

What are validated self-report adherence scales really measuring?: a systematic review

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AIMS

Medication non-adherence is a significant health problem. There are numerous methods for measuring adherence, but no single method performs well on all criteria. The purpose of this systematic review is to (i) identify self-report medication adherence scales that have been correlated with comparison measures of medication-taking behaviour, (ii) assess how these scales measure adherence and (iii) explore how these adherence scales have been validated.

METHODS

Cinahl and PubMed databases were used to search articles written in English on the development or validation of medication adherence scales dating to August 2012. The search terms used were *medication adherence*, *medication non-adherence*, *medication compliance* and names of each scale. Data such as barriers identified and validation comparison measures were extracted and compared.

RESULTS

Sixty articles were included in the review, which consisted of 43 adherence scales. Adherence scales include items that either elicit information regarding the patient's medication-taking behaviour and/or attempts to identify barriers to good medication-taking behaviour or beliefs associated with adherence. The validation strategies employed depended on whether the focus of the scale was to measure medication-taking behaviour or identify barriers or beliefs.

CONCLUSIONS

Supporting patients to be adherent requires information on their medication-taking behaviour, barriers to adherence and beliefs about medicines. Adherence scales have the potential to explore these aspects of adherence, but currently there has been a greater focus on measuring medication-taking behaviour. Selecting the 'right' adherence scale(s) requires consideration of what needs to be measured and how (and in whom) the scale has been validated.

Introduction

There are many effective medicines available to treat illness, but the benefits of these medicines will only accrue to the patients that take them. The World Health Organization [1] defines adherence as:

The extent to which a person's behaviour – taking medication, following a diet and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider.

Medication non-adherence is common, with studies in a range of settings identifying up to 50% of patients as non-adherent to a medicine [2–6]. Poor medication adherence results in adverse health outcomes [7–9] and increased health care costs [7].

Patients may be non-adherent due to different beliefs, barriers and a range of other factors. Patients may intentionally decide not to take their medicines based on well-informed or mistaken beliefs about the benefits and risks of their medicines [10, 11]. Patients can unintentionally non-adhere to medicines due to forgetfulness, careless-

ness, health literacy and socioeconomic factors. Non-adherence can also occur at different stages of the medication-taking process. A patient may exhibit non-adherence at the *initiation* of treatment, during treatment (where the patient may exhibit sub-optimal *implementation* of the treatment regimen) or the patient may *discontinue* the treatment early [12]. Strong evidence for any single approach to improve medication adherence is lacking, but interventions that are tailored to a patient's specific reasons and stage of non-adherence can be expected to better support good medication-taking behaviour [13–17].

Adherence to medicines is measured for different purposes. Common reasons to measure adherence include better informing the assessment of an intervention (as unrecognized non-adherence may lead to an underestimation of possible treatment effects), determining influences on adherence to medicines in people with specific disease states (such as hypertension or HIV) and identifying patients requiring education or support to improve medication use. Ideally, clinicians and researchers wanting a comprehensive assessment of adherence need measures that are inexpensive, relatively easy to administer, accurately identify the patient's current medication-taking behaviour and any barriers or beliefs that may influence the patient's use of medicines.

There are a number of ways of measuring adherence. Objective measures, including measurement of clinical outcomes, dose counts, pharmacy records, electronic monitoring of medication administration (e.g. the Medication Event Monitoring System, MEMS) and drug concentrations [18–21], seemingly provide the best measure of a patient's medication-taking behaviour in many contexts [22–27]. It is important to recognize that, while objective, most of these measures have drawbacks. MEMS, arguably the best objective measure of medication-taking behaviour, records package opening or device actuation, rather than actual medication-taking and the possibility of intentional dose dumping remains. MEMS, or MEMS-like devices, are also expensive and not readily available for some dose forms [21, 28–30]. While clinical outcomes are the ultimate aim of any intervention to improve adherence, the use of clinical outcomes as a proxy of adherence can be confounded by disease-specific factors independent of medication-taking behaviour.

Subjective measures of adherence include physician or family reports, patient interviews and self-report adherence scales [10, 31–34]. These measures have the potential to identify the specific reasons for a patient's non-adherence. Subjective measures can be relatively simple to use and are less expensive. However, they are prone to recall bias and the prospect that respondents provide answers that conform to their perceived expectations of their interviewer [35, 36]. There are a large number of adherence scales that are suitable for use in research or clinical settings. A number of well-validated adherence

scales have been strongly correlated with objective measures of adherence in several different populations of patients.

There is a need for scales that are easy to administer and correctly identify medication-taking behaviour, key barriers to adherence and beliefs associated with medication use that influence adherence. There have been few systematic attempts to describe the available self-report adherence scales and their benefits and limitations with respect to both medication-taking behaviour and the identification of barriers and beliefs associated with adherence [37, 38]. The aim of this review is to (i) identify self-report medication adherence scales that have been correlated with a comparison measure of medication-taking behaviour, (ii) assess how these scales measure adherence and (iii) explore how these adherence scales have been validated.

Methods

A literature search for adherence scales was conducted using Cinahl and PubMed electronic databases. The initial search terms used to identify the articles were: *medication adherence*, *medication non-adherence*, *medication compliance* and *medication non-compliance*. This broad database search identified the names of the self-report adherence scales, which were then searched individually. This search was limited to English language studies published between 1981 and 2012. The date of the last search was on 1 August 2012. The reference lists of the relevant studies were searched to identify additional articles.

Inclusion and exclusion criteria

Adherence scales were included if they had been correlated against a comparison measure (objective or subjective) of medication-taking behaviour. To be included there needed to be a full text article, written in the English language on the development and/or validation of the adherence scale. Studies that used the self-report adherence scale without correlating the adherence scale against a comparison measure of medication-taking behaviour were excluded. The list of scales was reviewed for completeness with two adherence researchers.

