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A text message programme designed to modify patients' illness and treatment beliefs improves self-reported adherence to asthma preventer medication

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Objective. While effective preventative medication is readily available for asthma, adherence is a major problem due to patients' beliefs about their illness and medication. We investigated whether a text message programme targeted at changing patients' illness and medication beliefs would improve adherence in young adult asthma patients.

Methods. Two hundred and sixteen patients aged between 16 and 45 on asthma preventer medication were recruited from pamphlets dispensed with medication and e-mails sent to members of a targeted marketing website. Participants were randomized to receive individually tailored text messages based on their illness and medication beliefs over 18 weeks or no text messages. Illness and medication beliefs were assessed at baseline and at 18 weeks. Adherence rates were assessed by phone calls to participants at 6, 12, and 18 weeks and at 6 and 9 months.

Results. At 18 weeks, the intervention group had increased their perceived necessity of preventer medication, increased their belief in the long-term nature of their asthma, and their perceived control over their asthma relative to control group (all p's $< .05$). The intervention group also significantly improved adherence over the follow-up period compared to the control group with a relative average increase in adherence over the follow-up period of 10% ($p < .001$). The percentage taking over 80% of prescribed inhaler doses was 23.9% in the control group compared to 37.7% in the intervention group ($p < .05$).

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Conclusion. A targeted text message programme increases adherence to asthma preventer inhaler and may be useful for other illnesses where adherence is a major issue.

Asthma is a common medical condition caused by chronic inflammation of the airways. Characteristic symptoms of the illness include attacks of shortness of breath, wheezing, tightness in the chest, and cough. Asthma is commonly treated by inhaled corticosteroids, which help to suppress inflammation of the airways and reduce the frequency of severe symptoms and attacks. This medication in the form of inhalers is known as preventer or controller medication and many patients also take short-acting bronchodilators to control acute symptoms (reliever medication). In order to provide therapeutic benefit, preventer medication needs to be taken regularly on a daily basis. However, non-adherence to preventer medication is a common problem in patients diagnosed with asthma and this results in the overuse of reliever medication, increased asthma symptoms, more frequent asthma attacks, and hospital admissions (Stern *et al.*, 2006). Optimal adherence to inhaled corticosteroids requires patients to take their preventer medication on 80% or more occasions, as this is associated with greatest asthma control (Lasmar *et al.*, 2009).

Age is a factor that has been associated with non-adherence in a number of studies. Younger patients in the 14–25 years - age range have been found to report using preventer inhalers less than older patients (Diette *et al.*, 1999; Legorreta *et al.*, 1998). In general, adherence rates to preventer medication improve with increasing age (Jessop & Rutter, 2003; Tettersell, 1993). This makes young people an important group to target for improving adherence and reducing their underuse of preventer-inhaled corticosteroids.

A number of studies have also highlighted the low rates of adherence to preventer inhalers being due to patients' beliefs about the nature of the illness (Kaptein, Klok, Moss-Morris, & Brand, 2010). A common pattern with asthma is to experience relatively normal symptomless periods interspersed with intermittent periods of shortness of breath, wheezing, and more serious attacks. This can reinforce the belief that asthma is only present when symptoms are also apparent or a 'no symptoms = no asthma' perception (Halm, Mora, & Leventhal, 2006; Ulrik *et al.*, 2006). This perception is often strengthened by the fact that the effectiveness of preventer medication is poor when used by patients to reduce the acute symptoms of asthma. These two aspects will often lead patients to erroneously rely more on reliever medication and less on preventer medication and other long-term management strategies. Unfortunately, this pattern of medication usage tends to be associated with worse patient outcomes, including lower quality of life, worse asthma control, and greater symptom severity than those patients who use more preventer medication (Schatz *et al.*, 2006). Patients under-using preventer medication are also more likely to have been hospitalized or attend emergency departments for their asthma (Tan *et al.*, 2009).

