Potentially predictive factors included beliefs about medication, medication adherence self-efficacy, social support and the ability to refill medication. Two stages in the disease trajectory, the acute phase and rehabilitation, were chosen to determine if patterns of stage-specific predictive factors could be identified, which

might lead to development of targeted nurse-led interventions to improve medication adherence at each stage.

2.2 Participants, sampling and sample size

Participants were patients with cardiac disease who were admitted to a hospital in Sydney for an acute cardiac event such as myocardial infarction or percutaneous coronary intervention, or who had been referred to and attended a cardiac rehabilitation program (Al-Ganmi et al., 2018). The acute cardiac patient population of the hospital comprised approximately 125 patients with CVD admitted per month to the cardiac ward, with 18% uptake of referrals to the cardiac rehabilitation centre (unpublished hospital data). The inclusion criteria specified adults aged 18 years and above with a diagnosis of CVD, currently treated with one or more cardiac medicines and personally responsible for taking them, prior to hospital admission or when attending cardiac rehabilitation. Participants needed to understand written and spoken English to complete the survey. Patients with vision and hearing impairment, cognitively impaired patients, those with history of psychiatric diseases, and patients who were not taking any cardiac medication were excluded (See Appendix 1).

A sample size of 85 participants was calculated to demonstrate a moderate sized effect ($\alpha = 0.05$, 5% level of significance) and power = 0.80 based on medication adherence as reported by Ma, Zhou, Zhou, and Huang (2014) and calculated based on a formula by Viechtbauer et al. (2015). Taking into account the possibility of as much as 50% non-response or incomplete response, given the busy clinical environments in which recruitment occurred, the sample was increased to 129 participants. In total, 120 participants were recruited.

2.3 Study setting

The study setting was one hospital in Sydney, Australia, which has in-patient diagnostic and interventional cardiac services including a cardiothoracic intensive care and sub-acute surgical ward, and a coronary care and sub-acute cardiology ward.

2.3.1 Routine medication care

The Australian Cardiac Rehabilitation Association recommends that routine care for cardiac patients should include: education on the importance of adherence to cardiovascular medicines including the reasons for their use, barriers to medication adherence, medication doses and frequency, and monitoring medication adherence using a tested tool (Woodruffe et al., 2014). Nurses and pharmacists are mainly responsible for providing medication education to patients with CVD during their stay in the cardiac ward and as a part of their cardiac rehabilitation.

2.4 Ethical considerations

The study was approved by the relevant health services and university human research ethic committees (reference numbers:16/085-HREC/16/POWH/218; ETH16-0635).

2.5 Data collection

Between October 2016 and December 2017, 120 completed questionnaires were obtained from 89 in-patients and 31 out-patients (Appendix 1). For in-patients, the questions referred to medication adherence in the period immediately prior to hospital admission. Data collection took place in the cardiac ward for in-patients, and during attendance at cardiac rehabilitation in the waiting room.

2.5.1 Study instruments

The survey comprised questionnaires about patients' adherence to cardiac medication, their beliefs, behavioral and psychological factors linked with medication non-adherence in previous studies (Horne, Weinman, & Hankins, 1999; Morisky, Green, & Levine, 1986), identified as potentially predictive of medication adherence and offering opportunities for nurse-led interventions to enhance adherence. The survey was piloted with five participants; no problems were identified. Completion took 10-15 minutes. The language was deemed manageable for those with poor literacy skills.

2.5.1.1 Sociodemographic and health-related factors

Data collected in this section included: age (years), gender (male, female), employment status (employed, unemployed, retired), living arrangement (lives alone or with spouse/partner/others), marital status (married/co-habiting or not in a relationship). It also asked for years of full-time education, ethnic background (Australian/New Zealander, others), presence of co-morbidities such as hypertension, diabetes mellitus, respiratory or renal disease, and number of cardiac medications taken daily. Co-morbidities were included because increasing numbers of diseases are linked to increasing numbers of medications and both have been linked to medication adherence. Comorbidities comprised kidney disease, respiratory disease and diabetes mellitus. Diabetes was identified separately because of the high occurrence and high burden of medication management of this disease in people with CVD.