Data extraction and analysis

The data extracted from the studies included the number of items in the adherence scale, study setting, criteria for identifying non-adherence, response rate and time to complete the adherence scale. Each validated self-report adherence scale was categorized according to whether it contained items that elicited information on (i) specific medication-taking behaviours: dose taken, dose frequency, dose administration and prescription refills, (ii) barriers to adherence: e.g. forgetfulness, treatment

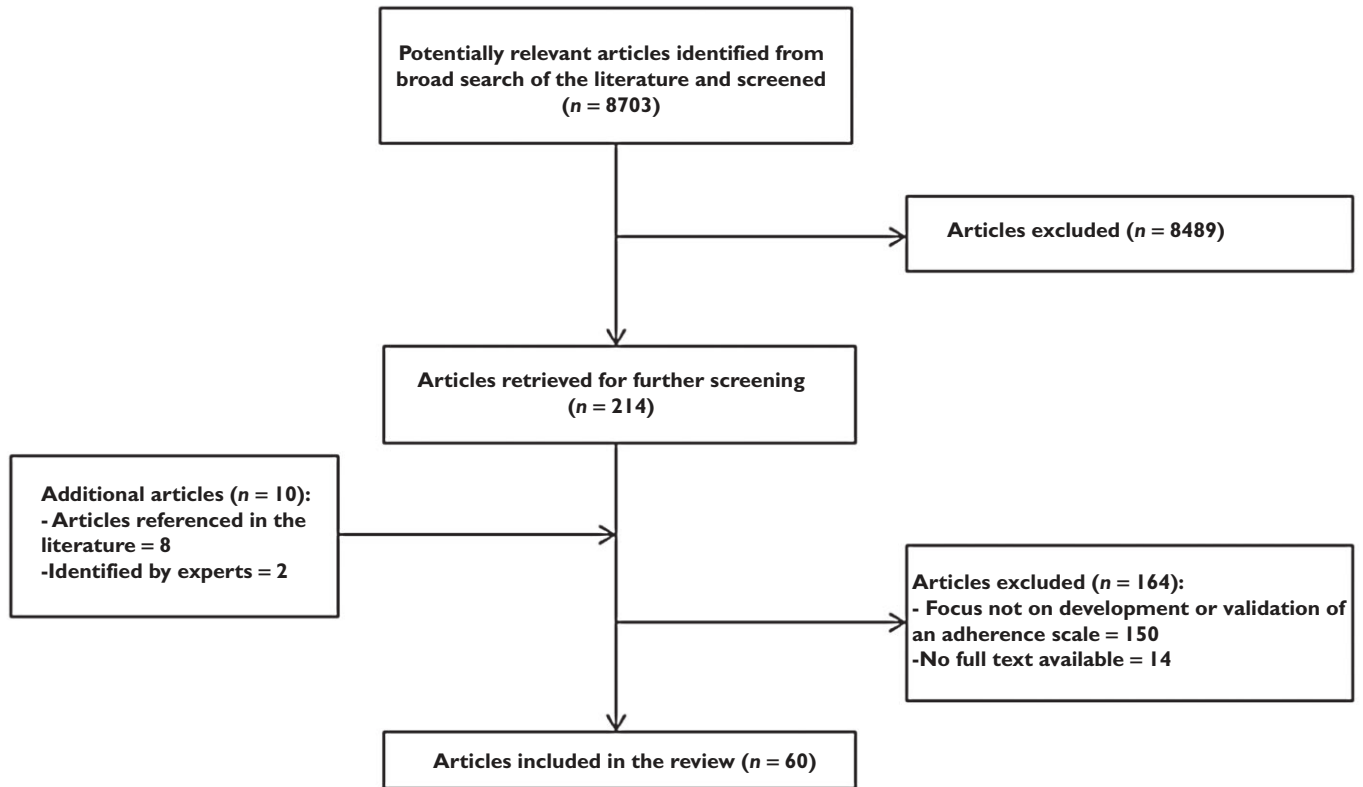


Figure 1

Flow chart of study selection process

complexity and side effects and/or (iii) beliefs associated with adherence: e.g. perceived necessity of medicines and concerns about medicines. Adherence scales were also assessed on whether or not the scale identified the initiation, implementation or discontinuation of treatment as per the taxonomy proposed by Vrijens *et al.* [12].

To assess the quality of the correlation study, the following criteria were extracted: how the adherence scale was administered, sample size, the adherence comparison measures, internal consistency and, where reported, the sensitivity and specificity of the scale against a standard of adherence. Information on criterion, content and construct validity was also extracted to assess the validation of the adherence scale. The results of the studies were reviewed and compared.

Results

Search strategy

The study selection process is illustrated in Figure 1. Twenty-one articles were retrieved using the Cinahl search engine and the remaining were identified using the same strategy in the PubMed database and from reference lists. Some adherence scales were excluded, as shown in Table 1.

Table 1

Excluded self-report adherence scales

Excluded adherence scale	Reason for exclusion
Adult AIDS Clinical Trials Group (AACTG) Adherence Scale [90]	No validation studies were found in the literature search
Basel Assessment of Adherence Scale (BAAS) [91]	No validation studies were found in literature search.
Medication Adherence Evaluation Scale (MAES) [92]	No full-text article available
Medication Adherence Measure (MAM) interview [32]	Semi-structured interview and thus was not consistent between patients
Multicentre Aids Cohort Study (MACS) adherence form [93]	No adherence comparison measure

The literature search retrieved 60 articles that met the inclusion criteria (Figure 1). The sample size of the studies ranged from 40 to 1367 (Table 2) [39, 40]. The median sample size of the studies was 228. Twenty-two of the studies reported the response rate, ranging from 29 to 98%. The average response rate was 72% (Table 3). Forty-three self-report adherence scales were identified from the included studies.

