Identifying determinants of medication adherence following myocardial infarction using the Theoretical Domains Framework and the Health Action Process Approach

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Background: Despite evidence-based recommendations, adherence with secondary prevention medications post-myocardial infarction (MI) remains low. Taking medication requires behaviour change, and using behavioural theories to identify what factors determine adherence could help to develop novel adherence interventions.

Objective: Compare the utility of different behaviour theory-based approaches for identifying modifiable determinants of medication adherence post-MI that could be targeted by interventions.

Methods: Two studies were conducted with patients 0–2, 3–12, 13–24 or 25–36 weeks post-MI. Study 1: 24 patients were interviewed about barriers and facilitators to medication adherence. Interviews were conducted and coded using the Theoretical Domains Framework. Study 2: 201 patients answered a telephone questionnaire assessing Health Action Process Approach constructs to predict intention and medication adherence (MMAS-8).

Results: Study 1: domains identified: Beliefs about Consequences, Memory/Attention/Decision Processes, Behavioural Regulation, Social Influences and Social Identity. Study 2: 64, 59, 42 and 58\% reported high adherence at 0–2, 3–12, 13–24 and 25–36 weeks. Social Support and Action Planning predicted adherence at all time points, though the relationship between Action Planning and adherence decreased over time.

Conclusions: Using two behaviour theory-based approaches provided complimentary findings and identified modifiable factors that could be targeted to help translate Intention into action to improve medication adherence post-MI.

Keywords: Theoretical Domains Framework; Health Action Process Approach; medication adherence; myocardial infarction

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Coronary artery disease remains a leading cause of death, accounting for a third of mortality in people over 35 (Lloyd-Jones et al., 2010) and for half of myocardial infarction (MI)-related deaths (NCEP, 2002). Promisingly, cardiovascular morbidity and mortality rates have been declining, with one reason being the development of effective medications including statins, anti-platelet agents, beta-blockers and angiotensin inhibitors. Mortality risk can be reduced by up to 75% when people are adherent to all four medication classes (Hippisley-Cox & Coupland, 2006). Conversely, lack of adherence to such medication is linked with higher mortality rates (Rasmussen, Chong, & Alter, 2007). Some evidence suggests that while medication non-adherence levels are initially relatively low at 2 weeks post-MI (20% non-adherence), non-adherence increases to 54 and 53% at 6 and 12 months post-MI, respectively (Molloy et al., 2014). Unfortunately, we lack reliably effective interventions to address medication adherence and thus improve patient outcomes (Nieuwlaat et al., 2014).

Identifying modifiable determinants of medication adherence by drawing upon behaviour change theories and frameworks can provide a basis for developing a cumulative evidence-base. Two approaches tend to be used in applying behaviour theory to identify potential determinants: framework-based and model-based approaches.

The framework-based approach often uses qualitative methods to explore pre-specified theory-based topics. One such framework is the Theoretical Domains Framework (TDF; Cane, O’Connor, & Michie, 2012; Michie et al., 2005), which is composed of 14 theoretical domains (Knowledge, Skills, Social/Professional Role and Identity, Beliefs about Capabilities, Beliefs about Consequences, Optimism, Reinforcement, Intentions, Goals, Memory/Attention/Decision Processes, Environmental Context and Resources, Social Influences, Emotion, Behavioural Regulation; see Cane et al., 2012 for definitions). These domains summarise the content of 33 theories of behaviour change, and thus a wide breadth of modifiable factors that have been linked with behaviour and behaviour change. The TDF has been used for intervention development (French et al., 2012) and to inform interviews identifying barriers and facilitators to enacting behaviours (Patey, Islam, Francis, Bryson, & Grimshaw, 2012). To date, as far as we know, this framework has not been used to identify barriers and facilitators to taking medication.

The model-based approach often uses a quantitative, questionnaire-based approach to assess a small set of factors linked within a model specifying how the factors are related to behaviour and to one another. One example of a theoretical model of behaviour change is the Health Action Process Approach (HAPA; Schwarzer, 2008). The theory suggests that behaviour is formed through two phases: a motivational phase and a volitional phase. In the motivational phase, individuals form an Intention to perform a behaviour, determined by how confident they are in being able to enact the behaviour (Self-efficacy), what outcomes might result from engaging in the behaviour (Outcome Expectancies) and/or Risk Perceptions about performing (or not performing) the behaviour. The volitional phase describes how these Intentions are translated into behaviour. This phase consists of Action Planning to specify when, where and how to perform the behaviour, Coping Planning how to circumvent anticipated barriers to ensure the behaviour is performed, and Action Control involving being aware of standards, self-monitoring progress and putting in effort (Pakpour et al., 2014). Self-efficacy plays a role in both phases, as do Barriers and Resources and Social Support. The HAPA can help to understand what modifiable factors determine Intention (or lack thereof) to adhere to medication, as well as post-intentional factors that help to ensure that motivation is
translated into medication adherence. We selected the HAPA based on three criteria: (a) its comprehensiveness as a theory of behaviour change that can be used to identify factors to target in an intervention and their interrelationships; (b) provides an explanation of behaviour that accounts for contemporary theorising including pre- and post-intentional processes; and (c) encompasses constructs previously shown to be relevant for understanding medication adherence while providing a novel perspective.

