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Improving medication adherence: A review of assessment methods and interventions

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Abstract

The World Health Organization (WHO) defines adherence to medication treatment as "the extent to which the individual's behavior conforms to what is recommended in relation to treatment by the health care provider." Medication adherence continues to be a major challenge of medical treatment, with important implications for patient outcomes and the effectiveness of healthcare systems. Increased medication adherence has been associated with improved clinical outcomes, reduced costs to healthcare systems, and an improvement in the patient's quality of life. On the other hand, non-adherence has been shown to lead to treatment failure, disease progression, as well as an increase in the number of hospitalizations. This review article analyzes the complex nature of medication adherence concerning assessment, intervention strategies, and related outcomes (including intention to treat). Adherence assessment methods include a range of methodologies, from self-reporting through electronic monitoring systems to the analysis of biochemical values. We discuss the advantages and disadvantages of these different methods, emphasizing the need for the implementation of validated instruments according to the patient's needs. Regarding improving medication adherence, multiple strategies need to be implemented. Maximizing adherence if, and where, feasible will reduce the disease burden of chronic illness, improve patient prognosis, and ultimately lead to more efficient healthcare. This review highlights the need to continually research and innovate in this critical area.

Keywords: Evaluation, Implementation Strategies, Healthcare Efficiency, Improvement, Medication Adherence, Patient Outcomes.

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1. Introduction

Despite the claim that patients take less than half of their prescribed doses, there is continuous evidence of low medication adherence among patients [1-4]. Numerous studies and meta-analyses have linked poor health outcomes to inadequate medication adherence [5, 6], mortality [7], and even greater subsequent healthcare expenses, which are mostly represented by a rise in hospital stays and emergency department utilization [8-10]. Medication nonadherence is often concealed as shown in a study presented by Lapane et al. [11] where 83% of patients did not inform their healthcare providers that they would not be filling a new prescription [11].

Qualitative studies indicate that the approach of healthcare providers (HCPs) plays a crucial role when inquiring about a patient's medication use. This is important for determining whether the patient is truly not adhering to their prescribed medication regimen [12]. Many studies evaluate and some of them have confirmed the impact of different pharmacist-led interventions on the improvement of patients' treatment adherence for patients in different countries [13-17]. Since most patients obtain their medications from community pharmacies, community pharmacists are in a unique position to offer patient-centered medication adherence interventions [18]. It would be beneficial to offer strategies for community pharmacists to consistently improve patient medication adherence, either on their own or in conjunction with other allied healthcare providers.

Direct and indirect methods, which could be used independently or in combination, are the most frequently used approaches for the evaluation of medication adherence. Study published in 2015 evaluate direct measurements, such as direct observation, therapeutic drug monitoring (TDM) and biochemical markers, and indirect measurements, such as the medication possession ratio (MPR), proportion of days covered (PDC), self-report, questionnaire, pill counting, dose counting device, electronic prescribing, patient interviews, etc [19].

The measurements could potentially be divided into the following categories:

1. Employing electronic medication event monitoring systems, counting pills, or reviewing pharmacy refill records can provide objective measurements obtained by assessing the pharmacy refill records, counting pills, or using electronic medication event monitoring systems.
2. Subjective measurements, which are obtained by questioning the patient, family members, or HCPs about the patient's medication, use patterns and biochemical measurements, which are obtained by incorporating a nontoxic marker for the medication taken and identifying its presence in blood or urine or measurements of serum drug levels [19].

Medication adherence is an important factor for the success of treatment outcomes and patient prognosis as a whole. Failure to adhere can result in sub-optimal therapeutic effects, disease progression and exacerbated healthcare expenditures resulting in more adverse events. The ability to measure and consequently monitor medication adherence is therefore one of the parameters of patient care, which can facilitate improvements in health outcomes [20]. This is the reason various tools available for these measurements have been introduced, but in order to be applicable, they must be valid, reliable, and sensitive to change [21]. Bellow, characteristics of the methods often used to monitor medication adherence are given:

- Pill Counts: This approach involves manually counting the number of pills remaining in a medicine bottle to infer adherence. It is a simple method that is easily applicable in clinical practice.
- · Self-Report (Questionnaires, Interviews): Patients are instructed to describe their adherence to medication in questionnaires or interviews. This approach yields information about patient adherence behavior and attitudes toward adherence.
- Electronic Monitoring (e.g., MEMS caps): Electronic devices are used to monitor medication adherence. For example, opening a medicine bottle many times a day creates an increasingly high time resolution dataset for MEMS (Medication Event Monitoring System). Still, electronic monitoring is costly and impractical for patients who need to open their bottles to register the count, and it doesn't really measure whether the medication was actually taken.
- Pharmacy Refill Records: Adherence is measured through prescription refills at pharmacies. This technique offers objective information on medication purchasing behavior over time. This technique can be used to identify medication gaps and might hint at (non-)adherence, but it does not assess the ingestion of medication. Pharmacy refill records offer longitudinal data on refill patterns for prescriptions, a pure objective measure of adherence. However, pharmacy refill records are not relevant if one is stockpiling medicine and therefore refills a prescription without taking the drug.
- Therapeutic Drug Monitoring (TDM): Drug concentrations in plasma are kept in check to guarantee the intended therapeutic levels. Despite the main application of TDM in medication dose adjustment, TDM can also provide, through indirect means, an estimate of medication adherence.
- Smartphone Applications: Mobile applications are used for monitoring and intervening in patients' medication regimens through reminders to take medicine. These apps are capable of acquiring real-time data on adherence and providing additional support functionalities.

2. The Benefits of Adhering to Medication Therapy

There are important benefits when improving medication adherence [22]. Some of them are listed below in Figure 1.

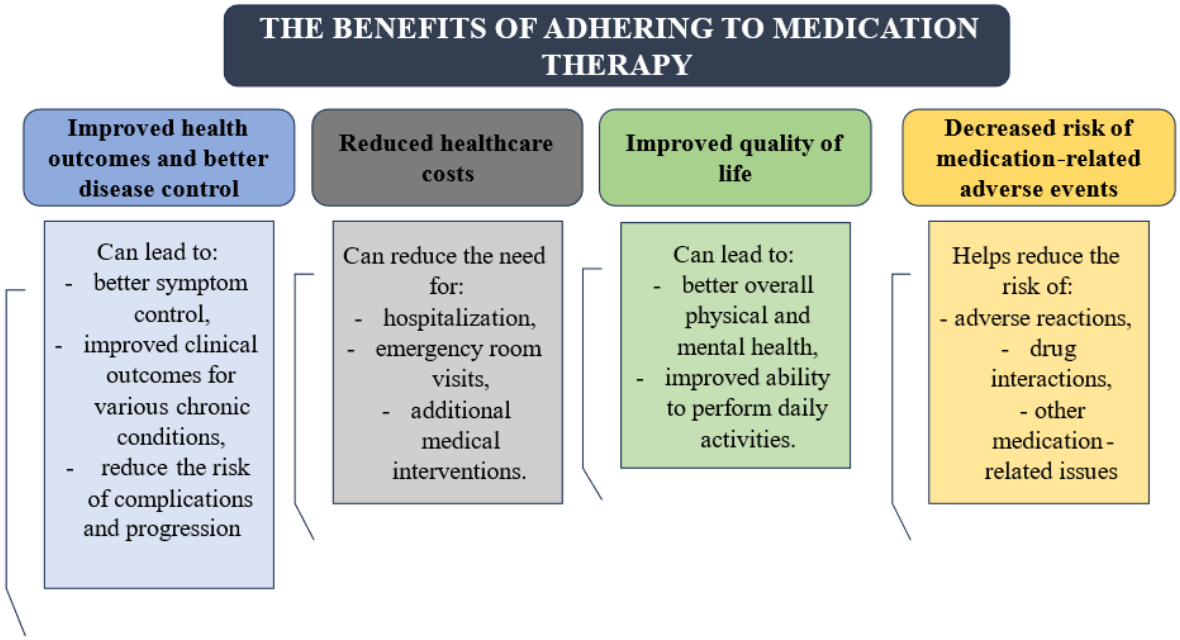

Figure 1.
Schematic representation of important benefits of adhering to medication therapy.