Previous work on patients' illness and treatment beliefs shows they cluster along specific dimensions (Horne, Weinman, & Hankins, 1999; Petrie & Weinman, 2006). Patients' illness perceptions are comprised of beliefs about: (1) the symptoms that patients associate with their illness label; (2) why they developed the illness; (3) the implications of the illness for their life; (4) how long the illness will last; and (5) how the illness is cured or controlled by what the patient can do themselves or by the medication itself. Research has shown that adoption of a chronic rather than an acute illness belief model is associated with better adherence to preventer medication in patients with asthma (Byer & Myers, 2000; Jessop & Rutter, 2003).

Just as patients develop perceptions about their illness, they also develop ideas about the medication they are prescribed to control their illness (Horne *et al.*, 1999). Two particular perceptions seem to be associated with adherence to preventer medication in asthma – the first is the patient's beliefs about the necessity of the medication and the second is the patient's concerns about taking the medication. Research has consistently confirmed the relationship between believing a medication is necessary and using it as prescribed (Byer & Myers, 2000; Hand, 1998; Tettersell, 1993). Asthma patients often cite fear of unwanted negative effects of medication as a primary reason for non-adherence, and this belief is strongly associated with low adherence (Horne & Weinman, 2002). Worries about the long-term safety of taking steroids and dependence are common concerns among patients who are non-adherent with preventer medication (Apter *et al.*, 2003).

In the current study, we tested whether text messages could be used to improve adherence in young adults with asthma. Text messages have recently begun to be used as a tool for behaviour change in a variety of health settings with mostly positive results (see Cole-Lewis & Kershaw, 2010). Text message interventions have been developed to deliver or supplement different health-promotion interventions including encouraging diabetes management in young people (Franklin, Waller, Pagliari, & Greene, 2006; Rami, Popow, Horn, Waldhoer, & Schober, 2006), as well as supporting weight loss in overweight adults (Patrick *et al.*, 2009) and as a method of providing assistance with smoking cessation (Rodgers *et al.*, 2005).

In this study, we investigated whether targeted text messaging based on an assessment of patients' illness and medication beliefs can improve adherence to asthma preventer inhalers. Patients had their illness and medication beliefs assessed at baseline and were either randomized to normal care or to receive tailored text messages for 18 weeks. We hypothesized that the text message group would show changes in their illness and medication beliefs as well as improved adherence to their preventer inhaler at follow-ups over a 9-month period.

Method

Participants

Two hundred and sixteen individuals were recruited from flyers dispensed with asthma preventer medication and e-mails sent to members of a targeted marketing website (www.smilecity.co.nz). This website invites members to participate in online shopping, surveys, and read e-mails in return for rewards. Participants were offered to go into the draw to receive an Apple ipod. To be included, participants had to be between 16 and 45 years of age, diagnosed with asthma, be not currently adhering to their preventer medication as prescribed, and own a mobile phone capable of receiving text messages. Non-English speakers and individuals with a diagnosis of chronic obstructive pulmonary disease were excluded from the study.

Instruments and procedure

People interested in participating called a phone number or e-mailed their contact details to register for the study. These potential participants were called back, provided with more information about the study, asked to return a consent form and questionnaire by mail, and completed a baseline phone interview. The interview screened participants for eligibility, and asked about the number of inhaler preventer doses prescribed each

week by the participant's doctor and the number of doses currently taken. Two hundred and sixteen people responded to the advertisement and were screened, and of these 147 (100 females and 47 males) were eligible and sent in the consent form and baseline questionnaire assessing illness perceptions.