Table 2

Comparison of the self-report adherence scales

Self-report adherence scale	Based on	Number of questions	Time to complete	Barriers identified	Stage of medication-taking identified	Number of development and correlation studies
Group 1: Medication-taking behaviour						
Adherence Self-Report Questionnaire (ASRQ) [41]	CQR	1	Not reported	- Nil	Implementation	2
Adherence Visual Analogue Scale (VAS) Computerized [52]	Literature review	1	Not reported	- Nil	Implementation	1
Brief Adherence Rating Scale (BARS) [33]	CATIE trial	4	Not reported	- Nil	Implementation	1
Barroso <i>et al.</i> 30-day Adherence Question [53]	Did not specify	1	Not reported	- Nil	Implementation	1
Bell <i>et al.</i> Adherence Question [42]	Did not specify	1	Not reported	- Nil	Implementation	1
Centre for Adherence Support Evaluation (CASE) Adherence Index [54]	Literature review	3	Not reported	- Nil	Implementation	1
Gehi <i>et al.</i> Adherence Question [9]	Expertise	1	Not reported	- Nil	Implementation	1
Grymonpre <i>et al.</i> Adherence Question [43]	Did not specify	1	Not reported	- Nil	Implementation	1
Kerr <i>et al.</i> Adherence Question [44]	Expertise	1	Not reported	- Nil	Implementation	1
Medication Adherence Report Scale – 5 (MARS-5) [71, 85]	MARS-10	5	Not reported	- Nil	Implementation	3
Stages of Change for Adherence (SOCA) [55]	Stages of Change model	2	Not reported	- Stages of change in regards to medication adherence	Discontinuation Initiation Implementation	1
Group 2: Medication-taking behaviour and barriers						
Adherence to Refills and Medications Scale (ARMS) [51]	Literature review, MAQ and Hill-Bone Compliance Scale	12	Not reported	- Correct administration - Forgetfulness - Prescription refill ability	Implementation Discontinuation	1
Adherence Starts with Knowledge-12 (ASK-12) [45]	ASK-20	12	Not reported	- Patient-perceived barriers - Inconvenience - Forgetfulness - Medication beliefs	Implementation Discontinuation	1
Adherence Starts with Knowledge-20 (ASK-20) [46]	Literature review, patient focus groups and expert panel input	20	Not reported	- Medication-taking behaviour - Patient-perceived barriers - Evaluates regimen	Implementation Discontinuation Implementation	2
Brief Medication Questionnaire [40]	Literature review and patient feedback	9	Not reported	- Medication-taking problems - Forgetfulness - Carelessness	Implementation	1
Brooks Medication Adherence Scale (BMAS) [56]	MAQ	4	Less than 5 min	- Forgetfulness - Adverse effects and efficacy	Implementation Discontinuation	2
Choo <i>et al.</i> 5-item Questionnaire [57]	Brief Medication Questionnaire	5	Not reported	- Unintentional and intentional non-adherence	Implementation	1
Fodor <i>et al.</i> Adherence Questionnaire [72]	Did not specify	9	Not reported	- Blood pressure awareness	Implementation Discontinuation	1
Godin <i>et al.</i> Self-Reported Adherence Questionnaire [47]	Expertise	6	5 min	- Barriers to adherence	Implementation	1
Hill-Bone Compliance Scale – 10 [8]	The Hill-Bone Compliance Scale – 14	10	Not reported	- Medication adherence - Appointment-making - Sodium intake	Implementation	1

Hill-Bone Compliance Scale – 14 [62]	Literature review and Clinical expertise	14	5 min	<ul style="list-style-type: none"> - Medication adherence - Appointment-making - Sodium intake - Forgetfulness - Carelessness - Adverse effects - Previous history - Adverse effects - Access to medications 	Implementation	1
Immunosuppressant Therapy Adherence Scale (ITAS) [58]	MAQ	4	Less than 5 min	<ul style="list-style-type: none"> - Forgetfulness - Carelessness - Adverse effects - Previous history - Adverse effects - Access to medications 	Implementation Discontinuation	1
Medication Adherence Assessment Tool (MAAT) [80]	Literature review and Expert clinicians	12	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation	1
Morisky Medication Adherence Scale (MMAS) [34]	MAQ and behavioural aspects	8	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation Discontinuation	3
Osteoporosis-Specific Morisky Medication Adherence Scale (OS-MMAS) [48]	MMAS	8	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation Discontinuation	1
Pediatric Inhaler Adherence Questionnaire (PIAQ) [49]	Literature review, expertise and focus groups, Literature review	6	1–3 min	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation	1
Reported Adherence to Medicine (RAM) Scale [10]	Literature review, expertise and focus groups, Literature review	4	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation	2
Self-Reported Adherence (SERAD) Questionnaire [59]	SERAD study	13	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation	1
Simplified Medication Adherence Questionnaire (SMAQ) [39]	MAQ	6	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation Discontinuation	1
The Patterns of Asthma Medication Use Questionnaire [60]	Literature review, Expertise	5	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Medication-taking behaviour - Adverse effects and problems - Missed and additional doses - Barriers to adherence - Forgetfulness - Dose adjustments - Dose frequency adherence - Barriers to adherence - Forgetfulness - Adverse effects - Forgetfulness - Medication-taking strategy 	Implementation	1
Group 3: Barriers to adherence						
Adherence Attitude Inventory (AAI) [63]	Health Belief Model, Health Promotion Model, Reasoned Action	28	Not reported	<ul style="list-style-type: none"> - Cognitive functioning - Patient-Provider - Self-efficacy - Commitment - Forgetfulness and carelessness - Adverse effects and efficacy - Medication self-efficacy - Access to medications - Adverse effects - Lifestyle barriers - Medication self-efficacy - Lifestyle barriers - Adverse effects 	Implementation	1
Medication Adherence Questionnaire (MAQ) [73]	5-item questionnaire by Green <i>et al.</i>	4	Not reported	<ul style="list-style-type: none"> - Forgetfulness and carelessness - Adverse effects and efficacy - Medication self-efficacy - Access to medications - Adverse effects - Lifestyle barriers - Medication self-efficacy - Lifestyle barriers - Adverse effects 	Implementation Discontinuation	8
Medication Adherence Self-Efficacy Scale (MASES) [64]	Patient interviews	26	Not reported	<ul style="list-style-type: none"> - Forgetfulness and carelessness - Adverse effects and efficacy - Medication self-efficacy - Access to medications - Adverse effects - Lifestyle barriers - Medication self-efficacy - Lifestyle barriers - Adverse effects 	Implementation	1
Medication Adherence Self-Efficacy Scale Revised (MASES-R) [79]	MASES	13	Not reported	<ul style="list-style-type: none"> - Forgetfulness and carelessness - Adverse effects and efficacy - Medication self-efficacy - Access to medications - Adverse effects - Lifestyle barriers - Medication self-efficacy - Lifestyle barriers - Adverse effects 	Implementation	1