2.5.1.2 Questionnaires addressing medication adherence

The validity and reliability of the study instruments to detect medication non-adherent behaviors in patients with CVD in various cardiac settings have been established (Al-Ganmi et al., 2018). The Medication Adherence Questionnaire (MAQ) (Morisky et al., 1986) is a four-item scale used to assess medication adherence and adherence determinants such as forgetfulness, carelessness, efficacy and adverse effects. The MAQ questionnaire has been

validated in various patient populations and patients with cardiac conditions such as heart failure, CVD and dyslipidaemia (Nguyen, Caze, & Cottrell, 2014). It has demonstrated acceptable internal consistency of $\alpha = 0.61$, sensitivity 0.81 and specificity 0.44 in patients with hypertension (Lavsa, Holzworth, & Ansani, 2011). The MAQ score was found to be a significant independent predictor of cardiovascular medication nonadherence in a multivariate logistic regression model (Shalansky, Levy, & Ignaszewski, 2004).

The Adherence to Refills and Medications Scale (ARMS) (Kripalani, Risser, Gatti, & Jacobson, 2009) is a 12-item scale used to assess patients' ability to self-administer and refill their medications. The ARMS subscales are highly correlated with the MAQ-4 items questionnaire, and with medication refill adherence (Kripalani et al., 2009). The ARMS has been validated in patients with CVD and multiple chronic conditions and has demonstrated high internal consistency using Cronbach's alpha, with $\alpha = 0.814$ (Kripalani et al., 2009).

The Belief about Medicine Questionnaire (BaMQ) (Horne et al., 1999) consists of eight questions used to evaluate patients' beliefs about the necessity of medications plus concerns, medication overuse and general harm. The BaMQ has been shown to be a valid and reliable tool, correlated significantly with other medication adherence questionnaires such as MAQ and the Medication Adherence Rating Scale (MARS-5) (Gatti, Jacobson, Gazmararian, Schmotzer, & Kripalani, 2009). Each BaMQ subscale has been evaluated for internal consistency using Cronbach's alpha, with α values of specific-necessity=0.77, specific-concerns= 0.76, general-overuse= 0.60, general-harm= 0.78 (Horne et al., 1999). The four BaMQ categories have been shown to correlate highly with patients' beliefs about the adverse effects of medication and specific-concerns as assessed by the Sensitive-Soma Scale administered to general medical and cardiac groups to demonstrate the criterion validity of BaMQ (Horne et al., 1999).

The Medication Adherence Self-Efficacy Scale-Revised (MASES-R) (Fernandez, Chaplin, Schoenthaler, & Ogedegbe, 2008) is a 13-item questionnaire to evaluate patients' confidence in taking their medications as part of everyday routine. The MASES-R has been shown to correlate significantly with electronic medication adherence records (MEMS) at three-months, confirming its predictive validity. The MASES-R has been evaluated for internal consistency using Cronbach's alpha, with $\alpha = 0.91$ (Fernandez et al., 2008). The concurrent validity of the MASES-R has also been confirmed.

The Medication Specific Social Support (MSSS) scale (Lehavot et al., 2011) is an eight-item scale to evaluate how often patients receive support with their medication from family, friends, or healthcare providers (Lehavot et al., 2011). The MSSS has demonstrated high internal consistency using Cronbach's alpha, with $\alpha = 0.85$ (Lehavot et al., 2011). Permission to use these questionnaires was obtained from their authors.