The TDF and the HAPA provide potentially complementary perspectives to inform identification of determinants of medication adherence. What remains unclear is whether the broader TDF approach identifies any domains not covered by the more specific HAPA that may inform medication adherence intervention development.

We aimed to (a) identify modifiable determinants of medication adherence post-MI using two behaviour change theory-based approaches, (b) investigate whether determinants of adherence differ depending on time since the MI, and (c) to triangulate findings between the two theoretical approaches to inform intervention development.

Overview
We conducted two studies to identify modifiable factors linked with medication adherence post-MI and whether these differ depending on time since MI. Both studies involved cross-sectional samples of patients 0–2 weeks, 3–12 weeks, 13–24 weeks or 25–36 weeks after their MI. In Study 1, we conducted semi-structured telephone interviews using the TDF. We used the TDF as a basis for exploring barriers and facilitators to adhering to medication and therefore had no preconceived hypotheses. In Study 2, we conducted structured telephone questionnaires to assess HAPA constructs and medication adherence. In Study 2, we hypothesised that the tenets of the HAPA would be supported for medication adherence behaviour. Namely, we hypothesised that (1) Intention would be a function of Self-efficacy, Risk Perception, Outcome Expectancies and Social Support; (2) that behaviour would be a function of Action Planning, Coping Planning, Self-efficacy and Social Support, and (3) that the relationship between Intention and adherence would be mediated through Action Planning and Coping Planning (mediation hypothesis).

The local research ethics board (HIREB 02-245) approved the protocol for both studies. Eligible patients in both studies were those with an MI who underwent coronary angiography during calendar year 2014 at a regional tertiary referral centre serving a region of over 1.4 million people and performs over 8000 angiograms a year. In Ontario (Canada), health care delivered in hospitals is provided free of charge, as are most cardiac medications for those over age 65. Within that healthcare system, patients under 65 years old either (1) pay out of pocket, (2) join private or group medication insurance plans or (3) have government-supported medication coverage through disability or social assistance programmes.

Study 1 – Theoretical Domains Framework interviews

Methods

Data collection
Research staff identified potential participants, confirmed interest and identified a preferable time for a one-hour interview. We contacted eligible patients in groups, according to the number of weeks since their MI. We estimated our sample size to inform recruitment
using the 10 + 3 rule for establishing theoretical data saturation (Francis et al., 2010), whereby at least 10 interviews should be conducted and followed by a further three for which no new themes emerge. We sought six patients for each time point (0–2 weeks, 3–12 weeks, 13–24 weeks or 25–36 weeks; 24 total patients). Trained research personnel, familiar with the TDF, conducted interviews following a semi-structured interview guide (see online supplemental file for interview guide). The research personnel obtained verbal consent prior to the interviews. Interviews were recorded and transcribed verbatim, excluding identifiers.

Analysis
Participants’ responses were coded into the 14 domains of the TDF. Coded statements within domains were reviewed to generate belief statements representing a common theme relating a respondent’s beliefs to treatment adherence. Using established criteria from other TDF-based studies (Bussières, Patey, Francis, Sales, & Grimshaw, 2012; Islam et al., 2012; Patey et al., 2012; Roberts, Lorencatto, Manson, Brundage, & Jansen, 2016), domains were considered relevant based on a relatively high frequency of several belief statements mentioned by multiple respondents for a given domain, the presence of conflicting belief statements, or evidence of strong beliefs that may impact the behaviour. We also compared available data on age and sex between those who completed interviews to those who were contacted but did not respond.

Results
We attempted to contact 55/66 patients initially agreeing to receive further study information. When subsequently contacted, 31/55 (56%) were reached by telephone; all but one was interested in being interviewed. Non-responders could not be reached for reasons including not answering the phone (n = 18), leaving a message with a friend/relative (n = 4) and technical difficulties with the phone connection (n = 2). Interviews were completed until six patients at each time point were contacted (24 interviews in total). The mean age of interviewees was 62 years (SD = 10), most (20) were men; 18 were admitted using emergency services. No significant age difference (p = .14) was observed between interviewees (mean = 62; SD = 10) compared to non-respondents (mean = 58, SD = 9). Similarly, no significant difference between sexes (p = .12) was observed in respondents (women = 17%; men = 83%) compared to non-respondents (women = 36%; men = 64%).

