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MEDICATION ADHERENCE: AN OVERVIEW

Divya Verma * and Shashi Alok

Institute of Pharmacy, Bundelkhand University, Jhansi - 284128, Uttar Pradesh, India.

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Correspondence to Author:
Ms. Divya Verma
Student,
Institute of Pharmacy,
Bundelkhand University, Jhansi - 284128, Uttar Pradesh, India.

E-mail: divyaverma052002@gmail.com

ABSTRACT: Medication adherence is a critical determinant of therapeutic success, particularly in the long-term management of chronic diseases such as diabetes mellitus. Despite the availability of effective pharmacological therapies, non-adherence remains a widespread and under-recognized problem that significantly compromises clinical outcomes, increases healthcare utilization, and imposes a substantial economic burden. This work provides a comprehensive overview of medication adherence, encompassing its definition, phases, determinants, and associated clinical and economic consequences. An extensive literature review, supported by population-based observations and case-based evaluations, is used to examine adherence challenges among patients with diabetes. Clinical evidence demonstrates that poor adherence contributes to uncontrolled glycaemic levels, disease progression, increased hospitalizations, and higher mortality risk. The multifactorial nature of non-adherence is highlighted, involving patient-related, therapy-related, socio-economic, condition-related, and healthcare system factors. Evidence-based strategies to improve adherence including patient education, regimen simplification, motivational interviewing, technological interventions, reminder systems, and pharmacist-led follow-up are critically discussed. Emphasis is placed on the pivotal role of pharmacists in identifying non-adherence, addressing barriers, and delivering patient-centred interventions. Overall, this review underscores the need for structured, multidisciplinary, and patient-focused approaches to enhance medication adherence and optimize therapeutic outcomes in diabetes and other chronic conditions.

INTRODUCTION: Adherence is defined by the World Health Organization (WHO) as the extent to which a person's behavior taking medication, following a diet, and/or executing lifestyle changes corresponds with agreed recommendations from a health care provider. Medication adherence, in simple words, means taking your medicines exactly the way your doctor or pharmacist tells you to the right dose, at the right time, and for the right length of time.

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Good medication adherence helps the medicine work properly and keeps health problems under control especially for long-term diseases like high blood pressure and diabetes [1]. Clinical studies demonstrate this clearly.

For example, a 2025 meta-analysis involving over 226,000 cardiovascular disease patients found that patients who were consistently adherent had significantly lower risks of death and major cardiovascular events, whereas those with persistent non-adherence had markedly higher mortality and hospitalisation rates. Similarly, a large UK cohort study of 127,927 heart-failure patients (2024) showed that non-adherent patients had a 31% higher risk of all-cause mortality and more emergency hospital visits compared to

adherent patients [2]. In chronic diseases such as diabetes, evidence also shows major consequences of poor adherence. A study of 11,532 diabetic patients found that those who were non-adherent were more likely to be hospitalised (58% higher risk) and had a dramatically higher risk of death than patients who took their medications consistently. Beyond clinical outcomes, research also highlights the economic impact. A 2024 study in Parkinson's disease showed that low adherence is directly associated with higher medical costs, and a 2025 review of over 410 research articles concluded that non-adherence increases healthcare utilization, emergency visits, and both direct and indirect healthcare costs.

Medication Adherence Involves Three main Components:

Initiation: When the patient takes the first dose of a prescribed medication.

Implementation: How accurately the patient follows the prescribed dosing regimen over time (e.g., taking the correct dose at the right intervals).

Persistence: The length of time the patient continues the treatment before stopping it altogether.

Failure at any of these stages contributes to overall non-adherence. For instance, some patients may never start the prescribed medicine (poor initiation), others may skip doses or alter timing (poor implementation), and others may discontinue therapy prematurely (poor persistence). If someone forgets doses, stops early, skips medicines when they feel better, or takes them differently from what was prescribed, that's called non-adherence (or not sticking to the treatment).

FIG. 1: OBJECTIVE OF MEDICATION ADHERENCE

Some studies classify adherence as either primary or secondary.

Primary non-adherence is the frequency with which patients fail to fill prescriptions when new medications are started so it is related to refilling and initiation of the medication therapy. Secondary non-adherence is defined as the medication being not taken as prescribed when prescriptions are filled. It does not only affect the clinical outcome but also affect the financial outcome of the health system.