One of the best indicators of adherence is the patient's capacity to read and comprehend prescription instructions. Patients with low literacy levels may find it difficult to follow directions, which can result in inadequate medicine administration and decreased adherence [23]. Issues related to gender, culture, and psychology can all affect compliance rates. For instance, compared to men, women could be more meticulous in following their drug schedules. This might be particularly true for drugs that treat chronic conditions, such as antidepressants or antihypertensives [24].

However, other studies indicate that disobedience has not been consistently linked to any of the typical demographic factors, such as age, marital status, living alone, gender, race, income, employment, number of dependents, education, or personality type [25]. Patients forgetting to take their medications is one of the most common reasons for nonadherence. One study found that among the most common inadvertent reasons for non-adherence, 49.6% of patients cited forgetfulness [26].

Still, despite decades of research, there is minimal guidance available for healthcare professionals and researchers on selecting the most appropriate measures for medication adherence. Thus, the main purpose of our study is to compare different methods of observing medication adherence along with general criteria for identifying nonadherence in typical scenarios. In order to fill this gap, the review not only discusses the currently available methods to measure adherence but also the approaches to improve medication adherence and the way they may affect health outcomes. Tablet counting, electronic tracking devices, self-report measures, therapeutic drug monitoring, and some new and promising techniques are all within the scope of the study. The review provides a balanced overview of the literature addressing the strengths and weaknesses of each method and the parameters of measurement on each, which are then discussed in relation to each other in different healthcare environments. In addition, this review gives details about the benefits associated with adherence to prescribed medication regimens. A review of all evidence helps to provide a complete view of the hurdles that nonadherence presents to understanding what evidence-based solutions may address to the improvement of patient care and the efficiency of health systems.

3. Material and Methods

An electronic literature search was conducted through the PubMed / MEDLINE / Scopus database to identify items in English with the keywords "medication adherence", " medication adherence methods " AND “strategies to improve medication adherence”, “the benefits of adhering to medication therapy”. The literature search covered publications from 2007 to 2024.

Articles were selected based on the following inclusion criteria: focused primarily on medication adherence, addressing at least one relevant topic of interest, categorized as a review article, or report on studies that demonstrate good methodological quality. The research studies are classified according to the publication year, matched to the data table presented, and evaluated in terms of the methodologies used in the studies' conclusions.

4 Results

Referring to Table 1 provides an overview of methods for measuring adherence, including each study's assessment methods, advantages, disadvantages, and the parameters measured.

Table 1.
Overview of methods for measuring adherence

No.	Method of Assessment	Advantages	Disadvantages	Reference
1.	Electronic medication packaging (EMP) devices, pill count, medication adherence questionnaire (MAQ)	Identify partial adherence, can be used in various formulations, quickest to administer	Expensive Technical supports required, unable to identify medication taking pattern, mainly suitable for initial screening	Lam and Fresco [19]
2.	Therapeutic drug monitoring, questionnaires and structured interviews	A direct objective measure of medication adherence, easy applicability in clinical practice and low cost	Invasive method of sampling, recall and response bias	Al-Hassany, et al. [20]
3.	Pill counts, electronic databases, self-reported questionnaires, electronic monitoring systems	Simple, mostly used in clinical trials, easy to use, inexpensive, non-invasive, patients not aware that they are being monitored, one of the most accurate methods	Evidence of the drug being dispensed but not ingested, overestimated adherence, subjective, influenced by recall or reporting bias, the patient is aware of the evaluation	Anghel, et al. [27]
4.	Therapeutic drug monitoring, pill counts, instruments, interviews, devices, diaries	Measurable and objective, a researcher can accurately confirm patient took medication, the timing of doses can be recorded, and real-time data collection	Time and labor-consuming, not ideal for long-term studies, costly, reporting bias, performance bias	Shah, et al. [28]
5.	Self-reporting by the patient (interview, diary, questionnaire), electronic medication monitors	Simple and easy to use; noninvasive; readily available; inexpensive, objective, quantifiable and easy to perform, precise; results are easily quantified	Poorly integrates with the elderly no evidence that the drug is ingested, time-consuming	De las Cuevas and De Leon [29]
6.	Pill count (TDM) diaries and structured questionnaires	Low-cost and simple objective counting of dosage units Calculating adherence ratio detects/prevents drug toxicity, cost-effective	Does not directly measure adherence, underestimates adherence when patients refill before running out	Schnorrerova, et al. [30]
7.	Self-efficacy for appropriate medication uses scale (SEAMS), medication adherence rating scale (MARS), adherence questionnaire (PIAQ)	It can identify barriers, belief screen, and the recall screen	It is limited in generalizability, patients are required to list their medication regimen, difficult to score	Nassar, et al. [31]
8.	Brief medication questionnaire, medication diaries, pill counts, patient interviews	Non-invasive method, simple and easy to use	Overestimation, reporting bias	Basu, et al. [32]
9.	Direct observation, self-report, and electronic monitoring	Gold standard, inexpensive, objective data	Time- and resources-consuming, Overestimation of true compliance	Labeau [33]
10.	Self-report measures, pill count	Evaluates adherence based on patients, low cost and a simple method	Patients tend to overestimate their level of adherence; not generate a medication-taking pattern	Rusu, et al. [34]
11.	Patient interviews, questionnaires, pill counting, and therapeutic drug monitoring	Easy, inexpensive, cost-effective, high sensitivity	Overestimation of adherence, single-point evaluation of adherence	Sharma, et al. [35]
12.	Medication adherence questionnaire, self-efficacy for appropriate medication use	Identifies barriers to adherence and is an easy-to-administer, reliable and valid instrument	Does not assess patient self-efficacy, no sensitivity and specificity reported against objective criteria	Tesfaye and Peterson [36]
13.	Patient Self-Report Technology, Electronic Pill Boxes and Bags	May improve patient adherence patterns, easy to use	Costs, expensive	Mason, et al. [37]