Domains thought to be more useful in understanding medication adherence included: Beliefs about Consequences, Memory/Attention/Decision process, Behavioural Regulation, Social Influence, and Social Role and Identity. Table 1 provides illustrative belief statements for these domains. The relative importance of the domains changed little over time, with the exception of knowledge, which arose most often when patients were earlier in their recovery.

Beliefs about Consequences
Most respondents were confident that medication was helpful for their heart, but a number was less certain about the benefits, noting that they could not necessarily observe
the effects or as in the case of the quote below, did not expect to have an effect on their blood pressure or cholesterol but assumed it is nevertheless helpful in their recovery. Many expressed concerns about actual or potential side-effects, and some expressed their hopes to discontinue medications over time. There was no discernible pattern over time in these views.

I can’t see my blood pressure going up because it never has been up. I can’t see getting high cholesterol because it never has been high. So there’s a reason for it and I guess it’s for this heart attack, so that’s all I can say about that (68, male, 0–2 weeks post-MI)

**Behavioural Regulation**

Developing a routine for taking medications was viewed as an important aspect of turning a new behaviour into a habit. Many respondents found that pill organisers or other reminders acted as useful aids to keep track, at least until the habit was fully formed. Some changes in participant responses over time could be seen as a reflection of the extent to which new pill-taking routines had been successfully incorporated into their day-to-day life.

It’s a routine, when I finish my breakfast I take my morning medications there’s a set of seven pills and so the containers empty and that chamber’s empty and so if I have any second thoughts as to ‘Did I take my pills?’ I can go back and look in that chamber and make sure it’s empty. (68, male, 0–2 weeks post-MI)

**Memory/Attention/Decision Processes**

A few patients, mostly in later time points, reported intentionally stopping medications, but most denied ever considering such a decision. However, many patients at each time point admitted to occasionally forgetting their medications due to distractions or inattention.

I just kind of like totally – I got busy that day and just totally forgot. (51, female, 0–2 weeks post-MI)
Social Influences
The level of trust placed healthcare providers’ advice was a common justification for adherence. For some patients, family members were openly supportive or acted as a source of motivation. The role played by friends was less clear; few patients discussed their medications with their friends. No patterns emerged over time with regard to the role of social influences.

[The doctor says,] ‘I know you don’t like taking them’ – and she [the doctor] laughs – and I says well, ‘you know, you’re right’; she says, ‘but you have to take them’. So they cut back on the dosage, so now a lower dosage, but I follow her instructions, because I think she means what is best for me, means good, yeah. (79, male, 25–36 weeks post-MI)

Social/Professional Role and Identity
The instructions to take medications routinely and indefinitely post-MI often represented a considerable change in self-image particularly in terms of their perceived frailty. This was reflected in terms of how respondents viewed themselves and how they felt others viewed them. This notion arose more often in the later time points, possibly because patients who had been well prior to their MI hoped they might have completed their course of medications by that time.

I think it’s on a mental thing with me. Do you know what I mean? It’s like oh, I hate doing this, I hate – this. I think it’s a mental thing with me; it’s like my mind says I hate doing this, I hate taking them. I feel like I’m tied to medication. (70, female, 3–12 weeks post-MI)

Domains of lesser importance for designing a medication adherence intervention were: Beliefs about Capabilities, Knowledge, Reinforcement, Skills, Optimism, Goals, Intentions, Emotion, and Environment Context and Resources. While these domains contained some meaningful belief statements for some patients, they were either infrequently mentioned or thought to be difficult to modify in a future individual-level intervention (e.g. the role of financial constraints).

Study 2 – Health Action Process Approach Telephone Questionnaires
Methods
Data collection procedure
We used local registry information from the Heart Investigation Unit (Mercuri et al., 2015) and sent a notice to eligible patients one week prior to conducting the telephone questionnaire to inform them of the upcoming, optional survey and to provide a paper-based reference for the Likert scale that would be used for most of the telephone questions. Trained research personnel interviewed patients by following a structured questionnaire informed by the HAPA to evaluate determinants of adherence. Validated survey questions (with adaptations when necessary) were used to address relevant constructs. Patients provided verbal consent prior to responding to the questionnaire.
Behavioural outcome

Participants were asked to complete the eight-item Morisky Medical Adherence Scale (MMAS-8; Krousel-Wood et al., 2009; Morisky, Ang, Krousel-Wood, & Ward, 2008; Morisky & DiMatteo, 2011) to assess medication adherence.