The questionnaire assessed participants' illness perceptions using the Brief Illness Perception Questionnaire (BIPQ) (Broadbent, Petrie, Main, & Weinman, 2006). This measure comprises eight items designed to assess patients' perceptions of their asthma along the following dimensions: identity, consequences, timeline, personal control, treatment control, concern, understanding, and emotional response to the illness. Each item is scored on an 11-point scale (0–10) with higher scores representing a stronger endorsement of that item. The ninth causal item of this questionnaire was not used for this study. In addition, participants were asked to rate their belief about the necessity of their inhaler on an 11-point scale 'How much do you feel you need to take your preventer inhaler?' from (0) 'I don't need it at all' to (10) 'It is absolutely essential for me'. Concerns about using their prescribed preventer inhaler were assessed by asking participants to rate 'How concerned are you about using your preventer inhaler?' on a similar 11-point scale from (0) 'Not concerned at all' to (10) 'Extremely concerned'.

After completing the baseline assessment, participants were randomized to either the text message group ($n = 73$) or control usual care group ($n = 74$). The randomization sequence was generated by computer program and allocation was concealed in consecutively numbered sealed envelopes. Adherence rates were assessed by phone calls to participants at 6, 12, and 18 weeks as well as at 6 and 9 months. We examined the average self-reported adherence as well as the proportion of participants in each group achieving optimal asthma control of 80% or above adherence levels. As well as being assessed at baseline, participants' perceptions of their asthma and medication necessity and concerns beliefs were assessed again at 18 weeks using the same instruments.

Text message programme

Participants assigned to the text message group received tailored text messages for 18 weeks. Prior to the study, a bank of 166 text messages was generated with approximately 24 texts for each of the seven target beliefs. The particular beliefs targeted and example texts from the bank of texts associated with that belief are shown in Table 1. Each of the texts was designed to counteract the specific illness and medication beliefs that had previously been found to be associated with non-adherence to preventer medication (Halm *et al.*, 2006; Horne & Weinman, 2002).

Texts were sent at a frequency of two texts per day during weeks 1–6, one text per day from weeks 7 to 12, and three texts per week from weeks 13 to 18. The type of texts sent was determined by the participant's baseline scores on the BIPQ and the level of medication belief ratings. Participants scoring low or high on each of the target beliefs, defined as one standard deviation above or below the mean score on that item, were sent text messages chosen at random from that category that were designed to push the belief in a direction more consistent with higher adherence. If a patient did not score in the target low or high categories, they were not sent any text messages for that belief. Only two participants in the intervention group did not score high or low on at least one target illness perception and so did not receive any text messages (one in the control group also met these criteria).

Table 1. Target beliefs and sample texts

Belief	Examples of texts designed to change belief
Illness perceptions	
Short timeline	'Your asthma is always there even when you don't have symptoms'
	'Your asthma symptoms may come and go but your asthma is always there'
Low personal control	'You can control your asthma by taking your preventer every day'
	'Take your preventer everyday and control your asthma before it controls you'
Low illness identity (low symptoms)	'No asthma symptoms doesn't mean no asthma'
	'Asthma doesn't take a holiday. Even if you don't have symptoms your asthma is still there'
High illness identity (high symptoms)	'A puff of your preventer each day keeps the doctor away'
	'Reduce your risk of having an asthma attack by taking your preventer every day'
Low coherence (poor understanding)	'The medicine in your preventer doesn't work immediately but used regularly it will reduce the inflammation that causes asthma'
	'Asthma is caused by swollen and inflamed airways'
Medication beliefs	
Low necessity	'Taking your preventer every day protects you from asthma symptoms'
	'Your preventer works best when taken every day'
High concerns	'Your preventer medication is not addictive'
	'Your preventer controls your asthma by reducing the inflammation that causes asthma'

Data analysis

On the basis of previous research findings, mean baseline adherence rate was estimated at 50% ($SD = 25\%$) and an increase of 15% was deemed to be clinically relevant. These figures generate an effect size, Cohen's d of 0.6. To detect an effect size of 0.6 at the 5% level of significance and with 80% power, 50 participants were needed in each arm of the two-arm (intervention and control) trial. Allowing for an attrition rate of 50%, a total of 200 participants were screened at baseline.