Table 2
Continued

Self-report adherence scale	Based on	Number of questions	Time to complete	Barriers identified	Stage of medication-taking identified	Number of development and correlation studies
Medication Adherence Reasons Scale [66]	Literature review	15	Not reported	<ul style="list-style-type: none"> - Managing issues - Beliefs - Multiple medication issues - Availability issues - Forgetfulness - Specific problem areas - Self-efficacy 	Implementation Discontinuation	1
The Self-Efficacy for Appropriate Medication Use Scale (SEAMS) [65]	Literature, expertise and patient interviews	13	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Specific problem areas - Self-efficacy 	Nil	1
Group 4: Beliefs associated with adherence Beliefs about Medicines Questionnaire [10]	Health Belief Model and Patient Beliefs	18	Not reported	<ul style="list-style-type: none"> - Medication necessity beliefs - Medication concerns 	Nil	4
Drug Attitude Inventory (DAI) [4]	Literature review and patient reports	30	Not reported	<ul style="list-style-type: none"> - Attitudes towards medications - Beliefs on medications 	Discontinuation	1
Group 5: Barriers and beliefs Beliefs and Behaviour Questionnaire (BBQ) [67]	Qualitative interviews with Chronic Obstructive Pulmonary Disease (COPD) patients	30	Not reported	<ul style="list-style-type: none"> - Beliefs - Experiences 	Nil	1
Brief Evaluation of Medication Influences and Beliefs (BEMIB) [68]	Health Belief Model and Patient/Investigator feedback	8	Less than 5 min	<ul style="list-style-type: none"> - Forgetfulness - Access to medications - Support network - Benefits of medication 	Implementation	1
Compliance Questionnaire Rheumatology (CQR) [75]	Patient interviews	19	Approximately 12 min	<ul style="list-style-type: none"> - Forgetfulness - Value of doctor instructions 	Implementation	2
Maastricht Utrecht Adherence in Hypertension (MUAH) Questionnaire [69]	Patient interviews	25	Average 25 min	<ul style="list-style-type: none"> - Medication attitude - Discipline and aversions - Coping with health problems 	Implementation	1
Medication Adherence Report Scale (MARS) [70]	MAQ and DAI	10	Not reported	<ul style="list-style-type: none"> - Forgetfulness - Adverse effects - Value of medication - Behaviour and attitudes 	Implementation Discontinuation	2

Table 3

Self-report adherence scales – administration, response and validation data

Self-report adherence scale	Reference number	How scale was administered	Response rate	Internal consistency	Sensitivity	Specificity	Correlation (criterion validity)	Comparison measure of adherence	Sample size
Group 1: Medication-taking behaviour									
Adherence Self-Report Questionnaire (ASRQ)	[41]	Clinician-administered (Other HCP)	Not reported	Not reported	Not reported	Not reported	Significant	Electronic monitoring (MEMS)	245
	[94]	Clinician-administered (Primary physician)	53%	Not reported	Not reported	Not reported	Not significant (all)	Electronic monitoring (MEMS) and Other scale (VAS)	78
Adherence Visual Analogue Scale (VAS) Computerized	[52]	Self-administered (Home, Internet)	Not reported	Not reported	Not reported	Not reported	Significant (all)	Dose counts and Clinical outcome (Viral load)	290
Brief Adherence Rating Scale (BARS)	[33]	Researcher-administered (Clinic)	Not reported	$\alpha = 0.92$	0.73	0.74	Significant	Electronic monitoring (MEMS)	61
Barroso <i>et al.</i> 30-day Adherence Question	[53]	Researcher-administered (Clinic)	Not reported	Not reported	Not reported	Not reported	Significant	Clinical outcome (Viral load)	93
Bell <i>et al.</i> Adherence Question	[42]	Self-administered (Clinic, Absent)	80%	Not reported	Not reported	Not reported	Not significant (all)	Electronic monitoring (MEMS) and Dose count	80
Centre for Adherence Support Evaluation (CASE) Adherence Index	[54]	Clinician-administered (Primary physician)	Not reported	Not reported	0.70	0.71	Significant (all)	Clinical outcome (Viral load) and Self-report	524
Gehi <i>et al.</i> Adherence Question	[9]	Researcher-administered (Clinic)	Not reported	Not reported	Not reported	Not reported	Significant	Clinical outcome (Cardiovascular events)	1015
Grymonpre <i>et al.</i> Adherence Question	[43]	Researcher-administered (Home)	Not reported	Not reported	Not reported	Not reported	Significant (all)	Pharmacy records and Dose counts	135
Kerr <i>et al.</i> Adherence Question	[44]	Researcher-administered (Clinic)	Not reported	Not reported	Not reported	Not reported	Not significant	Pharmacy records	88
Medication Adherence Report Scale – 5 (MARS-5)	[5]	Clinician-administered (Primary physician)	Not reported	Not reported	0.085	0.97	Not significant	Pharmacy records	128
[85]	[71]	Self-administered (Clinic, Present)	Not reported	$\alpha = 0.78$	Not reported	Not reported	Significant (all)	Drug levels and Self-report	255
Stages of Change for Adherence (SOCA)	[55]	Self-administered (Clinic, Absent)	Not reported	Not reported	Not reported	Not reported	Significant (all)	Electronic monitoring (MEMS) and Other scale (BMAS)	731
Group 2: Medication-taking behaviour and barriers									
Adherence to Refills and Medications Scale (ARMS)	[51]	Researcher-administered (Clinic)	89%	$\alpha = 0.81$	Not reported	Not reported	Significant (all)	Clinical outcome (BP control), Pharmacy records and Other scale (MAQ)	435
Adherence Starts with Knowledge-12 (ASK-12)	[45]	Self-administered (Clinic, Absent)	Not reported	$\alpha = 0.75$	Not reported	Not reported	Significant (all)	Pharmacy record and Other scale (MAQ)	112
Adherence Starts with Knowledge-20 (ASK-20)	[46]	Self-administered (Home, Internet)	Not reported	$\alpha = 0.85$	Not reported	Not reported	Significant	Self-report	605
	[95]	Self-administered (Clinic, Present)	Not reported	$\alpha = 0.76$	Not reported	Not reported	Significant (Scale only)	Pharmacy records and Other scale (MAQ)	112
Brief Medication Questionnaire	[40]	Researcher-administered (Clinic)	92%	Not reported	0.80	1.00	Significant	Electronic monitoring (MEMS)	43
Brooks Medication Adherence Scale (BMAS)	[56]	Self-administered (Unclear)	86%	$\alpha = 0.69$	Not reported	Not reported	–	Nil	294
Choo <i>et al.</i> 5-item Questionnaire	[96]	Self-administered (Home)	63%	$\alpha = 0.86$	Not reported	Not reported	Significant (all)	Pharmacy records and Self-report	98
	[57]	Researcher-administered (Telephone)	Not reported	Not reported	Not reported	Not reported	Significant	Electronic monitoring (MEMS)	286