HAPA-based predictors

Risk Perceptions were assessed using a shared stem ‘If I keep my lifestyle the same as before my heart attack, I would…’ followed by three items (α = .86): ‘…have another heart attack’, ‘…have coronary health problems’ and ‘…have more health-related problems’. Items were based on Sniehotta, Schwarzer, Scholz, and Schuz (2005). Outcome expectancies were assessed with four items (α = .77), with a common stem ‘If I take my heart medication exactly as prescribed…’ followed by ‘it will prevent another heart attack’, ‘it will be good for my health’, ‘I will feel better physically’ and ‘it will improve my quality of life’. Items were adapted from Renner and Schwarzer (2003). To assess Self-efficacy, we used an adapted version of the medication adherence Self-efficacy scale (MASES; Ogedegbe, Mancuso, Allegrante, and Charlson (2003)), using the common stem ‘I am confident that I can take each dose of my prescribed heart medication every day, even when…’ followed by 19 potential barriers and facilitators. While the original MASES includes 26 items, we omitted seven items that focused on symptoms not relevant to the type of medication under investigation (e.g. ‘if they sometimes make you feel dizzy’; ‘if they make you want to urinate while away from home’), and omitted items measuring confidence in self-regulatory skills as we were interested in identifying barriers specifically affecting confidence levels in performing the behaviour per se, to be consistent with tenets of the HAPA. The 19-item scale showed high internal consistency (α = .93). Given our aims to detect modifiable intervention targets, we computed mean scores for each item to identify those items for which reported self-efficacy levels were lowest and which could be potentially modified in an intervention: ‘I am busy at home’; ‘they cause some side effects’; ‘I am afraid of becoming dependent upon them’; ‘there is no one to remind me’; ‘I do not have any symptoms’; ‘I have other medications to take’. This six-item scale showed good internal consistency (α = .76) and may serve as a sensitive tool for assessing process changes during subsequent intervention whilst reducing response burden. Intention was assessed using three standard items ‘Thinking about taking your heart medication over the next three months…’ followed by ‘I want to take my prescribed medication every day’; ‘I will take my prescribed medication every day’; and ‘I intend to take my prescribed medication every day’ (α = .74). Action Planning measures involved three items based on those used by Sniehotta et al. (2005), with the stem ‘I have made a specific plan that details…’, ‘… when I will take my prescribed heart medication’; ‘… where I will take my prescribed heart medication’; and ‘…how I will take my prescribed heart medication’ (α = .80). Two items (α = .74) were used to assess Coping Planning sharing the stem ‘I have a plan to make sure I take each dose of my prescribed heart medication every day that takes into account…’ followed by ‘…if something interferes with my plans to take my heart medication’ and ‘…What to do if a difficult situation arises’, based on Molloy, Dixon, Hamer, and Sniehotta (2010). Social Support was assessed using three items based on Molloy et al. (2010), sharing the stem “During the last
four weeks, I have...’ followed by ‘...Had somebody encourage me to take my heart medication everyday’, ‘Had somebody help me to take my heart medication everyday’, and ‘Felt supported in taking my heart medication every day’ ($\alpha = .70$)

**Sample size estimation**
Using G-Power, our sample size estimation showed that 180 participants were required to detect a difference in adherence rates and in scores on HAPA constructs between respondents sampled from the four post-MI time points, assuming a medium effect size. This sample size was also sufficient for running the planned regression models, for which power calculations showed that 131 participants would be needed to detect a medium effect size in a model composed of up to 13 variables (five HAPA constructs associated with adherence, two demographic variables, time since MI and five interaction terms between time and HAPA variables). Our budget provided an opportunity to recruit 50 respondents per time point aiming for 200 participants in total, providing us with a sufficient sample size for the analyses.

**Analysis**
We compared available data on age and sex between those completing questionnaires to those who did not. We first ran one-way ANOVAs to test whether adherence and scores on any constructs differed depending on time since the MI, and conducted post hoc Tukey tests to further explore any observed omnibus effects. We then investigated the bivariate correlations between measured variables and ran multivariate linear regressions to test for predictors of Intention and medication adherence behaviour (MMAS-8 scores). We then tested all HAPA predictors, sex and age, and their interaction with time since MI. Next, we reduced the model to only HAPA predictors and any significant interaction effects with time since MI. To test the hypothesis that the relationship between Intention and adherence would operate through planning, we conducted bootstrapped multiple mediation models (1000 resamples [Hayes, 2013]), controlling for covariates identified in regressions.