Causes of Medication Non-Adherence: Non-adherence affects therapeutic effect in pharmacological terms by disrupting the drug's ability to achieve and maintain therapeutic plasma concentrations. When doses are missed or taken incorrectly, the drug level often falls below the minimum effective concentration (MEC), meaning the receptors or target sites are not sufficiently activated to produce the desired therapeutic response. Irregular dosing also prevents the drug from reaching steady-state levels, leading to unstable pharmacokinetics and reduced efficacy. In some cases, sudden stopping may cause rebound effects or withdrawal due to rapid changes in drug concentration. Poor adherence can also alter pharmacodynamic responses, because inadequate drug levels fail to produce the expected receptor occupancy or biochemical changes. Overall, non-adherence results in subtherapeutic drug levels, reduced receptor interaction, inadequate physiological response, and ultimately poor therapeutic outcomes [3].

The five major causes of medication non-adherence as identified by the World Health Organization (WHO).

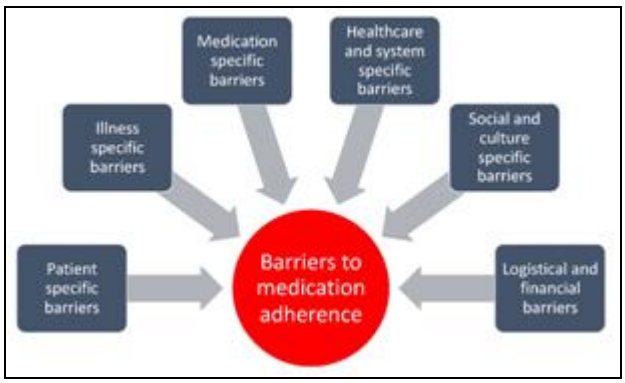

FIG. 2: BARRIERS TO MEDICATION ADHERENCE

Patient Related Factor:

1. Forgetfulness
2. Lack of understanding about the disease or medication
3. Poor motivation or denial of illness
4. Psychological issues (e.g., depression, anxiety)
5. Cultural or personal beliefs against medication
6. Cognitive or physical limitations

Therapy Related Factor:

1. Complex dosing regimens
2. Long duration of treatment
3. Frequent changes in therapy
4. Unpleasant or severe side effects
5. Drug–drug or drug–food interactions that complicate use.

Condition-Related Factors:

1. Chronic or long-term illnesses
2. Asymptomatic conditions where patients don't feel sick
3. Severe or fluctuating symptoms
4. Presence of multiple medical conditions (comorbidities)
5. Disability or physical limitations that hinder medication use

Healthcare System/Provider Factors:

1. Limited access to healthcare services
2. Poor patient–provider communication
3. Long waiting times or inconvenient clinic hours
4. Lack of follow-up or monitoring
5. Fragmented care or poor coordination between providers

Socio-Economic Factors:

1. High medication or healthcare costs
2. Low income or financial instability
3. Limited access to transportation
4. Low education or health literacy
5. Lack of social or family support

Medication-Access Factors:

1. Limited availability of medicines
2. Stock outs at pharmacies or clinics
3. Long distance to pharmacy/health facility
4. High medication costs
5. Insurance or reimbursement barriers
6. Complex refill processes or delays [4].

Consequences of Medication Non-Adherence: Medication non-adherence is a silent but serious barrier to effective chronic disease management. It leads to worsening of disease, higher healthcare costs, psychological suffering, and increased mortality. In conditions like hypertension and diabetes where regular medication is key to preventing complications non-adherence can reverse years of medical progress [5].

Importance of Medication Non-Adherence: Medication adherence is critically important because it ensures that drugs achieve their intended therapeutic effect. In pharmacology, medications must reach and maintain a specific therapeutic concentration in the bloodstream to produce the desired action. When patients take their medication consistently and correctly, drug levels stay within the therapeutic window the range between the minimum effective concentration (MEC) and the minimum toxic concentration (MTC). Maintaining levels within this window allows the medication to interact effectively with its receptors, enzymes, or target cells, leading to the desired pharmacological response.

Adherence also supports the development of steady-state drug levels, where the rate of drug administration equals the rate of elimination. Steady-state levels are essential for chronic conditions such as hypertension, diabetes, HIV, epilepsy, and asthma. Without proper adherence, drug levels fluctuate, causing reduced efficacy or increased risk of adverse effects.