14.	Medication Adherence Questionnaire; pill counts, electronic diaries	Cost-effectiveness, Inexpensive, Ease of use (according to patient experience)	Recall and response bias, technical limitations	Gackowski, et al. [38]
15.	Smartphone medication adherence apps: potential benefits to patients and providers.	Online data entry, database of medications, sync/export/print data, tracks missed and taken doses, free-only apps.	Variable feature availability, Cost and subscription fees, Lack of personalized support.	Dayer, et al. [39]

4.1. Methods of Assessment Medication Adherence

In relation to the acquired data presented in Table 1, the offered methods focus more on the respective content areas as presented in various studies and research attempts, along with the measures of medication adherence.

4.1.1. Pill Counts and Electronic Databases

A study by the authors Anghel et al. [27] contends that these methods are uncomplicated, straightforward, and cost-effective, and they are largely employed in clinical trials [27]. They are passive and during such times patients do not know that they are being observed, hence making these techniques one of the best possible methods available [27]. This research examined four distinct instruments such as pill counts, electronic databases, self-reported questionnaires, and electronic monitoring systems, emphasizing their advantages and disadvantages. The methodology involving the counting of pills is methodical. However, although this formula showed the number of drugs dispensed, it did not establish adherence, thus overestimation was the result. Likewise, electronic databases are limited, as they depend on dispensing records, which are not an actual representative tool for adherence. The self-reported questionnaires bring the patients' points of view, which no other method can, into the discussion, contributing valuable insights into the barriers to adherence. Still, it is due to their dubious accuracy that they are more inclined to recall and report biases. Lastly, electronic monitoring systems were lauded as one of the most accurate tools in cases where subjects are unaware of being monitored, but the systems are not yet capable of verifying actual drug use.

Still, describing this method of pill count, other authors in their study referred to this technique as practical, which can be measured, and can be evidenced as supportive to the researchers as they confirm a patient's drug intake event. However, they argue that counting pills is very time and labor-intensive and therefore becomes less preferable in long-term studies [28].

4.1.2. Self-Reported Questionnaires and Interviews

According to one study from 2020, self-report methods are simple, easy to use, noninvasive, readily available, and inexpensive [29]. In a recent study from 2024, authors emphasize the structured diaries and questionnaire approaches. They claim that these methods are low-cost and easy to implement [30].

According to several studies, these self-reported techniques do have certain drawbacks, such as recall or reporting bias. There is a limit to the use of these procedures in certain situations since the patient is aware that evaluation can influence responses. Self-reporting methods may be vulnerable to recall or reporting bias because they are subjective. Responses may be compromised since the patient is aware of the evaluation [27].