Table 3
Continued

Self-report adherence scale	Reference number	How scale was administered	Response rate	Internal consistency	Sensitivity	Specificity	Correlation (criterion validity)	Comparison measure of adherence	Sample size
Fodor <i>et al.</i> Adherence Questionnaire	[72]	Researcher-administered (Clinic)	Not reported	Not reported	Not reported	Not reported	Significant	Clinical outcome (BP control)	359
Godin <i>et al.</i> Self-Reported Adherence Questionnaire	[47]	Self-administered (Clinic, Absent)	Not reported	Not reported	0.71	0.72	Not significant	Clinical outcome (Viral suppression)	256
Hill-Bone Compliance Scale – 10	[8]	Researcher- and self-administered (Clinic)	Not reported	$\alpha = 0.79$	Not reported	Not reported	Significant	Clinical outcome (BP control)	98
Hill-Bone Compliance Scale – 14	[62]	Researcher- and self-administered (Clinic)	Not reported	$\alpha = 0.84$	Not reported	Not reported	Significant	Clinical outcome (BP control)	718
Immunosuppressant Therapy Adherence Scale (ITAS)	[58]	Self-administered (Home)	91%	$\alpha = 0.81$	Not reported	Not reported	Significant (all)	Pharmacy records, Drug levels and Clinical outcome (Rejection)	222
Medication Adherence Assessment Tool (MAAT)	[80]	Self-administered (Clinic)	29%	$\alpha = 0.80$	Not reported	Not reported	Significant	Pharmacy records	289
Morisky Medication Adherence Scale (MMAS)	[34] [20] [97] [48]	Researcher-administered (Clinic) Self-administered (Unclear) Researcher-administered (Clinic) Self-administered (Home)	98% 66% 82% 39%	$\alpha = 0.83$ Not reported $\alpha = 0.56$ $\alpha = 0.82$	0.93 Not reported 0.73 Not reported	0.53 Not reported 0.36 Not reported	Significant Significant Significant Significant	Clinical outcome (BP control) Pharmacy records Pharmacy records Other scale (Beliefs about Medicines Questionnaire)	1367 87 151 197
Pediatric Inhaler Adherence Questionnaire (PIAQ)	[49]	Self-administered (Clinic, Absent)	Not reported	Not reported	0.63	0.91	Significant	Dose counts	64
Reported Adherence to Medicine (RAM) Scale	[10] [50]	Self-administered (Clinic, Absent) Self-administered (Home)	Not reported Not reported	$\alpha = 0.72$ Not reported	Not reported Not reported	Not reported Not reported	– Significant	Nil Other scale (Beliefs about Medicines Questionnaire)	524 271
Self-Reported Adherence (SERAD) Questionnaire	[59]	Researcher-administered (Clinic)	Not reported	Not reported	Not reported	Not reported	Significant (all)	Electronic monitoring (MEMS), Dose counts and Drug levels	530
Simplified Medication Adherence Questionnaire (SMAQ)	[39]	Clinician-administered (Primary physician)	Not reported	$\alpha = 0.75$	0.72	0.91	Significant (all)	Electronic monitoring (MEMS) and Clinical outcome (Viral load)	40
The Patterns of Asthma Medication Use Questionnaire	[60]	Self-administered (Home)	70%	Not reported	Not reported	Not reported	Significant (all)	Pharmacy records and Clinical outcome (Asthma)	176
Group 3: Barriers to adherence									
Adherence Attitude Inventory (AAI)	[63]	Self-administered (Clinic, Absent)	Not reported	$\alpha = 0.90$	Not reported	Not reported	Not significant	Self-report	165
Medication Adherence Questionnaire (MAQ)	[73] [76] [5] [77]	Researcher-administered (Clinic) Researcher-administered (Clinic) Clinician-administered (Primary physician) Researcher-administered (Clinic)	73% Not reported Not reported Not reported	$\alpha = 0.61$ $\alpha = 0.32$ Not reported Not reported	0.81 Not reported 0.32 Not reported	0.44 Not reported 0.73 Not reported	Significant Significant Not significant Significant (all)	Clinical outcome (BP control) Pharmacy records Pharmacy records Electronic monitoring (MEMS), Dose counts and Drug levels	290 377 128 385