Additionally, medication adherence reduces the risk of treatment failure and disease progression. When medications are not taken as prescribed, drug concentrations may drop too low to be effective, allowing diseases to worsen or complications to develop. In infectious diseases, poor adherence can

contribute to antimicrobial resistance, making future treatment far more difficult. Good adherence ensures that treatment plans yield consistent and predictable results, improving clinical outcomes, minimizing hospital admissions, and reducing overall healthcare costs. It also enhances a patient's quality of life**,** as proper drug therapy leads to better symptom control, fewer relapses, and improved daily functioning. From clinical data across multiple studies, medication adherence is consistently associated with better health outcomes, fewer complications, and reduced mortality. Clinical data also demonstrate that non-adherence leads to increased hospital admissions, higher emergency visits, greater disease progression, and higher healthcare costs. In chronic conditions, studies show that even moderate non-adherence (e.g., taking <80% of prescribed doses) can reduce therapeutic effectiveness dramatically. In infectious diseases, clinical evidence shows that poor adherence contributes to treatment failure and the development of antimicrobial resistance [6].

Here are some clinical-data backed findings from research articles that highlight the importance of medication adherence.

Older Adults & Mortality / Hospitalisation:

A. A systematic review and meta-analysis of adults aged ≥50 years found that medication non-adherence was significantly associated with *all-cause hospitalisation*.

B. In the same study, good medication adherence was associated with a 21% reduction in long-term mortality risk compared to non-adherence (adjusted hazard ratio 0.79, 95% CI 0.63–0.98) [7].

Coronary Artery Disease (CAD): A meta-analysis involving 106,002 patients with stable coronary artery disease showed that good adherence to evidence-based drugs (like β-blockers, ACE inhibitors/ARBs, statins, antiplatelets) was associated with:

A. 44% lower all-cause mortality (Risk Ratio = 0.56, 95% CI: 0.45–0.69)

B. 34% lower cardiovascular mortality (Risk Ratio = 0.66, 95% CI: 0.51–0.87)

C. 39% reduction in cardiovascular hospitalization or myocardial infarction (Risk Ratio = 0.61, 95% CI: 0.45–0.82) [8].

Diabetes – Hospitalisation and Death: In a retrospective cohort of 11,532 diabetic patients, those who were non-adherent (proportion of days covered < 80%) had:

Higher Risk of Hospitalization: Odds Ratio = 1.58 (95% CI: 1.38–1.81)

Higher Risk of All-Cause Mortality: Odds Ratio = 1.81 (95% CI: 1.46–2.23). [9]

Hospital Admissions across Conditions:

A. A systematic review of prospective observational studies estimated that a median of 4.29% of hospital admission**s** (IQR: 3.22%–7.49%) are associated with medication non-adherence.

B. According to the same review, most of these non-adherence-related admissions are *preventable* [10].

Economic Burden:

A. A narrative review of 43 systematic reviews (covering 410+ clinical studies) found that nonadherence is linked to: higher mortality, more hospitalizations and emergency department visits, and greater healthcare cost**s**, including increased direct (medical visits, inpatient care) and indirect costs (loss of productivity).

B. In a specific observational study in Parkinson's disease (using electronic medical records), lower medication adherence (measured by the proportion of days covered) was associated with higher direct medical costs [11].

Patients who require Highest Level of Medication Adherence:

Patients with Chronic Diseases: Patients living with chronic conditions rely heavily on regular medication to keep their symptoms under control and prevent serious complications. Conditions such as hypertension, diabetes, asthma, heart failure, and epilepsy require long-term adherence, and even a few missed doses can worsen the illness.

For example, a patient with hypertension who forgets their blood pressure medication for several days may experience dangerously high blood pressure, increasing the risk of a stroke.

Patients with Mental Health Conditions: Individuals with mental health disorders depend on consistent medication use to maintain emotional stability and prevent relapse of symptoms. Conditions such as depression, bipolar disorder, and schizophrenia often worsen quickly if medications are skipped.

Patients with Infectious Diseases: For infectious diseases, adherence is necessary not only for patient recovery but also to prevent drug resistance and protect public health. Diseases like HIV/AIDS, tuberculosis, hepatitis, and bacterial infections become harder to treat when medications are not taken properly [12].

Post-Transplant Patients: Patients who have undergone organ transplants must take immunosuppressant medications consistently to prevent their immune system from attacking the new organ. Missing doses even once can lead to acute rejection, which may result in organ failure. For example, a kidney transplant patient who skips their immunosuppressive medication could experience organ rejection that requires hospitalization or another transplant.