There are other articles that describe other questionnaires e.g., the Self-Efficacy for Appropriate Medication Uses Scale (SEAMS) and the Medication Adherence Rating Scale (MARS). They also state that although these devices may aid the detection of barriers and beliefs, their generalizability is low and scoring is difficult [40].

4.1.3. Electronic Monitoring Systems

There are some studies, for example study of Lam and Fresco [19], where electronic medication packaging (EMP) devices are criticized [19]. One of the key findings is that these devices are able to measure partial adherence and are suitable for any medication form. Nonetheless, they also claim that these systems are high-priced and need technological help.

Mason et al. [37] in their study from 2022, describe e-pill boxes more closely. They argue that these instruments can cultivate patients' compliance with health habits and are easy to operate. Even so, their cost is still a huge drawback to their wide implementation [37].

4.1.4. Therapeutic Drug Monitoring

Biomarker monitoring and therapeutic drug monitoring (TDM) offer direct measures of medication ingestion or drug concentration levels in biological samples. TDM is the process of measuring the concentration of drugs in the blood, while biomarker monitoring consists of measuring the amount of sample metabolite recovered in blood or urine. This allows for objective confirmation of ingestion and is used to make individualized doses after considering the metabolism of a specific patient. Biomarker monitoring requires special instruments and is not possible to be done for all medications, and TDM requires proper timing and methods to collect and analyze the sample.

Authors Shah et al. [28] in their research work from 2023, have found that TDM is the only one that can be measured, and this is the most accurate method for researchers to figure out the validity of the patient's claim that they took the prescribed pills. Different approaches such as therapeutic drug monitoring (TDM), pill counts, and interviews were integrated. TDM was the method that kept its objectivity in the determination of ingestion and was able to completely rectify the disadvantages of the dispensing-dependent methods of pill counts. Despite these advantages, the cost and the fact that it is invasive make it

less convenient for application in large-scale or long-term studies. The authors also mentioned in their study devices like electronic medication packaging (EMP) that may implement real-time monitoring of the taking of doses and data collection [28].

One study emphasized that therapeutic drug monitoring (TDM) serves as an objective indicator of medication adherence. TDM has been successful since it is easily applicable in the clinical setting, and it is also relatively low in cost compared to other methodologies. Also, the authors noted that TDM requires blood or other samples, which may be a challenge for some patients, especially children, when participating in clinical trials [20].

Other authors in their work stated that although TDM is very sensitive, it provides only a single-point measurement of drug adherence, thus making it difficult to assess the results for the patient's adherence to the treatment over an extended period of time [35].

4.1.5. Direct Observation and Medication Diaries

A study by Labeau [33] points out that direct observation is a method that is used by healthcare professionals as a gold standard, which supplies objective data, but it is time-consuming and demanding of resources [33]. Other authors in their work emphasize medication diaries by shedding light on their use in the assessment of medication adherence in low-resource settings. They point out that the diaries are noninvasive, and so they are quite simple and easy to use. Nevertheless, they also allude to the fact that there is a risk of over-reporting when using this method behaviorally, or due to bias [32].

The use of electronic diaries is also discussed in the study of Gackowski et al. [38]. They refer to this method as cheap and user-friendly from the patient's perspective. And yet, they also state that some technology might not work as intended and that, overall, the problem of remembering and replying to the survey remains a pressing one. Still, they identify electronic diaries as promising in measuring drug adherence. Despite the reduced cost and ease of use, the tools are still inaccurate because of technical limitations and due to memory and response bias. The set of things that will cover the future of medication adherence measurement is likely to include multi-methods and technologies. Indeed, this research review has indicated that each system is good in a specific scenario, and in some instances, the system has shortcomings. By being different, the approaches used by researchers and health officers might end up having an overall view of the medication adherence process and accurate data [38].

5. Discussions

This comprehensive analysis of medication adherence measurement techniques accentuates the fact that this area is indeed complex, and the accurate assessment of patient compliance is full of hurdles and challenges. Many studies examined these methods, each analyzing their advantages and limitations [27-29].