**Results**

**Response rates and demographics**
We attempted to contact 661 patients meeting eligibility criteria. Of these, 380 were unable to be contacted due to death ($n = 15$), wrong contact information ($n = 78$) or no answer despite frequent attempts ($n = 287$). Telephone questionnaire interviews were completed in 201/281 (71.5%) patients contacted. Those who declined did so because of language barriers ($n = 23$), feeling unwell ($n = 6$) or disinterested ($n = 51$). Overall, 39% (78) of the sample were women and mean age of respondents was 68 years (SD = 12). There was no significant difference in age ($p = .13$) between respondents (mean age = 68, SD = 12) and non-respondents (mean age = 66, SD = 13). However, fewer men and more women responded compared to non-respondents (respondents: 39% women; 61% men, non-respondents: 30% women; 70% men, $p = .01$).
Adherence levels at each time point post-MI

Combining all respondents, the adherence according to the MMAS-8 cut-off categories was medium (mean 7.38 out of 8). Adherence levels differed between time points, ranging from a mean of 7.62 (.69) at 0–2 weeks post-MI to 7.45 (1.06) at 3–12 weeks, 7.07 (1.12) at 13–24 weeks and then back up to 7.39 (.99). ANOVA showed a statistically significant difference in adherence scores over time ($F(3,197) = 2.77, p = .04$). Post-hoc Tukey HSD tests showed that adherence scores at 0–2 weeks were significantly higher than those at 25–36 weeks. Online supplemental File 1 shows the variability over time in adherence.

Predictors of adherence at each time point post-MI

No significant differences in any predictor variables across time were observed, including sex and age (see Table 2). The invariance in predictors over time justified combining all time points to identify predictors of adherence. Time since MI was added as a predictor in the model. We tested whether the relationship between adherence and any predictors depended on time since MI by testing Time $\times$ predictor interaction effects.

Bivariate correlations between adherence and HAPA predictors

Adherence scores correlated with Self-efficacy, Social Support, Action Planning and Age, lending support to the volitional phase of the HAPA in particular. Intention was correlated with HAPA-specified constructs as expected, including Self-efficacy, Outcome Expectancies, Risk Perceptions, Action Planning and Coping Planning, but not sex, age or Social Support (see Table 3).

Testing predictors of Intention and adherence to heart medication

We tested two models of predictors of Intention based on the HAPA; the first model included all possible Time $\times$ predictor interactions. There were no observed interactions

Table 2. Means, standard deviations and comparison results at each time point post-MI.

|                      | 0–2 weeks (n = 50) | 3–12 weeks (n = 51) | 13–24 weeks (n = 50) | 25–36 weeks (n = 50) | p    |
|----------------------|--------------------|----------------------|----------------------|----------------------|------|
| Age                  | 67.26 (11.14)      | 65.04 (11.21)        | 68.55 (13.78)        | 69.82 (10.48)        | .21  |
| Sex (% women)        | 34%                | 47%                  | 40%                  | 34%                  | .48  |
| Adherence (MMAS-8)   | 7.62 (.69)         | 7.45 (1.06)          | 7.07 (1.12)          | 7.39 (.99)           | .04  |
| Intention            | 4.46 (.48)         | 4.34 (.47)           | 4.33 (.51)           | 4.23 (.42)           | .12  |
| Self-efficacy        | 4.15 (.49)         | 4.13 (.39)           | 4.11 (.43)           | 4.14 (.42)           | .96  |
| Outcome              | 4.12 (.60)         | 4.15 (.60)           | 3.92 (.57)           | 4.00 (.54)           | .16  |
| Expectations         | 3.69 (.99)         | 3.69 (1.02)          | 3.33 (.94)           | 3.60 (.97)           | .19  |
| Risk Perceptions     | 3.35 (1.04)        | 3.43 (1.02)          | 3.05 (.93)           | 3.11 (.93)           | .16  |
| Social Support       | 4.21 (.59)         | 4.11 (.59)           | 4.19 (.60)           | 4.13 (.34)           | .75  |
| Action Planning      | 4.06 (.87)         | 4.18 (.55)           | 4.05 (.74)           | 4.06 (.60)           | .77  |

Note: MMAS-8 scaled from 0 to 8. All other scales 1–5. All $p$ values based on one-way ANOVA with Tukey post hoc tests, except sex, which is based on a $\chi^2$ test.

*p < .05; **p < .01.
Table 3. Means, standard deviations and bivariate correlations ($N = 201$).

|       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. Adherence | 7.38 (.99) |         |         |         |         |         |         |         |         |         |
| 2. Intention  | .05 | 4.34 (.48) |         |         |         |         |         |         |         |         |
| 3. Self-efficacy | .16* | .58** | 4.13 (.43) |         |         |         |         |         |         |         |
| 4. Outcome expectancies | .01 | .37** | .32** | 4.05 (.58) |         |         |         |         |         |         |
| 5. Risk perceptions | -.01 | .14 | .07 | .10 | 3.68 (.97) |         |         |         |         |         |
| 6. Social support | .15* | .04 | .03 | .19** | .15* | 3.24 (.98) |         |         |         |         |
| 7. Action planning | .22** | .51** | .48** | .26** | .07 | .07 | 4.16 (.54) |         |         |         |
| 8. Coping planning | .06 | .40** | .39** | .28** | .09 | .10 | .38** | 4.09 (.69) |         |         |
| 9. Sex | .15* | -.05 | .02 | -.31** | .04 | .05 | .03 | .04 | 67.65 (11.75) |         |
| 10. Age  |       |         |         |         |         |         |         |         |         |         |
| Cronbach's alpha | .60 | .94 | .76 | .77 | .86 | .70 | .80 | .74 |         |         |

*p < .05; **p < .01.
between time and predictors of Intention – consistent with the ANOVA findings presented in Table 2. A second reduced model was run without the interaction terms (see Table 4). Key predictors of Intention in the final model included Outcome Expectations, Self-efficacy and time since the MI, which combined to explain 39% of the variance in Intention.