Older Adults or Patients on Multiple Medications (Polypharmacy): Older adults often take several medications for different chronic conditions, making it harder to remember and organize dosing schedules. Poor adherence in this group can lead to worsening disease, drug interactions, or hospitalization [13]. For example, an older adult taking medications for diabetes, heart disease, and arthritis may forget a dose of their blood sugar medication, causing dangerously high glucose levels.

Patients with Cognitive or Physical Limitations: Patients with memory problems, dementia, vision impairment, or difficulty handling medication containers face unique barriers to taking their medications correctly [14]. For example, a patient with Alzheimer's disease may repeatedly forget to take their heart medication, putting them at higher risk of complications.

Role of Pharmacist in Medication Adherence:

Patient Education: Pharmacists play an essential role in educating patients about their illness, the purpose of each medication, correct dosing schedules, and the importance of consistent adherence. By explaining how medications control conditions and addressing fears or misconceptions, pharmacists empower patients to take responsibility for their treatment and prevent therapy discontinuation.

Simplification of Therapy: Complex medication regimens can discourage adherence. Pharmacists help simplify treatment plans by recommending once-daily formulations, fixed-dose combinations, or aligning medication times. This reduces pill burden, minimizes confusion, and increases the likelihood of patients following their regimen correctly and consistently.

Monitoring and Follow-Up: Through regular monitoring such as tracking refill records, conducting pill counts, or using adherence questionnaires pharmacists can identify early signs of non-adherence. Continuous follow-up enables them to address barriers immediately [15].

Reminder and Support Systems: Pharmacists assist patients in setting up reminder tools such as pill organizers, medication diaries, phone alarms, or digital apps. These systems help prevent forgetfulness, one of the most common causes of unintentional non-adherence, especially among elderly or busy patients.

Socioeconomic Support: Financial barriers often prevent patients from adhering to long-term therapy. Pharmacists help by suggesting cost-effective generic drugs, guiding patients toward government or insurance assistance programs, and ensuring medication availability [16].

Motivational Counseling: Pharmacists use motivational interviewing techniques to understand patients' beliefs and attitudes toward medication. They provide encouragement, address fears or doubts, and emphasize the benefits of adherence in preventing complications. This personalized counseling builds trust and promotes long-term behavioral change.

Collaboration with Healthcare Team: Pharmacists work closely with physicians, nurses, and other healthcare professionals to ensure coordinated care. By sharing information about a patient's medication use, adherence patterns, and potential side effects, pharmacists contribute to better-informed treatment decisions and more effective disease management.

Side Effect Management: Adverse drug effects are a common reason for patients to stop taking medication. Pharmacists monitor, identify, and manage these side effects, educating patients on what to expect and when to seek medical help [17].

The Information that Patient need to know which Pharmacist can imparts Include:

a. Medication's name and its intended use.

b. Instructions on the timing and method of administration.

c. Potential adverse effects to the watch for.

d. Necessary precautions to consider.

e. How the drug may interact with foods or other medications.

f. The expected length of the treatment course.

g. Guidance on what to do if a dose is missed.

h. Indicators to determine whether the medication is effective or not [18].

Stratigies to Improve Patient Pharmacist Relationship: A strong and trusting relationship between the pharmacist and the patient is essential for promoting medication adherence. When patients feel respected, understood, and supported, they are more likely to communicate openly and follow prescribed therapies.

Building this relationship requires effective communication, empathy, trust, and consistent engagement. The following strategies can help strengthen the patient–pharmacist relationship and improve adherence outcomes [19].

a. Communicate clearly and in simple language

b. Listen actively to patient concerns

c. Show empathy and respect

d. Provide personalized counseling

e. Maintain patient confidentiality and trust

f. Encourage questions and give adequate time

g. Offer follow-up support on medication use

h. Be culturally sensitive

i. Use friendly, approachable body language

j. Ensure consistency and reliability in service

Motivational Interviewing: Motivational Interviewing (MI) is a patient-centered communication technique designed to encourage positive behavioral changes. In healthcare, MI is widely used to improve adherence to chronic disease treatments, including diabetes, hypertension, and mental health therapies. The method relies on four core processes: engaging (building a trusting relationship), focusing (identifying the main change goal), evoking (eliciting the patient's own motivations), and planning (helping them commit to actionable steps) [20]. Clinicians use key communication techniques such as open-ended questions, reflective listening, affirmations, summarizing, and eliciting "change talk," which refers to patient statements that express desire, ability, reason, or need to change.