Changes in illness perceptions over time were computed by subtracting baseline scores from scores at 18 weeks. ANCOVA analyses were conducted to assess differences in changes in illness perceptions between treatment groups controlling for baseline scores. To analyse adherence over time and between groups, a mixed ANOVA was conducted. Due to the high drop-out rate, only those participants who responded at week 6 were retained in analysis and the mean replacement method was used for missing data from these participants for further time points. In addition, the average adherence for each person was calculated across all time points and an independent samples t-test was conducted to compare overall mean adherence between groups. The number of

people who had an average adherence rate ≥ 80% was also compared between groups using Pearson's chi square. We repeated the analyses using the carry last observation forward approach for missing data, as well as by running multiple imputation procedures. All tests were two-tailed and $p < 0.05$ was considered statistically significant.

Results

There was an expected attrition rate: 147 of the 216 people screened returned the consent form (68%); by week 6, 124 of these original 147 participants completed the follow-up questionnaire (84%), 58 in the intervention and 66 in the control group; and 93 of the 124 completed to last-follow-up point (75%), 41 in the intervention and 52 in the control. Chi-squared tests showed the drop-out rates were not significantly different between groups. A sample size of 124 participants still allows the detection of an effect size of .60 with power of 80%. A comparison of the baseline adherence scores using the sample of 216 people screened, between those who remained in the study at 6 weeks and those who did not, showed that those who dropped out were significantly more adherent at baseline than those who remained (mean 67.1% vs. mean 46.7%; $t = 4.47$, $p < .001$).

Illness and medication beliefs

There were no significant differences in illness perceptions between groups at baseline ($p > .05$). Changes in illness perceptions between groups are shown in Table 2. By 18 weeks, the intervention group had increased perceived duration of their asthma, increased perceived control over their asthma, and increased perceived necessity of preventer medication. This analysis shows the text message group did change their beliefs in a direction consistent with greater adherence.

Adherence

Across the entire sample of 216 participants, baseline mean adherence was 54% ($SD = 31.8\%$) in the control group, and 56.5% ($SD = 35.3\%$) in the intervention group, $t(213) = -.53$, $p = .60$. Figure 1 shows adherence over time in the 124 participants who responded at week 6. A mixed ANOVA showed no overall time effect, but a significant group effect ($F(1,122) = 9.35$, $p = .003$), and a significant group by time effect ($F(5) = 2.27$, $p < .05$).

Average self-reported adherence over all time points in the control group was 43.2% ($SD = 26$) and the intervention group was 57.8% ($SD = 27.1$), $t(122) = -3.06$, $p = .003$). The proportions with average adherence of 80% or above for the control group was 7 of 66 (10.6%) and for the intervention group 15 of 58 (25.9%). The difference between the two groups was 15.3%, $p = 0.034$ (Fisher's exact test). Repeating these analyses using the carry last observation forward approach to missing data, or using multiple imputation procedures, did not change the significance of the results, Figures 1 and 2.

Discussion

This study tested whether sending text messages designed to encourage patients with asthma to adopt beliefs about their illness and medication that are more compatible with adherence would improve adherence with preventer inhaler medication. We found targeted text messages changed timeline, personal control, and medication

Table 2. Baseline, 18 weeks, and estimated marginal mean changes controlling for baseline values, in illness perceptions and medication beliefs between groups