We also tested two models of predictors of adherence, informed by the HAPA. The first model included all Time × predictor interactions and showed that Self-Efficacy and Action Planning’s relationship with adherence varied over time. The final model therefore included both these interaction terms alongside the main HAPA predictors. Social Support and Action Planning were the two key direct predictors. The relationship between Self-efficacy and adherence depended upon time since MI (stronger relationship with increased time post-MI). While Action Planning had a direct positive relationship with adherence overall, that relationship also depended upon time since MI, with a weaker relationship with increased time post-MI. The final model explained 15% of the variability in adherence (see Table 4), which is consistent with a medium effect size (Cohen, 1992).

Post-intentional volitional factors as mediators of motivation to take medication

The HAPA proposes that Intention’s effect on behaviour operates through post-intentional factors such as Action Planning. As shown in Figure 1, we identified a significant indirect effect of Intention on adherence via Action Planning \((B = .11, \ SE = .05, \ 95\% \ CI .03-.25)\), showing that indeed the relationship between Intention and medication adherence operates via post-intentional processes.

Table 4. Testing predictors of Intention and medication adherence.

| Predictors of Intention | B   | SE  | β    | p    | Lower | Upper |
|-------------------------|-----|-----|------|------|-------|-------|
| Outcome Expectations    | .16 | .05 | .20  | <.01 | .06   | .26   |
| Self-efficacy           | .56 | .07 | .50  | <.01 | .43   | .69   |
| Risk Perceptions        | .03 | .07 | .07  | .26  | -.03  | .09   |
| Social Support          | -.02| .03 | -.04 | .54  | -.07  | .04   |
| Time Since MI           | -.05| .02 | -.13 | .03  | -.10  | -.01  |
| Sex                     | .02 | .06 | .02  | .74  | -.09  | .13   |
| Age                     | .00 | .00 | -.03 | .61  | -.01  | .00   |

| Predictors of Adherence | B    | SE  | β    | p    | Lower | Upper |
|-------------------------|------|-----|------|------|-------|-------|
| Intention               | -.31 | .19 | -.15 | .10  | -.68  | .06   |
| Self-efficacy           | -.39 | .42 | -.17 | .35  | -1.22 | .44   |
| Social Support          | .15  | .07 | .15  | .03  | .01   | .29   |
| Action Planning         | 1.26 | .36 | .68  | <.01 | .54   | 1.97  |
| Coping Planning         | -.10 | .11 | -.07 | .36  | -.32  | .12   |
| Time Since MI           | -.12 | .06 | -.14 | .05  | -.24  | .00   |
| SE × Time Since MI      | .31  | .16 | .35  | .05  | -.01  | .62   |
| AP × Time Since MI      | -.37 | .15 | -.49 | .01  | -.67  | -.08  |
| Sex                     | .13  | .14 | .07  | .34  | -.14  | .41   |
| Age                     | .01  | .01 | .14  | .05  | -.00  | .02   |
Given the mediation findings, we conducted a post hoc analysis drawing on another insight from the HAPA: Action Planning may be most effective in individuals with strong Intention. We explored whether the indirect effect of Intention on adherence via Action Planning depended on the level of Intention itself, i.e. whether the mediation is moderated by the level of Intention. We ran a bootstrapped moderated mediation analysis (Hayes, 2013), controlling for the same factors as above. In this motivated sample, all but one respondent had an Intention score of at least four out of five. Even within this motivated sample, it is possible that Action Planning may be more beneficial at different levels of positive intention. Intention did indeed moderate the mediation effect ($B = -0.12, SE = 0.06, 95\% CI_{BCA} = -0.27$ to $-0.03$), but not in the expected direction. The mediation of the intention–behaviour relationship via Action Planning was strongest at 1 SD below the mean Intention score ($B = 0.19, SE = 0.09, 95\% CI_{BCA} = 0.06$ to $0.40$) than one SD above the mean Intention score ($B = 0.08, SE = 0.08, 95\% CI_{BCA} = 0.01$ to $0.21$), suggesting that the role of Action Planning in supporting Intention enactment is stronger when Intention is above the midpoint of the scale but not at its maximum.