2.6 Data analysis

Nine of the 129 questionnaires were incompleted due to missing information regarding medication adherence. These questionnaires were not included in the analysis (Appendix 1). A complete data were obtained from 120 patients (Appendix 1). The questionnaires were analyzed using IBM SPSS version 23. Descriptive statistics were conducted to analyze patients' socio-demographic characteristics, medication adherence values, medication adherence self-efficacy, beliefs about medication and social support. Among sociodemographic, health and medication-related data, continuous variables were presented as means and standard deviations, and categorical variables by frequencies and percentages (Table 1). Independent samples t-tests were used to analyze differences between patients with CVD from the cardiac rehabilitation and cardiac ward groups with continuous variables, and Chi-square ($\chi 2$) tests for categorical variables. Medication adherence was categorized as high,

medium/ low and Chi-square ($\chi 2$) was used to compare the patient groups. Bivariate analyses were used to examine the association between potential medication adherence factors and medication adherence (MAQ scale) using Spearman's rank correlation coefficient (Rho). Variables significantly associated with medication adherence in these analyses were examined using logistic regression, reporting the odds ratios and confidence intervals for predictive variables. The level of significance was set at less than 0.25 for entry into regression models and less than 0.05 for the logistic regression test. The forced entry method was used, in which all potential predictors were forced into the model in the first step then sequentially removed. Two-sided tests were conducted with significance set at 0.05.

3. Results

3.1 Participants' characteristics

Participants' characteristics are presented in Table 1. Most socio-demographic and health data did not differ significantly between participants in the two study settings. Compared to participants from the cardiac ward, cardiac rehabilitation participants took significantly fewer cardiac medications per day (Table 1). They tended to be better educated, more often employed, and younger, although these differences between the groups were not statistically significant (Table 1).

3.2 Medication adherence

Based on the 4-item MAQ scores, 62.5% of patients in both groups were classified as high (scoring 0) and 37.5% medium/low adherent (scores 1-4). Since only one patient reported low medication adherence, we dichotomized the dependent variable into two groups: high adherence (score 0) and medium/low adherence (score 1-4). Medium/low adherence rate was higher among participants recruited from cardiac rehabilitation rather than the cardiac ward

(41.9% versus 36.0%; respectively; p=0.001). Cardiac rehabilitation participants were also more likely to forget the names of their medications than ward participants (30.8% vs. 16.1%, respectively; p= 0.04). Forgetfulness was the most commonly reported reason for medication non-adherence (32.3% vs. 31.5% in out-patients and in-patients, respectively). Medication-related variables (ARMS, MASES, BaMQ, MSSS) did not differ significantly between the groups (Table 2).

None of the twelve sociodemographic or health variables were significantly associated with medication adherence, although the ability to refill medications (ARMS), medication adherence self-efficacy (MASES-R) and beliefs about medications (BaMQ) were all significantly associated with medication adherence (MAQ), demonstrating positive moderate-strong correlations which explained 45%, 15% and 11% of patients' medication adherence, respectively (Table 3). Patterns of the associations revealed similar findings when the analyze were conducted separately for each group. In both groups, there was a significant link between MAQ with ARMS and MASESR (for ward patients, *Rho*= 0.655, p<0.001; *Rho*= 0.355, p<0.002, respectively; for rehabilitation patients, *Rho*= 0.716, p<00.1; *Rho*= 0.498, p< 0.001, respectively). For ward-based participants, the association between MAQ and BaMQ just missed statistical significance (*Rho*= 0.200**,** p<0.06) which was demonstrated for rehabilitation participants (*Rho*= 0.696, p<0.001).

These variables were entered in the sole binary logistic regression model that was created, see table 4 (Al-Ganmi et al., 2019). The results of the analysis indicated that ability to refill cardiac medications and beliefs about cardiac medications were significant predictors of cardiac medication adherence: participants with greater ability to refill cardiac medications (Odds ratio= 0.463, p=0.001) and with more positive beliefs about their medications were more likely to report better medication adherence (Odds ratio =1.142, p= 0.04). The logistic regression analysis recorded a significant Omnibus test for the model (significance < 0.001).