	Control ($N = 46$)			Intervention ($N = 57$)			
Perceptions	Baseline mean (*SD*)	18-week mean (*SD*)	Adjusted difference	Baseline mean (*SD*)	18-week mean (*SD*)	Adjusted difference	*p*
Asthma perceptions – (BIPQ)							
Consequences	4.50 (2.16)	3.96 (2.04)	−.46	4.07 (2.10)	3.88 (2.11)	−.26	.51
Identity	4.87 (2.12)	4.17 (2.31)	−.57	4.43 (2.13)	3.86 (2.03)	−.64	.88
Timeline	8.17 (2.11)	7.83 (2.73)	−.43	8.46 (2.22)	9.09 (1.81)	.70	.006
Concern	5.17 (2.59)	4.37 (2.62)	−.63	4.46 (2.53)	4.26 (2.20)	−.34	.48
Personal control	6.41 (2.05)	6.96 (2.21)	.38	6.79 (1.96)	8.02 (1.56)	1.36	.009
Coherence	6.70 (2.27)	7.35 (2.16)	.65	6.70 (2.30)	7.46 (2.21)	.71	.83
Treatment control	7.15 (2.14)	7.26 (2.20)	.13	7.07 (2.59)	7.84 (1.80)	.75	.08
Emotional representation	3.30 (2.36)	2.37 (2.20)	−.98	3.43 (2.51)	2.49 (2.31)	−.86	.77
Medication Beliefs							
Preventer concern	3.37 (3.25)	2.52 (2.76)	−.77	3.12 (2.77)	1.75 (1.91)	−1.48	.10
Preventer necessity	5.83 (2.71)	5.11 (2.88)	−.80	6.18 (3.16)	6.52 (2.98)	.46	.01

necessity beliefs at 18 weeks in the intervention group. At follow-up, intervention group participants held longer timeline or a more chronic view of their illness, which is more consistent with regular adherence particularly in the absence of asthma symptoms (Halm *et al.*, 2006). Furthermore, the text message intervention also increased participants' perceptions of how much they could control their illness and their personal necessity for preventer medication. These beliefs are also compatible with increased adherence to long-term medication (Horne & Weinman, 2002; Lavole *et al.*, 2008). Data from the study also show the intervention to increase adherence by around 10% in the intervention group. The text message programme also resulted in a significantly higher percentage of the intervention group achieving the 80% or greater adherence level.

The results of the study are consistent with a number of recent trials designed to change health behaviour that have shown improved disease monitoring and management through the use of text messages (Krishna, Boren, & Balas, 2009). While several studies have used text messaging purely as reminders (e.g., Charles *et al.*, 2007; Downer, Meara, DaCosta, & Sethuraman, 2006), more interventions are being developed to send more personalized messages targeting specific behaviours (e.g., Franklin *et al.*, 2006; Kim & Kim, 2008). Text messaging has the advantage of being inexpensive, easy to access – especially across different socio-economic groups – and texting programmes are readily scalable to large populations. At present penetration into older populations may not be