	[98]	Researcher-administered (Clinic)	32%	Not reported	Not reported	Not reported	Not reported	Significant	Clinical outcome (Diabetes control)	186
	[99]	Researcher-administered (Home)	88%	$\alpha = 0.42$	Not reported	Not reported	Not reported	Not significant	Dose counts	319
	[78]	Researcher-administered (Clinic)	Not reported	Not reported	Not reported	Not reported	Not reported	Significant	Dose counts	413
	[100]	Researcher-administered (Clinic)	81%	$\alpha = 0.62$	Not reported	Not reported	Not reported	Significant	Clinical outcome (Diabetes control)	294
Medication Adherence Self-Efficacy Scale (MASES)	[64]	Self-administered (Unclear)	Not reported	$\alpha = 0.95$	Not reported	Not reported	Not reported	Not significant	Clinical outcome (BP control)	72
Medication Adherence Self-Efficacy Scale Revised (MASES-R)	[79]	Self-administered (Clinic, Present)	Not reported	$\alpha = 0.91$	Not reported	Not reported	Not reported	Significant (all)	Electronic monitoring (MEMS) and Other scale (MAQ)	168
Medication Adherence Reasons Scale	[66]	Self-administered (Home, Internet)	Not reported	$\alpha = 0.65$	Not reported	Not reported	Not reported	Significant	Other scale (MAQ)	840
Self-Efficacy for Appropriate Medication Use Scale (SEAMIS)	[65]	Self-administered (Clinic)	Not reported	$\alpha = 0.89$	Not reported	Not reported	Not reported	Significant	Other scale (MAQ)	436
Group 4: Beliefs associated with adherence										
Beliefs about Medicines Questionnaire	[10]	Self-administered (Clinic, Absent)	Not reported	$\alpha = 0.70$	Not reported	Not reported	Not reported	Significant	Other scale (RAM)	524
	[2]	Self-administered (Clinic, Absent)	57%	Not reported	Not reported	Not reported	Not reported	Significant	Other scale (MARS-5)	324
	[101]	Self-administered (Clinic)	Not reported	$\alpha = 0.73$	Not reported	Not reported	Not reported	Significant	Other scale (MAQ)	192
	[102]	Self-administered (Clinic, Present)	93%	Not reported	Not reported	Not reported	Not reported	Significant	Other scale (MMAS)	275
Drug Attitude Inventory (DAI)	[4]	Self-administered (Home)	Not reported	$\alpha = 0.93$	0.72	0.63	0.63	Significant	Therapist report	150
Group 5: Barriers and beliefs										
Beliefs and Behaviour Questionnaire (BBQ)	[67]	Self-administered (Home, Post)	53%	$\alpha = 0.65$	Not reported	Not reported	Not reported	Significant	Other scale (MARS)	276
Brief Evaluation of Medication Influences and Beliefs (BEMIB)	[68]	Self-administered (Clinic, Absent)	Not reported	$\alpha = 0.63$	0.83	0.71	0.71	Not significant (all)	Pharmacy records and Other scale (DAI)	63
Compliance Questionnaire Rheumatology (CQR)	[61]	Researcher-administered (Home)	Not reported	$\alpha = 0.71$	0.98	0.67	0.67	Significant	Self-report	127
Maastricht Utrecht Adherence in Hypertension (MUAH) Questionnaire	[75]	Self-administered (Home)	82%	Not reported	0.62	0.95	0.95	Significant	Electronic monitoring (MEMS)	127
	[69]	Researcher-administered (Clinic)	90%	$\alpha = 0.74$	Not reported	Not reported	Not reported	Significant (all)	Electronic monitoring (MEMS), Pharmacy records and Other scale (Brief Medication Questionnaire)	255
Medication Adherence Report Scale (MARS)	[70]	Self-administered (Clinic, Absent)	Not reported	$\alpha = 0.75$	Not reported	Not reported	Not reported	Significant (Drug levels only)	Drug levels or Caregiver report	66
	[103]	Self-administered (Clinic, Absent)	Not reported	$\alpha = 0.62$	Not reported	Not reported	Not reported	Significant	Caregiver report	277

Home—patients completed adherence scale at home; Clinic—patients completed adherence scale in clinic, researcher or clinician may be present or absent while patient fills out form; Telephone—patients completed adherence scale over the telephone; Primary physician = Patient's usual physician; Other HCP = Other health care professionals looking after patient; α = Cronbach's alpha of reliability; BP = Blood pressure.

Content of the scales

The adherence scales can be categorized into five groups based on the information they seek to elicit (the number of scales is given in parentheses, full details in Table 2). Group 1 scales seek information only on medication-taking behaviour (11), group 2 scales seek information on medication-taking behaviour and barriers to adherence (19), group 3 scales seek information only on barriers to adherence (6), group 4 scales seek information only on beliefs associated with adherence (2) and group 5 scales seek information on barriers and beliefs associated with adherence (5).

Thirty of the 43 scales contained items that asked specific questions about medication-taking behaviour (groups 1 and 2). Most of these adherence scales measure the number of doses taken [9, 33, 41–50] and contain items such as ‘how many days over the past month did you take less than prescribed?’ [33] and ‘did you miss a tablet yesterday?’ [42]. Other adherence scales measuring medication-taking behaviour do so through exploring the frequency of patients not refilling their prescription on time [40, 45, 46, 51].

Twenty adherence scales measuring medication-taking behaviour specified a timeframe for the questions. The timeframe specified ranged from 1 day to 12 months [9, 33, 40, 41, 47, 52–58] [34, 39, 42, 44, 48, 49, 59, 60].

Thirty scales contained items that elicited information on barriers to, and determinants of adherence (groups 2, 3 and 5). Some of these adherence scales are disease-specific and thus explore common barriers that may influence adherence in these disease populations [48, 49, 56, 60, 61]. For example, the Pediatric Inhaler Adherence Questionnaire (PIAQ) explores adherence in patients with asthma and assesses the patient’s difficulty in using asthma inhalers and the cost of inhalers [49]. Most of these adherence scales explore forgetfulness as a barrier to adherence and identify some of the situations where forgetfulness may be more common, such as when working or travelling [8, 62–65]. Some adherence scales also explore physical barriers to adherence, such as vision problems, dexterity issues and dysphagia [40, 49, 66].

Seven scales elicited information on the patient’s beliefs about their medicines that may relate to adherence (groups 4 and 5). These scales included items identifying beliefs that medicines are necessary, harmful and unnatural [4, 10, 61, 67–70]. For example, the Beliefs about Medicines Questionnaire explores whether the patient holds beliefs that their medicines are necessary as well as whether they have any concerns about their medicines [10].

Forty of the 43 scales contained items that sought to identify aspects of adherence that are consistent with the taxonomy provided by Vrijens *et al.* [12]. Most scales contain items that seek to assess the extent of implementation of a dosing regimen (39/43) (Table 2). Thirteen of the scales also contain items that seek to identify the dis-

continuation of treatment [34, 39, 45, 46, 48, 51, 56, 58, 66, 71–74]. The DAI contained items that sought information on discontinuation (alone) [4] and the SOCA scale identified the initiation of treatment [55]. Three adherence scales do not contain any items that seek to identify the initiation, implementation or discontinuation of treatment [10, 65, 67].