The Pseudo R Square statistic indicated that the model, as a whole explained between 38.7% (Cox & Snell R Square =0.387) and 52.8% (Nagelkerke R Square = 0.528) of the variance in medication adherence. ARMS + BaMQ explained 39.6% of variance but ARMS alone explained 36.6% of variance in MAQ.

4. Discussion

More than one-third of both groups had medium/low cardiac medication adherence. More participants recruited from cardiac rehabilitation reported medium-low medication adherence than those recruited as cardiac ward in-patients (41.9% versus 36.0%). Medication-related variables (ARMS, MASES, BaMQ, MSSS) did not differ significantly between participants recruited from the two settings.

Our findings are slightly better but broadly consistent with older data from the World Health Organization (2003), which highlighted medication non-adherence at 50%, with differing predictive factors in patients with chronic and acute cardiac diseases. At 36%, these findings from acute cardiac patients lie within the rates reported for similar patients elsewhere: in studies of patients with acute myocardial infarction, where 53.6% were found to be non-adherent to cardiac medications (Choudhry, Setoguchi, Levin, Winkelmayer, & Shrank, 2008). Patients referred to cardiac rehabilitation improved their adherence to cardiac medication from 43% to 55% (Shah et al., 2009); by contrast, in this study adherence rate were worse in the rehabilitation setting.

Consistent patterns of poor medication adherence in different patient groups suggests there may be common underlying problems, perhaps of inadequate patient education, or at least of patients' inadequate understanding of the importance of medication adherence, whether at the initiation of therapy or latter (Woodruffe et al., 2014). Perhaps this is the result of faulty beliefs, or practical or attitudinal barriers among patients attending cardiac rehabilitation

programs after acute cardiac events (Verburg, Selder, Schalij, Schuuring, & Treskes, 2019). Understanding patients' medication adherence behaviors is the first step towards enhancing their self-management and improving patients' outcomes. This study showed unacceptable adherence to cardiac medication in both groups, and in those recruited from the cardiac ward, this may have contributed to their hospital admission. The poor medication adherence reported by those undertaking rehabilitation indicates risk of recurrent cardiac disease and future hospitalization.

The logistic regression results showed that the ability to refill and administer medications was significantly predictive of adherence to cardio-protective medications for both in-patient and rehabilitation groups. Findings are congruent with those of Kripalani et al. (2009), who found that patients with CVD who were better able to refill their medications and self-manage had better adherence to regimens. Other studies suggest that patients' ability to refill medications may be linked to younger age, the number of daily medications, and patients' perceptions about the complexity of their medicines and ability to self-manage (Magnabosco et al., 2015). The ability to refill medications in a timely manner can be affected if patients have lower physical activity and mobility, or if younger patients lack understanding of their susceptibility to CVD-related complications (Magnabosco et al., 2015). Gazmararian et al. (2006) indicate that individuals with multiple medications manage refills better, as they are more focused on management of their health and resources for managing complex polypharmacy are readily available. These and other findings while sometimes inconsistent and even contradictory, make it clear that, while patients' ability to refill medications predicts medication adherence, other factors also exert significant influence in various groups. These findings flag the importance of examining individual patients at in-and-out patient settings and looking for factors, such as ability to refill medications, that may affect their medication adherence.

Like some other studies, our study found that patients with CVD from both in-patient and out-patient settings who held more positive beliefs about cardiac medications were more adherent to their medications. Several studies have found that patients' beliefs about the necessity of their medication were significantly predictive of medication adherence, for example in-patients with acute coronary syndrome (Allen LaPointe et al., 2011) and out-patients attending cardiac rehabilitation (Cooper, Weinman, Hankins, Jackson, & Horne, 2007). Uncertainty about the necessity of taking medications predicts lower medication adherence, specifically when patients have concerns about side-effects (Horne et al., 1999). Patients who hold less than strong beliefs about their medications and have concerns about side-effects reported forgetting or deliberately skipping prescribed doses (Sabaté, 2003). Our findings from both settings, that positive beliefs about cardiac medications were linked to medication adherence, is in line with other findings and highlights an important opportunity for improvement.