This approach is particularly effective in uncovering and addressing obstacles that prevent patients from adhering to their medication regimens. Unlike traditional counseling, MI is supportive and non-confrontational, focusing on enhancing the patient's internal drive to change rather than applying pressure or persuasion.

When applying Motivational Interviewing (MI) to boost medication adherence, pharmacists should partner closely with patients to encourage discussions about change, establish clear goals for consistent medication use, and collaboratively address any obstacles to sticking with the regimen. Research shows that MI effectively promotes behavior modification and strengthens patients' confidence in managing their health, which in turn supports better adherence to prescribed treatments [21]. Patients change more when they feel in control. Pharmacists should ask, "Which method would you try to take your meds better?" Before advising, ask permission, like, "May I share ideas to remember their meds?"

Ask open-ended questions to check patients' understanding of their medications and fix any gaps before they leave.

Three Essential Questions to Ask:

- What information did the prescriber provide about the medication's purpose? _ Identify the medication by name and understand its intended use.
- How did the prescriber instruct you to administer the medication? _ Details on dosage, method of administration, frequency, storage conditions, treatment length, and any special techniques required.
- What outcomes did the prescriber describe? _ Expected benefits, steps to take if results aren't seen, potential side effects, ways to minimize their chances, and guidance on what to do if side effects occur [22].

After these questions, confirm patient understanding using teach-back: have them explain in their own words. To ease embarrassment over mistakes, pharmacists should take responsibility. Say, "To be sure I didn't miss anything, please tell me how you'll take this medication." Asking patients to explain their understanding using three key questions and teach-back helps them remember information longer than traditional counseling. Regularly check patients' understanding of long-term medication use to prevent adherence issues. Simplifying doses and reducing side effects boost patient adherence. Pharmacists should quickly check if dosing is simple and ask patients about side effects, then consult doctors for alternatives.

Literature Review:

World Health Organization. Adherence to Long-Term Therapies: Evidence for Action. WHO; 2003: The World Health Organization's landmark report Adherence to Long-Term Therapies: Evidence for Action (2003) provides one of the most comprehensive early syntheses of global evidence on medication adherence. The report emphasizes that between 20–50% of patients with chronic diseases do not take medications as prescribed, and argues that poor adherence undermines the effectiveness of medical innovations more than limitations in drug efficacy. WHO presents a multidimensional framework in which adherence is shaped by five interacting domains social and economic factors, health-care system factors, condition-related factors, therapy-related factors, and patient-related factors highlighting that nonadherence is rarely due to patient behavior alone.

The report concludes that effective adherence improvement requires multicomponent, system-level, and sustained interventions, such as simplified regimens, stronger patient–provider communication, ongoing support, multidisciplinary teams, and integrated follow-up systems. Although published in 2003, this framework remains foundational and continues to guide contemporary adherence research and intervention design [23].

Hess LM, *et al.*, Measurement of adherence in pharmacy administrative databases: proposal for standard definitions and preferred measures. Ann Pharmacother 2006: Hess *et al*., (2006) begin their paper by reviewing the inconsistent landscape of refill-based adherence metrics used in pharmacy administrative databases and the methodological problems that hinder comparability across studies.

Their literature review shows that numerous measures (for example, various forms of medication possession ratio, proportion of days covered, cumulative measures and refill-based algorithms) have been proposed and applied with differing definitions, observation windows, truncation rules and handling of surplus medication, which produces widely divergent adherence estimates even from the same raw claims data.

On the basis of this review of published approaches (MEDLINE 1990–2006), they conclude that the field needs standard definitions, clear reporting of calculation rules, and preferred, practically implementable measures for routine use in pharmacoepidemiology and outcomes research a rationale that underpins their subsequent proposal of recommended measures and standardized terminology [24].

Rezaei M, *et al.*, Barriers of medication adherence in patients with type-2 diabetes: systematic review (2019): Rezaei *et al.*, (2019)

shows that medication adherence in type-2 diabetes is widely recognized as a major determinant of effective disease management, yet it remains a significant global challenge. Numerous studies report that non-adherence leads to poor glycaemic control, increased risk of complications, diminished quality of life, and higher healthcare expenditures. The authors highlight that adherence rates vary considerably between populations, partly due to the diverse methods used to measure adherence, ranging from self-report questionnaires to pharmacy refill records, each with inherent limitations. Prior research consistently identifies a range of barriers affecting adherence, including inadequate knowledge of diabetes and medications, misconceptions and negative beliefs about treatment, psychological factors such as stress and depression, complexity of therapeutic regimens, side effects, financial constraints, and limited access to healthcare services. Additionally, insufficient communication, weak patient–provider relationships, and low health literacy further hinder adherence. Because most of the existing evidence is quantitative and does not fully capture patients' personal experiences or contextual challenges, Rezaei et al. emphasize the need for qualitative, culturally informed studies to better understand the nuanced and multifaceted reasons underpinning non-adherence in diverse populations [25].