**Theoretical triangulation of findings**

Findings from each study demonstrate a degree of overlap between findings across both theoretical approaches used while also highlighting key unique contributions. Table 5 presents domains in the TDF and constructs from the HAPA mapped to each other, and theoretical triangulation of findings, showing consistency where findings align and diverge between each domain and construct.

**Discussion**

Two studies using different approaches helped to identify modifiable determinants of medication adherence post-MI. In Study 1 using the TDF, key factors highlighted by respondents included Beliefs about Consequences of taking medication, Memory/Attention/Decision Processes, Behavioural Regulation, Social Influence and Social Role and

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Figure 1. Bootstrapped mediation of relationship between intention and behaviour via action planning.
Identity. In Study 2 using the HAPA, key predictors of Intention to take medication included Outcome Expectancies, Self-efficacy and time since the MI event. Key predictors of adherence to medication itself included Social Support, Action Planning, Age, and a Time since MI x Action Planning interaction. Study 2 also showed that the relationship between Intention and adherence operated through Action Planning, and that this relationship was stronger for those with less than the highest reported Intention. The following discussion focuses on implications for informing intervention design to improve medication adherence post-MI, and on using a multi-theory, multi-method approach to identifying intervention targets.

**Adherence rates over time**

Self-reported adherence was higher in the present study relative to other studies, and a decrease in adherence levels over time was punctuated by higher rates in people at 25–36 weeks post-MI in the present study relative to other studies (Hippisley-Cox & Coupland, 2006). Given prior evidence that medication adherence wanes over time post-MI (Hudson, Richard, & Pilote, 2007; Newby et al., 2006; Shah et al., 2009), the slightly higher rates at 25–36 weeks were surprising. This may be due to the present study involving different individuals at each time point whereas others have used longitudinal data-sets to follow up the same participants over time. Nevertheless, there was room for improvement in adherence despite these patterns.

Contrary to expectation, despite differences in levels of adherence over time, people’s views about taking medication did not differ depending on duration since their MI. Thus, despite intuitive appeal, tailoring the intervention depending on time since
MI may not be as useful as addressing similar factors repeatedly. The exception appears to be for Action Planning. Action Planning’s link to adherence decreased as a function of time since MI, suggesting that supporting people to form Action Plans soon after their MI may have more benefit and that repeating Action Planning may not garner the same impact. Once an Action Plan is in place, adherers may no longer require them to be re-formed later on; however, repeated Action Planning may pick up those who did not form them earlier and may have some beneficial booster effect over time (Fleig, Pomp, Schwarzer, & Lippke, 2013).

Action Planning may be more helpful when motivation to take medication is strong but not at the top of scale. At the top end of motivated individuals, the life-threatening event of the MI may have been sufficient to ensure they take their medication. However, those not quite at that level of motivation may additionally benefit from support in forming very specific ‘when, where, how’ or ‘if-then’ plans for taking their medication to ensure that their motivation is translated into action. These forms of Action Planning have been used to target medication adherence in other clinical conditions (O’Carroll, Chambers, Dennis, Sudlow, & Johnston, 2013).

Building stronger motivation
While Intention to take medication was high, targeting factors shown to predict Intention from the HAPA could strengthen it in those whose motivation is lower. Targeting beliefs about the benefits of taking medication (Outcome Expectancies) and confidence in taking medication even when barriers are present (Self-efficacy) could also be explicitly supported. Using behaviour change techniques (Michie et al., 2013) for promoting Outcome Expectancies could include: using a credible source to provide information about health and social consequences of taking medication or not and highlighting the salience of consequences. Techniques for promoting Self-efficacy could draw on Social Cognitive Theory (Bandura, 2001), including demonstration of the behaviour, verbal persuasion about capability, and providing feedback on behaviour amongst others. Social Role and Identity, while not addressed in the HAPA, was highlighted in the TDF study, and is a key aspect of other contemporary behaviour change theories (e.g. PRIME theory (West, 2006)) and could be targeted with behaviour change techniques such as identification of self as a role model and reframing how the behaviour is viewed. While these factors may help to improve motivation, the well-acknowledged Intention–behaviour gap suggests that supporting motivation will be necessary but insufficient for ensuring adherence.

Translating motivation into action
The finding that Intention operated indirectly on adherence via Action Planning highlights the importance of considering post-intentional factors that help motivation be translated into action.

Coping Planning (forming detailed plans to counter any anticipated barriers to taking medication) did not predict adherence, which is counter to findings from other research (Pakpour et al., 2014). Coping planning may be more effective when guided and supported (Kwasnicka, Presseau, White, & Sniehotta, 2013).
Social Support is an established determinant of medication adherence (DiMatteo, 2004) and it is not surprising that it is among its key predictors. The theoretical approaches used in the two studies highlight how Social Support may operate alongside other factors determining adherence, and promoting both practical and emotional Social Support could be integrated into an intervention.