According to Bandura (2004), the central determinant affecting an individual's specific behaviors is self-efficacy, which influences motivation and affects other determinants. Bivariate analyses revealed that medication self-efficacy was significantly associated with medication adherence, a finding consistent with the results of two cross-sectional studies of patients attending cardiac rehabilitation (Greer, Milner, Marcello, & Mazin, 2015). However, differing from the results of Morrison et al. (2015), the impact of medication self-efficacy as an independent predictor of medication adherence disappeared in our regression analysis. Perhaps this reflects different characteristics of patients and may indicate opportunities for cardiac ward and rehabilitation nurses and pharmacists to develop stage-specific strategies to promote medication self-efficacy as a way to enhance medication adherence.

This study, like that of Wu et al. (2013), did not find sociodemographic factors significantly predictive of medication adherence. However, other studies have found age, for

example, to be significantly predictive, and significantly better medication adherence to hypertension medications has been noted among older people (Pamboukian et al., 2008). Given that the patients with CVD recruited for our study from cardiac rehabilitation were young, and likely to be employed and married, we might surmise that these patients had limited time and perhaps other activities took precedence over regular adherence to medications. Other studies have also been inconsistent about the effect of sociodemographic factors on medication adherence (Park et al., 2015).

Medication adherence, not just prescription, should be recognized as an essential focus for cardiac patients, and for policy-makers. Medication adherence education and counselling should be prioritized for cardiac patients in all hospital settings, with education sessions and face-to-face counselling integrated into care plans. The reinforcement of medication importance during cardiac rehabilitation and in routine follow-up visits will also improve medication refill compliance and enhance cardiac patients' beliefs in the necessity of taking their medications. Establishing medication adherence plans for patients in cardiac care settings will help nurses identify those who are likely to be non-adherent, and to target individual patients who need extra help with medication adherence.

More attention is required to the role of cardiac nurses in assessing cardiac patients' self-management and ability to refill medication, and in promoting innovative forms of follow-up that enhance their role in cardiac rehabilitation. An effective care provider-patient relationship will be an important component in building an encouraging environment to achieve treatment plan goals. Tailoring educational interventions to target cardiac patients' beliefs about cardiac medication may be an effective approach to enhance patients' beliefs about the efficacy of these medications and to increase adherence to them. Simple interventions such as: electronic prompts, interactive packages of education, reminders through text messages or phone calls

using smartphone and tablet devices, all easily manageable by nurses, have been found useful in improving adherence to medication in patients with CVD (Ferdinand et al., 2017).

4.1 Study limitations

Recruiting at a single site, study results may not be generalizable. The study was conducted in busy clinical cardiac settings where the cardiac patients were asked to complete questionnaires shortly after a rehabilitation session or (in the ward) when they were deemed clinically stable. Tiredness may have affected the attention to the survey questions, and the reported medication non-adherence rates may not have been completely accurate. Cardiac rehabilitation was a particularly challenging location for recruitment, with staff and cardiac patients time-pressured and preoccupied. In spite of an adequate study size, careful consideration must be paid when comparing the results for different cardiac patient groups. Future studies could take into account the impact of clustering and sampling.

Use of self-report questionnaires may have biased the study findings, with more socially acceptable but incorrect responses entered, as is the case in many studies. Use of standardized surveys meant participants could only provide ranked responses to the questions, and a qualitative enquiry providing a deeper understanding of cardiac patients' perspectives would be valuable. Differences between site sample sizes may have limited our ability to determine significant inter-site differences. Any differences in the prescribed cardiac medications between acute in-patient and rehabilitation participants were not considered, which may have impacted patients' adherence. Finally, as with many medication adherence studies, lack of a gold standard assessment introduces an element of uncertainty into the reported medication adherence assessments.