Peng Y, *et al.*, Effectiveness of Mobile Applications on Medication Adherence (JMCP 2020): Peng *et al.,* (2020) conducted a systematic review and meta-analysis evaluating the impact of mobile health applications on medication adherence across chronic disease populations. Analyzing data from randomized and quasi-experimental studies, the authors found that mobile apps produced small but statistically significant improvements in adherence compared with usual care, with the greatest benefits observed in interventions that incorporated reminders, self-monitoring features, and feedback loops. Despite the positive findings, the review highlighted substantial heterogeneity in app design, study quality, and adherence measurement methods, limiting comparability across trials. Peng *et al.* emphasized that while mobile applications show promise as accessible adherence-enhancement tools, more rigorous and longer-term studies are necessary to determine which app features are most effective and how digital interventions can be sustainably integrated into routine clinical care.[26]

Tolley A, Hassan R, Sanghera R, Grewal K, Kong R, Sodhi B, Basu S. Interventions to promote medication adherence for chronic diseases in India: a systematic review: Tolley *et. al.,* (2023) reviewed 22 studies assessing interventions to improve medication adherence for chronic diseases in India. Most studies targeted cardiovascular disease (8 studies) and type 2 diabetes (6 studies). Education-based interventions delivered by community health workers or pharmacists were most effective, with adherence improvements reported in 80–90% of these studies, and some showing better clinical outcomes such as reductions in HbA1c by 0.5–1.2% or blood pressure drops of 5–10 mmHg. Technology-only interventions had more modest effects, but combined education plus follow-up tended to enhance adherence further. Most studies had short follow-up (≤6 months) and relied on self-reported adherence, highlighting the need for longer, objectively measured trials. The review concludes that low-cost, scalable educational interventions are promising strategies for improving medication adherence in India [27].

Lanke A, *et al.*, Evaluating the Effectiveness of Mobile Apps on Medication Adherence: A Systematic Review and Meta-analysis. J Med Internet Res 2025: Lanke *et al.,* (2025) analyzed 14 clinical studies to assess the impact of mobile apps on medication adherence and found a significant overall improvement, with adherence scores increasing by around 0.57 points on the MMAS-8 scale and by about 18–19% on percentage-adherence measures.

Apps that included tracking, feedback, and communication features produced stronger effects than basic reminder-only apps. However, improvements were not consistent across all measurement tools, as studies using the MMAS-4 scale did not show significant changes. The authors concluded that while mobile apps can meaningfully enhance adherence, especially in chronic disease management, their effectiveness varies by app design and they are most beneficial when combined with wider clinical or behavioral support strategies [28].

Schnorrerova P, Matalová P, Wawruch M. Medication Adherence and Intervention Strategies: Exploring Initiation, Implementation, Persistence Phases. Bratisl Med J 2025: Schnorrerova *et. al.*, (2025) review how interventions to improve medication adherence can be targeted across the three phases of adherence initiation (starting therapy), implementation (taking medication as prescribed), and persistence (continuing therapy over time). They report that interventions such as patient education, digital tools and reminders, and pharmacist-led services have demonstrated effectiveness.

The review also highlights that simplifying treatment regimens (e.g., reducing pill burden) and using personalized strategies help overcome both practical barriers (like forgetfulness) and perceptual ones (e.g., doubts about medication necessity). Although the paper does not provide a single pooled effect size (because of heterogeneity across studies), it emphasizes that multifaceted, patient-centered and phase-aware interventions generally appear more effective than one-size-fits-all approaches [29].

Moon Z, Walsh J. Digital interventions in medication adherence: a narrative review of current evidence and challenges. Frontiers in Pharmacology 2025: In their 2025 narrative review, Moon and Walsh examine the evidence on digital tools (mobile apps, SMS, electronic pillboxes, *etc*.) for improving medication adherence across chronic conditions. They note that between 20% and 50% of patients fail to take medications as prescribed globally, highlighting the scale of the problem. While some digital interventions have shown positive effects on adherence, many yielded no improvement, reflecting considerable heterogeneity in design, delivery, and measurement.