Although conventional methods such as pill counting and filling out questionnaires bring objectivity and cost savings, they tend to be inaccurately inflated and biased. The most advanced systems, such as electronic monitoring systems and therapeutic drug monitoring, provide the highest degree of accuracy, but they require high costs and critical procedures as well.

The selected papers, entitled by different authors, present the current endeavor in the development and validation of new tools and technologies for measuring adherence. The innovations are geared to address the drawbacks of the current methods while at the same time, they utilize the merits of digital technology and real-time data collection [19, 31, 38].

One of the data inclusion strategies is the use of interviews and diaries to help gather qualitative information that TDM cannot, such as the causes of non-adherence or the challenges patients face daily [41]. Nevertheless, these methods are laborious ones for the subjects and might be distorted by the individual's views under self-reported diaries.

In a very recent study from 2024, two reported measurements, pill counts and TDM, were used as adherence tools. Even though pill counts are inexpensive and easy to use, they underestimate adherence when patients refill medications either prematurely or do not disclose their actual usage. TDM was noted as a method for collecting objective data about the prevention of toxicity. Nevertheless, its invasiveness (for example, blood sampling) and cost are its two main drawbacks, such that it is not often used during usual clinical practice. The authors also stated that the questionnaire was quicker to use in data collection, making it a more efficient solution, but one limitation in terms of confirming drug intake was identified by them [30].

Electronic medication packaging (EMP) is a contemporary instrument for measuring medication adherence. This device is capable of recording shortcomings in people's preferred actions and thus can achieve the goal of ensuring that all medications are taken by counting the number. Nevertheless, these devices that utilize advanced technology can also be challenging because they are expensive and require technical support. The inclusion of Medication Adherence Questionnaires (MAQ) provides a more accurate basis that is very reliable as a primary screening technique. Even though they are known for the speedy administration of medication adherence tools, the MAQ and similar instruments are still limited in determining the precise adherence patterns that are most relevant in cases of chronic diseases [19].

In a study by Nassar et al. [31], several self-reported tools were included as the Self-Efficacy for Appropriate Medication Uses Scale (SEAMS), Medication Adherence Rating Scale (MARS), and the Personalized Intervention Adherence Questionnaire (PIAQ). These tools are popular for detecting patient attitudes and barriers toward adherence and can provide some additional clinical information that clinical methods do not capture.

In a study by Basu et al. [32], brief medication questionnaires (BMQ), medication diaries, pill counts, and patient interviews are reviewed. Due to their simplicity and low resource requirements, these techniques work effectively in areas with little financial or infrastructure resources. But there are disadvantages to each of them as well. Medication diaries may not be a valid measure due to underreporting and selective reporting, for example, if patients forget to note down that they took the medications or feel coerced to portray improved adherence. Authors in their work emphasize medication diaries by shedding light on their use in the assessment of medication adherence in low-resource settings. They point out that the diaries are noninvasive, and so they are quite simple and easy to use. Nevertheless, they also allude to the fact that there is a risk of over-reporting when using this method behaviorally or due to bias. Pill counts may be one of the easier methodologies, but they can be biased when patients tend to refill the medications before they run out or just provide an inaccurate count. They are qualitative and can be easily subjected to interviewer bias, eliciting socially desirable responses [32].

Therefore, utilizing therapeutic drug monitoring (TDM), questionnaires, and structured interviews, we were able to evaluate the usefulness of self-report measures with TDM data in an evaluation of medication adherence in children with chronic illnesses, as Al-Hassany et al. [20] reported in their study from 2019. TDM provides a direct objective measure of adherence; it is hard data on whether the medicine is in the bloodstream. However, the invasive nature of blood sampling can be particularly challenging in pediatric populations, making it less feasible for routine adherence assessments. The study also examined more practical methods, such as questionnaires and structured interviews, which are less invasive and easier to implement in children and their caregivers. However, these tools rely on patient recall and honesty, leading to potential biases in reporting. Additionally, children and parents might misunderstand the questions or underreport non-adherence out of concern for judgment [20].