5. Conclusion

There is a need to enhance adherence to medication in patients with CVD through consideration of factors significantly associated with and predictive of medication adherence. This cross-sectional study demonstrates that ability to refill medications and positive beliefs about medication are independently predictive of greater cardiac medication adherence in patients with CVD. This suggests, first, that strategies are urgently required to improve the poor medication adherence demonstrated in this and other studies. Second, these strategies should be tailored to the factors that deter timely medication refill and to negative beliefs about medication adherence. Such interventions could include innovative educational interventions and counselling sessions by clinical nurses. Cardiac nurses have an opportunity to enhance their roles in assessing and improving cardiac patients' ability to refill medication and their beliefs about those medications which, in turn, should improve medication adherence and outcomes.

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Authors contributions

Study design: A.A., L.P., and L.G.;

Data collection: A.A.;

Data analysis: A.A., L.P., L.G., and A.A.;

Revisions for important intellectual content: A.A., L.P., L.G., and A.A.

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Table 1 Sociodemographic and health characteristics of patients recruited from the cardiac rehabilitation department and the cardiac ward

Variables	**Cardiac Rehab. n= 31 n (%)**	**Cardiac Ward n= 89 n (%)**	**Chi-Square test**	***df***	***P*-values**
Gender					
Male	19 (61.3%)	59 (66.3%)	0.25	1	0.62
Female	12 (38.7%)	30 (33.7%)			
Employment Status					
Employed	10 (32.3%)	21 (23.6%)	7.18	2	0.03*
Unemployed	6 (19.4%)	5 (5.6%)			
Retired	15 (48.4%)	63 (70.8%)			
Living Arrangement					
Lives alone	4 (12.9%)	23 (25.8%)	2.21	1	0.14
Lives with spouse/partner/others	27 (87.1%)	66 (74.2%)			
Marital Status					
Married/ co-habiting	23 (74.2%)	54 (60.7%)	1.83	1	0.18
Not in a relationship	8 (25.8%)	35 (39.3%)			
Ethnicity					
Australian/ New Zealander	18 (58.1%)	57 (64.0%)	0.35	1	0.55
Others	13 (41.9%)	32 (36.0%)			
Comorbidity					
None	26 (83.9%)	68 (76.4%)	0.76	1	0.39
Any	5 (16.1%)	21 (23.6%)			
Diabetes Mellitus					
No	21 (67.7%)	56 (62.9%)	0.23	1	0.63
Yes	10 (32.3%)	33 (37.1%)			
			t-test	***df***	**P-values**
Age; mean (SD)/ years	66.6 (11.9%)	69.9 (11.5)	-1.38	118	0.17
Years of full time education; mean (SD)	13.9 (3.6)	11.9 (3.5)	2.63	118	0.01**
Number of cardiac medications taken per day; mean (SD)	2.8 (1.1)	3.2 (0.9)	2.57	118	0.01**

Note: (SD) Standard Deviation, *Significant at 0.05, **Significant at 0.01.

Table 2 Medication adherence-related variables in patients recruited from the cardiac rehabilitation department and the cardiac ward