According to the review, digital solutions that tend to work better are those that are evidence-based, personalized, interactive, and ideally include some form of human or clinician-support integration, rather than simple reminder-only apps. However, the authors caution that because of mixed results, lack of long-term follow-up, and variable accessibility (digital divide), more rigorous development, evaluation, and equitable implementation are required before such tools can be relied upon at scale [30].

Ways to Increase Medication Adherence: Improving medication adherence requires a multifaceted approach because non-adherence is influenced by patient-related, therapy-related, healthcare system, socio-economic, and access-related factors. The following strategies provide a comprehensive framework for increasing adherence among patients, especially those with chronic diseases such as diabetes [30].

Patient Education and Counseling: Education is one of the strongest predictors of adherence. When patients understand why they need medication, they are far more likely to take it consistently. When patients understand why medicine is important and how it works, they are more motivated to follow their treatment. Using simple language, visual aids, and the teach-back method ensure that patients truly understand instructions and feel confident about taking their medication correctly.

Key Approaches:

- Explain disease and medication purpose in simple terms. Patients who know the role of each medicine are less likely to skip doses.
- Use the "Teach-back Method", asking patients to repeat instructions in their own words. This confirms understanding.
- Discuss consequences of non-adherence, such as complications in diabetes (neuropathy, kidney failure, vision loss).
- Clarify misconceptions for example, "I can stop when I feel better" or "I feel worse, so the medicine is harmful" [31].

Simplifying Medication Regimens: Complex regimens multiple doses, multiple drugs are strongly linked to poor adherence. Complex treatment plans make adherence difficult. Reducing dose frequency, using once-daily drugs, fixed-dose combinations, or aligning medication schedules with a patient's daily routine significantly improves consistency. When the regimen is simple, patients are less overwhelmed and more likely to stick with it long-term.

Strategies:

- Reduce dosing frequency (once-daily formulations when possible).
- Use fixed-dose combinations of single tablets containing two or more medications.
- Synchronize medication timings with daily routines (morning/night).
- Simplify treatment plans whenever clinically acceptable [32].

Reminder Tools and Technological Aids: Forgetfulness is one of the most common reasons for non-adherence. Forgetfulness is one of the most common reasons for non-adherence. Using reminders such as alarms, mobile apps, pill boxes, or calendar-based blister packs helps patients remember their doses on time. These tools are especially beneficial for elderly patients, busy individuals, and those managing multiple medications [33].

Useful Tools:

- Mobile phone reminders or apps
- Smart pill boxes with alarms
- Medication diaries
- Calendar-based blister packs
- Wearable device reminders

Improving Patient–Pharmacist Relationship: Strong communication and trust encourage honest dialogue about challenges. A trusting and supportive relationship encourage patients to share concerns and challenges related to their medication. Pharmacists who communicate clearly, listen empathetically, and provide regular follow-up guidance help patients stay committed to therapy. This relationship increases confidence and improves long-term adherence.

Approaches:

- Encourage open, non-judgmental communication.
- Let patients express fears or difficulties.
- Use motivational interviewing ask open-ended questions, listen actively, and support patient-driven solutions.
- Provide consistent follow-ups to monitor progress [34].

Addressing Side Effects in Advance: Side effects are a major reason patients stop treatment. Side effects often lead patients to stop medications without consulting their healthcare provider. Discussing potential side effects in advance and reassuring patients about which reactions are normal and which require attention helps reduce fear. Pharmacists can also suggest ways to minimize discomfort or coordinate with doctors to adjust therapy when needed.

Strategies:

- Educate patients about *possible* side effects.
- Clarify which side effects are common and which require urgent attention.
- Encourage reporting of discomfort early.
- Adjust therapy when needed in consultation with physicians [35].

Enhancing Healthcare System Support: Weak patient–provider communication and poor follow-up lead to non-adherence. Healthcare providers play a crucial role in improving adherence through clear communication, proper follow-up, and coordinated care. Systems such as electronic reminders, refill monitoring, and medication therapy management help identify non-adherence early. Adequate counseling time and consistent provider-patient interaction also enhance treatment success.

System-based Solutions:

- Provide adequate time for patient counseling.
- Improve continuity of care (same pharmacist/doctor for follow-ups).
- Use EMR-based reminders for refill tracking.
- Implement medication therapy management (MTM) programs [36].