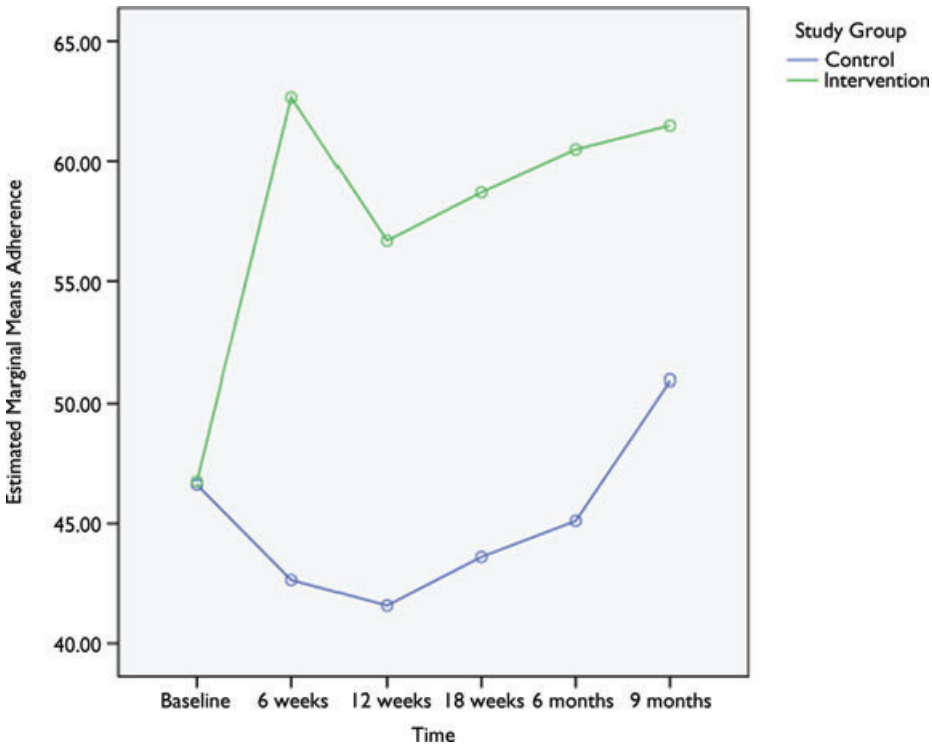

Figure 1. Adherence levels by group across the follow-up period.

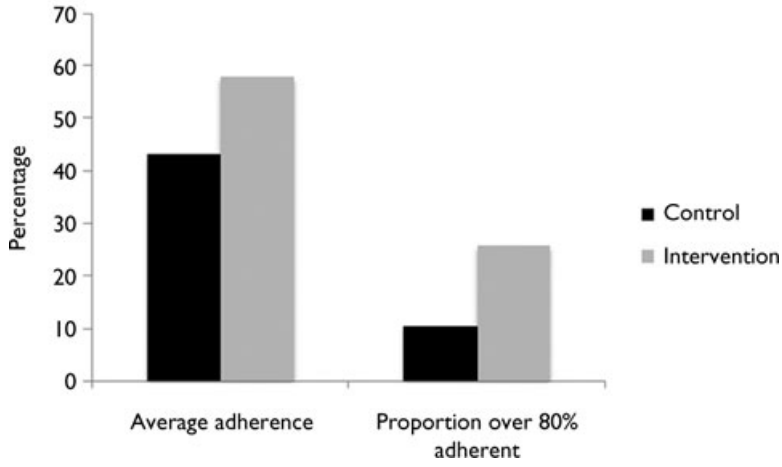

Figure 2. Average percentage adherence over time, and the percentage of participants over 80% adherent, in each group.

possible often due to a lack of familiarity with the technology but this is likely to change as people who are using texting regularly move into an older age group.

The current study is limited by the large dropout in participation early in the trial, which could have been due to a large number of individuals initially enrolling for the study motivated to win a prize. It is interesting to note that these early dropouts were

those with higher adherence at baseline and may have also felt less need to receive adherence-focused messages and hence to stay in the study. However, after the 6-week follow-up those still in the trial generally remained until the end of the study and the study was still large enough to detect a difference in rates of adherence. It should also be noted that the study was limited to participants aged 45 or under and it is not clear whether the study results will generalize to an older group of patients with asthma. As adherence problems with asthma medication are most evident in younger age groups, this may not be such a problem when considering interventions with this group but may be important when applying such a texting programme to other disease states. Future research may wish to investigate the effects of the intervention on health outcomes resulting from higher adherence, such as reduced health service use or reduced work absenteeism. The study assessed self-reported adherence and future research could utilize more objective measures of adherence.

The receipt of text messages meant that the intervention group received more contact than the control group, and this may have induced demand characteristics. However, this contact was minimal compared with many other psychological interventions, as it did not involve personal face-to-face interactions, so relationships were not formed with the researchers through the intervention. At 9 months (18 weeks after the intervention had finished and text messages were no longer being sent), adherence continued to remain higher in the intervention group, providing evidence for effects independent of demand characteristics.

Overall, the results of the study are consistent with the results of previous interventions that have targeted illness perceptions as a way of changing health behaviour (Broadbent, Ellis, Thomas, Gamble, & Petrie, 2009; Petrie, Cameron, Ellis, Buick, & Weinman, 2002). The results of the study are encouraging for developing further text messaging interventions in the adherence and disease management area as texting seems to be becoming more acceptable to patients (Pinnock, Slack, Pagliari, Price, & Sheikh, 2006) and texting has advantages in terms of reaching patients who may find face-to-face interventions difficult to access.

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