Medication adherence	Total n (%) n=120	Cardiac Rehabilitation n (%) n= 31	Cardiac Ward n (%) n= 89	Chi-Square Test	df	P-values
MAQ level						
High (0)	75 (62.5%)	18 (58.1%)	57 (64.0%)	28.033	1	0.001*
Medium/Low (1-4)	45 (37.5%)	13 (41.9%)	32 (36.0%)			
Medication recall						
Can remember all medications	83 (69.2%)	83 (69.2%)	26 (83.9%)	4.24	1	0.04**
Can't remember all medications	37 (30.8%)	37 (30.8%)	5 (16.1%)			
				t-test	***df***	**P-values**
ARMS mean (SD)		45.10 (3.1)	45.72 (2.9)	-1.000	118	0.32
MASES mean (SD)		34.06 (6.6)	35.6 (5.5)	-1.282	118	0.20
BaMQ mean (SD)		30.3 (6.1)	31.9 (4.4)	-1.474	118	0.14
MSSS mean (SD)		10.6 (5.6)	11.5 (7.5)	-0.577	118	0.56
MAQ individual items scores§ mean (SD)		3.5 (0.72)	3.5 (0.8)	-0.06	118	0.95
Forget to take						
Yes n (%)	38 (31.7%)	10 (32.3%)	28 (31.5%)			
No n (%)	82 (68.3%)	21 (67.7%)	61 (68.5%)			
Careless at times						
Yes n (%)	13 (10.8%)	3 (9.7%)	10 (11.2%)			
No n (%)	107 (89.2%)	28 (90.3%)	79 (88.8%)			
Sometimes stop taking when feel better						
Yes n (%)	5 (4.2%)	1 (3.2%)	4 (4.5%)			
No n (%)	115 (95.8%)	30 (96.8%)	85 (95.5%)			
Sometimes stop taking when feel worse						
Yes n (%)	9 (7.5%)	3 (9.7%)	6 (6.7%)			
No n (%)	111 (92.5%)	28 (90.3%)	83 (93.3%)			

Note: (n) number of participants, **(*df*)** degree of freedom, (**SD**) standard deviation, (**ARMS**) Ability to Refill Medication & Self-Management, (**MASES**) Medication Adherence Self-Efficacy, (**BaMQ**) Belief about Medication, (**MSSS**) Medication Social Support.
MAQ level: (0) = All answers with 'No', (1-4) = one to four answers with 'Yes'.
§ Morisky medication adherence scale, higher scores reflect non-adherence.
p< 0.001*.
p< 0.01**.

Table 3 Associations between medication adherence (MAQ) and potential predictors variables in both groups participants

Variables	*Rho*	P value
Age	-.023	0.803
Gender	-.132	0.803
Location of recruitment	.030	0.745
Employment status	.046	0.620
Living arrangement	.121	0.188
Marital status	-.111	0.229
Ethnicity	-.155	0.092
Number of full time years of education	-.131	0.41
Comorbidity	-.055	0.554
Diabetes Mellitus	-.129	0.160
Medications recall	.099	0.281
Total number of pills/day	-.079	0.660
Ability to refill medication and self-management (ARMS)	.676**	0.001*
Medication adherence self-efficacy (MASES-R)	.392**	0.001*
Beliefs about medication (BaMQ)	.335**	0.001*
Medication specific social support (MSSS)	-.036	0.697

ARMS: Ability to Refill Medication & Self-Management, **MASES-R**: Medication Adherence Self-Efficacy, **BaMQ**: Belief about Medication, **MSSS**: Medication specific social support.

**. Spearman's rank correlation rho (odds ratio)

*. Correlation is significant at the *P*-value = 0.001 level (2-tailed)

Table 4 Binary logistic regression model examining predictors of cardiac medication adherence.

Predictors		Cox & Snell R Square	Nagelkerke R Square	Odds ratio B	Standard Error S.E.	Wald	df	Sig.	Odds ratio Exp.(B)	95% C.I. EXP.(B)	
										Lower	Upper
Step 1[1]	Age			.795	.621	1.638	1	.201	2.215	.655	7.485
	Location of recruitment			.150	.631	.056	1	.813	1.162	.337	4.004
	ARMS	0.366	0.499	-.771	.170	20.520	1	.001*	.463	.332	.646
	MASERS			.000	.060	.000	1	.998	1.000	.889	1.124
	BaMQ	0.396	0.539	.133	.065	4.178	1	.041*	1.142	1.005	1.298
	MAQ	0.387	0.527								
	Constant			30.220	6.990	18.689	1	<0.001	133138346410.104		

a. Variable(s) entered on step 1: **Age**, **ARMS**: Ability to Refill Medication & Self-Management, **MASES**: Medication Adherence Self-Efficacy, **BaMQ**: Belief about Medication, **MAQ**: Medication Adherence level..
p< 0.05*.

Appendix 1 Flow diagram of the recruitment process