Socio-Economic Support: Financial constraints are a major predictor of poor adherence, especially for chronic diseases. Cost is a major barrier for many patients. Suggesting affordable generic medications, connecting patients to insurance or government programs, and helping them manage

expenses increase their ability to continue treatment. Reducing financial stress ensures better adherence and continuity of care.

Interventions:

- Recommend generic alternatives when available.
- Guide patients toward insurance plans, government schemes, or hospital support programs.
- Provide longer prescriptions to minimize visit frequency.

Family and Social Support: Family involvement improves routine adherence significantly. Family members and caregivers can help patients remember doses, understand instructions, and provide emotional support. Educating families about the patient's medication needs creates a reliable support system. This is especially helpful for older adults, patients with cognitive challenges, or those with chronic illnesses [36].

Approaches:

- Encourage family members to assist with reminders.
- Educate caregivers about dosing schedules.
- Create a supportive environment for chronic illness management.

Behavioral Interventions: Behavioral changes are essential for long-term adherence. Encouraging good habits, setting goals, using positive reinforcement, and helping patients develop routines strengthens adherence. Techniques like habit stacking linking medication to daily activities such as brushing teeth make adherence more automatic. Regular follow-up motivates patients and increases accountability [37].

Interventions:

- Goal setting with the patient.
- Positive reinforcement when adherence improves.
- Habit stacking (linking medication to an existing habit, such as brushing teeth).
- Regular follow-up to track progress.

Motivational Interviewing (MI): MI is a proven approach for improving adherence by encouraging patients to explore their own motivations. Motivational interviewing (MI) helps patients explore their own reasons for taking medication and commit to positive change [38]. Through open-ended questions, reflective listening, and shared problem-solving, pharmacists can help patients overcome barriers. MI increases patient autonomy and strengthens long-term adherence.

Core MI Techniques:

- Ask open-ended questions.
- Reflect the patient's concerns.
- Affirm their feelings.
- Guide them to solve barriers themselves.

Medication Access Improvement: Ensuring medication availability improves adherence substantially. Ensuring uninterrupted access to medicines is essential. Strategies such as early refills, home delivery services, reducing travel barriers, and maintaining adequate pharmacy stock prevent treatment gaps. Easy access to medication reduces missed doses and helps maintain therapeutic levels [39].

Strategies:

- Coordinate with pharmacies to avoid stock shortages.
- Encourage refilling prescriptions early.
- Provide home delivery options (hospital or pharmacy-dependent).
- Reduce geographical barriers through telepharmacy.

CONCLUSION: Medication adherence is a fundamental determinant of successful pharmacotherapy, particularly in the long-term management of chronic diseases such as diabetes mellitus, cardiovascular disorders, and other conditions requiring sustained treatment. Consistent and correct use of prescribed medications allows therapeutic drug concentrations to be maintained within the desired range, thereby optimizing clinical effectiveness, preventing disease progression, and reducing the incidence of avoidable complications.

In contrast, medication non-adherence remains a widespread and persistent challenge that significantly undermines treatment outcomes, increases hospital admissions, elevates mortality risk, and imposes a substantial economic burden on healthcare systems worldwide. The complexity of medication non-adherence reflects the interaction of multiple factors, including patient-related behaviors and beliefs, therapy-related challenges such as complex regimens or adverse effects, socio-economic constraints, and limitations within healthcare systems. As a result, improving adherence cannot rely on isolated or uniform interventions. Instead, a comprehensive and patient-centered approach is required one that recognizes individual needs, preferences, and circumstances while addressing both intentional and unintentional barriers to medication use.

Strategies such as targeted patient education, simplification of dosing regimens, behavioral and motivational support, and the use of reminder systems and digital health tools have demonstrated considerable value in supporting consistent medication use. Among healthcare professionals, pharmacists play a particularly important role due to their accessibility and frequent patient contact. Through individualized counseling, monitoring of medication use, early identification of adherence problems, management of adverse effects, and collaboration with physicians and other members of the healthcare team, pharmacists contribute significantly to sustained adherence and improved therapeutic outcomes. Ultimately, strengthening medication adherence requires coordinated efforts across multiple levels of care, supported by effective communication, continuity of services, and patient empowerment. Integrating adherence-focused practices into routine healthcare delivery has the potential to enhance clinical outcomes, improve quality of life for individuals with chronic illnesses, and promote more efficient and sustainable use of healthcare resources.

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