The TDF study also highlighted self-regulatory strategies that people already use to ensure to take their medication (reminders, pill boxes to self-monitor), and thus including relevant self-regulatory behaviour change techniques such as prompt/cues, adding objects to the environment and promoting self-monitoring of behaviour could further ensure the translation of good Intentions into action.

**Triangulating evidence**

Given the inherent overlap between the TDF and the HAPA on some domains, it is reassuring that findings from each are largely compatible despite the mixed-method approach to data collection. Behavioural Regulation findings from Study 1 reflect the clarity of the ‘when, where, how’ Action Plans shown to be predictive of adherence in Study 2. Findings highlighting the importance of Social Support in Study 1 were also reflected in Study 2. Beliefs about Consequences were a prominent domain in Study 1, as were Outcome Expectations in Study 2. However, Study 2 highlights the more specific role of Beliefs about Consequences as a predictor of Intention, rather than of adherence per se. This highlights an area where the theoretical model-based approach may be more informative than the theoretical framework approach, by situating the role of constructs in the process of behaviour change.

Furthermore, the findings from the TDF interviews are largely compatible with findings from the broader qualitative literature on factors described patients recovering from other acute events. For instance, Chambers and Colleagues (2011) highlighted memory, Social Support, knowledge, dislike of medication and consequences of non-adherence in an interview study with stroke survivors. Indeed, quotes between the two studies are notably similar. The present study builds on these findings by providing a theoretical framework for the conduct and analysis of the interviews, thus capturing similar content and ensuring a wide breadth of theoretical coverage.

Study 1 highlighted two key domains that the HAPA does not: Social Role and Identity and Memory/Attention/Decision Processes. Nevertheless, the latter is arguably addressed through volitional processes such as Action Planning whose mechanisms are rooted in memory and attention regulation and which has been used to target adherence in other settings (O’Carroll et al., 2013). The consideration of routinisation of the behaviour suggests that one area the HAPA might benefit from further theorising is by considering recent dual process theories (Hofmann, Friese, & Wiers, 2008) and how automatic processes may operate alongside reflective ones when considered alongside Action and Coping Planning.

Using a multi-theory, multi-method approach provided complementary insight to identify targets to inform intervention development. The TDF-based qualitative inquiry provided depth of understanding across a number of theoretical domains that transcend any one theoretical model, and the HAPA’s quantitative model-based approach provided a means of understanding which constructs are associated to one another and which
are predictive of Intention and adherence. The challenge remaining for intervention development is to balance the structure that models such as the HAPA provide, alongside any supplementary factors that broader frameworks such as the TDF might suggest targeting when ultimately developing the intervention logic model.

**Strengths and limitations**

To our knowledge, the effort to map determinants of adherence over time using multiple theories and methods is unique, and provides novel insights with implications for intervention. Namely, the triangulated findings highlighted overlaps while also pointing to the unique added contribution of particular constructs and relationships in understanding medication adherence. For instance, the role of planning in translating adherence intention into action and that the relationship between Action Planning and Self-efficacy and medication adherence may depend on time since the MI. In addition, some methodological limitations bear mentioning. First, the pragmatic choice to acquire cross-sectional data, rather than follow patients longitudinally limits the ability to conclude that time rather than other factors explained changes in key factors at different time points. Second, uncertainty regarding actual treatment adherence limits the ability to confirm reported/perceived determinants of adherence. Third, only one researcher (albeit experienced) coded TDF interviews. Future research could compare results of this telephone-based data collection method with other forms of data collection, such as postal and web-based data collection, to assess whether method of survey administration acts to modify any observed relationships. Fourth, while consistent with standard TDF methods, the criteria used for determining key belief statements were based on a judgement of what constituted ‘relatively high frequency of several belief statements’ rather than a priori quantitative thresholds, which could be explored in future research. Fifth, Study 2 respondents had fewer men and more women respondents than non-respondents; the specific findings for Study 2 should be taken in light of these discrepancies and further work will be needed to confirm the results in various populations. Future research could seek to replicate this work in other clinical populations to investigate whether the identified determinants of medication adherence generalise to other clinical conditions.

**Conclusions**

Two complementary theoretical approaches identified that Action Planning and Social Support are key predictors of medication adherence post-MI. Self-efficacy and Outcome Expectations are key predictors of Intention to take medication, and issues of Memory/Attention/Decision Processes and Social Role and Identity also appear to be worthwhile targets for interventions aiming to improve adherence. Novel theory-based interventions drawing on insights from theories such as the HAPA and theoretical frameworks such as the TDF could be developed to help support people to take their medication post-MI to maximise their recovery.

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