Administration of the scales

The adherence scales have been administered in different ways. Indeed, for the scales with more than one validation or correlation study, the additional studies often administered the scale in a slightly different way. Details of who completed the scale (i.e. patient, clinician or researcher) and where the scale was administered are provided in Table 3. There was a roughly even split between studies that requested the patient to complete the scale and those that had the researcher or clinician complete the scale in consultation with the patient. The location of administration (clinic, home, via telephone or internet) varied between the scales (as reported in Table 3). The time to complete the scale was reported in eight of the 43 adherence scales. Reported times varied from less than 5 min [49, 56, 58, 68] to approximately 25 min (Table 2) [69]. The scales taking less than 5 min to complete consisted of 4 to 14 items. Twelve min was required to complete a 19-item scale and 25 min to complete a 25-item scale [69, 75].

Figure 2 illustrates the conditions in which the adherence scales have been validated. Most of the adherence scales have been validated in a single disease population [4, 8, 9, 40, 42, 44, 47, 49, 51, 53, 54, 56–59, 62, 72] (Figure 2). The Medication Adherence Questionnaire (MAQ), which is a simple four-item questionnaire, has been validated in a broad range of diseases, including hypertension, dyslipidaemia, heart failure and Parkinson’s disease [73, 76–78].

Approaches to assessing self-report adherence scales

Assessing the validity of self-report adherence scales differed among the 60 included studies. Details of the studies, assessment of internal consistency, comparison measures and whether the scale was significantly correlated with the comparison measure are provided in Table 3. Similar approaches to validation were seen from scales with similar content.

Medication-taking behaviour The primary method for assessing group 1 and group 2 scales was to determine the correlation between the scale and an objective measure of adherence. Twenty-eight of the 30 scales included in groups 1 and 2 assessed how well the scale correlated with an objective measure of adherence, eight of these scales have been assessed against MEMS and 12 against clinical outcomes (Figure 3).

Figure 2

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Comparison measure	Caregiver reports	Provider reports	Drug concentrations	Dose counts	Self-report	Electronic monitoring	Pharmacy records	Other scale	Clinical outcome			
	●		●				●	●	●			
		●									Group 5	Barriers AND beliefs
											Group 4	Beliefs

Figure 3

Comparison measures of medication-taking behaviour used to validate the self-report adherence scales

Barriers and beliefs Scales in groups 3–5 were more likely to rely on alternative approaches to validation. Content validity was typically assessed via a panel of subject matter experts. A range of approaches was utilized for construct validity, including item analysis against tools validated to elicit specific types of health beliefs and factor analyses of responses to other scales or semi-structured interviews.

Three of the six group 3 scales (scales that contain items that elicit information on barriers to adherence only) have been assessed against an objective measure of adherence (one using MEMS, one using clinical outcomes and one using MEMS and clinical outcomes). All six of these scales have been tested for content validity [63–66, 73, 79] and four have also been tested for construct validity [63, 64, 66, 73].

Adherence scales that solely focus on eliciting information regarding a patient's beliefs about their medicines (group 4) have not been assessed against objective measures of adherence. The Beliefs about Medicines Questionnaire and DAI have been significantly correlated with other adherence scales (Table 3). Both scales have been tested for content validity, in addition the Beliefs about Medicines Questionnaire has also been tested for construct validity [4, 10].

Two out of the five group 5 scales (beliefs and barriers) have assessed the correlation between the scale and an objective measure of adherence (both against MEMS). All five of the adherence scales have been correlated with subjective measures: other scales ($n = 3$), self-report ($n = 1$) and caregiver reports ($n = 1$). Four of these adherence scales have also been correlated with objective measures of adherence (Figure 3). All of these adherence scales have been tested for content validity and three (BBQ, BEMIB and MARS-10) have been tested for construct validity [67, 68, 70].

Identifying non-adherence Many self-report adherence scales have recommended cut-offs for identifying non-adherent patients. Twenty-eight scales categorized medication adherence by determining the overall score and separating the population into two groups: adherent and non-adherent [4, 9, 33, 39, 42–47, 49–51, 53, 54, 56–63, 65, 68, 72, 79, 80]. Where reported, the cut-off point to identify non-adherence is most commonly the score that corresponds to patients that took 80% of their medicines as ascertained by an objective measure of adherence such as MEMS. Some scales, such as the Beliefs and Behaviour Questionnaire (BBQ) [67], suggest a cut-off point that corresponds to the score of *another* self-report adherence scale which has been seen to correspond to patients that took 80% of their medicines according to an objective measure. Other adherence scales, such as the DAI, AAI and MASES-R first split the population into adherent and non-adherent based upon responses to questions about whether medicines were taken or not, and then compared the mean scores of the adherence scales to determine the

cut-off [4, 63, 79]. The SERAD and Gehi *et al.* Adherence Questionnaire contain direct medication-taking behaviour questions and answers to these questions are utilized to determine the percentage of adherence and thus dichotomize adherence [9, 59].

A small number of adherence scales have taken a different approach to assigning the adherence cut-off. The MAQ, MMAS, Brief Medication Questionnaire, ASRQ and VAS divided non-adherence into more than two groups, ranging from three to seven [34, 40, 41, 52, 73]. This categorization further differentiated between different levels of patient's adherence to their medicines. The MAQ and MMAS categorized the population into high, medium and low levels of adherence [34, 73]. The MMAS cut-off points were selected based on the correlation with blood pressure control. The Brief Medication Questionnaire grouped the study population into repeat, sporadic and no non-adherence [40]. The ASRQ and VAS classified non-adherence into six and seven levels, respectively based on the researchers' expertise [41, 52].

A small number of scales (12) have assessed the sensitivity and specificity of their cut-off against an objective measure of adherence. The results of these studies are reported in Table 3.

Discussion

We identified 43 adherence scales that have been correlated with a comparison measure of adherence. The identified adherence scales elicit information regarding different facets of adherence including medication-taking behaviour, barriers to and determinants of adherence and beliefs associated with adherence. This information, where accurate, can be put to different uses. Self-report adherence scales can (i) measure medication-taking behaviour, where use of the scale either complements objective measures, or is used as an alternative to objective measures and/or (ii) identify *reasons* for a patient's non-adherence, by identifying patient-specific barriers or beliefs that impede adherence. The data obtained in this systematic review provide information on how well specific adherence scales can be expected to perform these tasks.

Most of the scales identified as group 1–3 focus on measuring medication-taking behaviour by asking direct questions about medication-taking behaviour or eliciting barriers to good medication-taking behaviour. Group 3 scales focus on barriers to adherence and have the potential to both measure medication-taking behaviour and identify barriers to adherence. The purpose of some group 3 scales is to measure medication-taking behaviour by eliciting information on barriers, as opposed to providing a comprehensive assessment of patient barriers to adherence. The MAQ, for example, is a short four-item group 3 scale that has been well-validated against objective

measures of adherence. The demonstration of a significant correlation between the adherence scale and a suitable objective measure in patients with the same disease seems a reasonable minimum requirement on the use of a scale as an alternative to an objective measure. Of the 36 group 1–3 adherence scales, 20 have been significantly correlated with either MEMS or clinical outcomes. Nine of the 36 adherence scales exploring medication-taking behaviour significantly correlated with the MEMS. The MEMS can record the time of dose actuation and can provide detailed information on medication-taking behaviour over time [28–30]. Fifteen group 1–3 adherence scales have been correlated with clinical outcomes. Few scales have been shown to correlate with MEMS or clinical outcomes in multiple disease states, making the choice of a scale more difficult in patient groups other than those included in the validation studies.

A link between specific levels of adherence and clinical outcomes has been demonstrated in some disease states (e.g. HIV [25, 53, 81] and cardiovascular disease [9, 82, 83]). For the vast majority of disease states, however, no such link has been made. Most adherence scales provide suggested cut-offs for identifying 'non-adherent' patients. Cut-offs permit the identification of patients who may be non-adherent and benefit from education or support. However, the arbitrary nature of the cut-offs provided for most self-report adherence scales needs to be kept in mind. Dichotomizing adherence does not differentiate between types of non-adherence, repeat vs. sporadic adherence or patients at different stages of the medication-taking process. Recent taxonomies of adherence recognize the dynamic nature of patient medication-taking behaviour. Vrijens *et al.* acknowledges that the process of medication-taking starts when the patient takes the first dose of medicine (initiation) continues with the implementation of the regimen and ends when the patient discontinues the medicine [12]. Gearing *et al.* propose a six-phase dynamic model of adherence: treatment initiation, treatment trial, partial treatment acceptance, intermittent treatment adoption, premature discontinuation and full adherence [84]. An important area for future research is the use of self-report adherence scales to identify the different types of non-adherence suggested by Vrijens *et al.* [12] and Gearing *et al.* [84].

A substantial number of scales have been validated against clinical outcomes, but no direct measure of medication-taking behaviour such as MEMS; examples include the Barroso 30-day Adherence Question and the Hill-Bone Compliance Scales. A demonstrated correlation between a self-report adherence scale and clinical outcomes in a specific patient population has relatively clear benefits for use of the scale in similar populations of patients. Knowing when this evidence is transferrable into new populations of patients, however, is challenging. For most disease states there are influences on clinical outcomes in addition to medication-

taking behaviour. Factors that influence clinical outcomes play a part in addition to the many factors that may separate measures of adherence by self-report adherence scales from actual medication-taking behaviour. No doubt some of these scales have focused on clinical outcomes due to the availability of clinical data and the relative cost or availability of MEMS. However, validation of a scale against both clinical outcomes and direct measures of medication-taking behaviour is beneficial.

Scales included in groups 2 to 5 include items that elicit reasons a patient may be non-adherent. These scales may identify barriers the patient is experiencing to good medication-taking behaviour, and any patient-specific beliefs about their medicines that may influence adherence. While some Group 3 scales focus more on measuring medication-taking behaviour (e.g. the MAQ), others seek more detailed information on barriers that an individual may be experiencing (e.g. the Pediatric Inhaler Adherence Questionnaire). Scales included in groups 4 and 5 seek to identify patient beliefs about medicines that may influence adherence. Of these scales, the most extensively assessed is the Beliefs about Medicines Questionnaire (BMQ). The BMQ-Specific identifies whether patients hold the belief that their medicine is *necessary* as well as whether the patient has *concerns* about their medicine [10].

Scales that focus on identifying reasons for non-adherence appropriately employ validation strategies focused on content and construct validity. The BMQ is a good example of a self-report adherence scale focused on measuring an aspect of adherence other than medication-taking behaviour. The items of the BMQ have been validated through confirmatory principle components analysis and the criterion and divergent validity assessed against similar items in the Illness Perceptions Questionnaire and the Sensitive Soma Scale [10]. The BMQ-Specific has been shown to correlate well with medication-taking behaviour measured by self-report adherence scales. Patients who believe their medicine to be necessary and have fewer concerns have consistently been shown to be more adherent in a range of diseases [85–89].

Scales such as the BMQ are not stand-alone comprehensive adherence scales but, like scales that focus on identifying barriers to adherence, they provide the opportunity for a more comprehensive assessment of a patient's adherence, and the drivers behind that adherence, than subjective or objective measures that focus on measuring medication-taking behaviour. The information provided by self-report adherence scales that seek to identify barriers and beliefs that are influencing adherence may prove useful in addition to accurate information on the patient's medication-taking behaviour. Specifically, these scales may help inform tailored interventions to improve medication adherence, but their use for this purpose is yet to be assessed.

Limitations

This systematic review only included studies of self-report adherence scales that included a comparison measure of medication-taking behaviour. This was deemed appropriate given the importance of measuring medication-taking behaviour in assessing adherence. A consequence of this criterion is that this study does not provide a comprehensive analysis of the validation of self-report adherence scales.

Conclusions

Self-report adherence scales have the potential to measure both medication-taking behaviour, and/or identify barriers and beliefs associated with adherence. Selecting an adherence scale requires consideration of what the adherence scale measures and how well it has been validated. Research on validating and using the existing self-report adherence scales as a measure of medication-taking behaviour is relatively strong. There has been less focus on assessing how information gained from scales that identify patient-specific barriers and beliefs associated with adherence may be used to support wise medicine use. This presents an important and exciting avenue for further research.

Competing Interests

All authors have completed the Unified Competing Interest form at http://www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare no support from any organization for the submitted work, no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years and no other relationships or activities that could appear to have influenced the submitted work.

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