The article from 2023 discusses techniques that are frequently used in clinical practice to evaluate adherence, such as pill counts and self-report measures. These methods are cost-effective and easy to implement, making them attractive options for routine evaluations. Nonetheless, self-reports are highly subjective and can lead to an overestimation of adherence. This occurs because patients often forget or feel pressured. They may report good adherence behaviors to avoid criticism. Pill counts provide more objective measures. However, they are also open to misrepresentation. This occurs if patients refill medications early. The problem also arises if they do not reveal the exact number of pills taken. Additionally, pill counts do not consider complicated medication regimens, and the timing of doses is not taken into account [34].

There is also a study concerns adherence assessment methods for antihypertensive drugs that are key to managing chronic conditions like hypertension [35]. Pill counts and questionnaires used for patient interviews were included in this study. The use of Therapeutic Drug Use Monitoring (TDM) is a useful for monitoring drug absorption and aiding in treatment optimization. This gives a direct indication of how effectively a drug is being absorbed in the body, thus ensuring that the drug will stay inside the optimum therapeutic range and would not cause toxicity. Traditional measures of adherence such as pill counts are limited. For example, patients who refill their medications before the appropriate time might appear to be adherent, which could result in inaccuracies in evaluating their use of medication [35].

A review was conducted on the usage of patient self-report technology. With a focus on smart medication bags and electronic pillboxes, the study assesses patient self-report technologies for medication adherence. The results show that these tools facilitate real-time tracking and monitoring of adherence, which may lead to improved patient compliance [37].

Technical support is required for the implementation of adherence measurement strategies. It highlighted the benefits gained from enhancing the measurement of medication adherence via multiple assessment methods. It describes how adding medication adherence questionnaires, pill counts, and electronic diaries improves monitoring by offering an affordable, convenient, and simple approach to enhance its day-to-day routine [38].

There are different methods for assessing medication adherence, so detailed evaluation is needed to ultimately set the stage towards determining an appropriate approach that would provide reliable measurement and follow-up for the monitoring of patient adherence to prescribed treatment regimens. Evaluating medication adherence is a crucial step in implementing interventions to enhance adherence [42]. Clinicians may sometimes find it challenging to identify patients who are not adhering to their treatment plans.

There is no "gold" standard for assessing medication adherence, despite the fact that the literature contains a wide variety of indirect measures of adherence [43].

Perhaps the most commonly used method for assessing medication adherence is a modality called the pill count, whereby healthcare providers manually count the number of pills remaining in a patient’s pill organizer or bottle. It is simple, inexpensive, and does not require special training or equipment. It also provides a direct indication of medication use.

A second way methods for assessing medication adherence is self-report, which uses questionnaires or interviews where patients report their medication-taking behavior, and they are a practical method for assessing a patient's adherence to medication that can be used routinely [44].

Self-report methods are convenient to implement and give interesting data on patient behavior. Although there is recall bias (e.g. patients overestimate adherence or give socially desirable answers which can result in an incorrect estimate of medication adherence) these are the most reliable methods [45].

Using of electronic monitoring, e.g. MEMS caps, to measure medication adherence, allows for precisely recording bottle openings using objective rather than clinical methodology. It enables to differentiation between the type and the amount of non-adherence and gives more information for follow-up [46].

Finally, smartphone applications are an easy and accessible tool to track adherence by providing reminders and motivational support to the patients [47]. For example, these patients facing apps can gather real-world data around the timing and adherence of medications in real time, down to the pill, and helps the patient stay involved and accountable. But their

effectiveness is dependent on patients' access to and familiarity with technology, and they may not represent true adherence if patients dismiss reminders or forget to use the applications regularly [39].

Healthcare systems will need to provide educational materials, support groups, and technology for patients to be better able to administer medications. That will propel us towards building a health system that sees compliance as not a roadblock but a critical cornerstone of full-spectrum and patient-centered care to improve patient outcomes and quality of life on a large scale, addressing the differences between health systems. All drug adherence approaches are not the complete picture, and there are trade-offs. How you use a measure in clinical or research settings should depend on the cost, ease of use, precision, and patient needs. Adding several different approaches or leveraging technologies could provide a better whole-person measure of medication adherence and patient outcomes in clinical practice.

6. Conclusions

Based on the reviewed literature, it may be concluded that medication adherence can have a tremendous impact on quality and length of life, health outcomes, and overall healthcare costs. Engaging patients and the healthcare team is essential for success in achieving medication adherence and persistence. Ultimately, pharmacists' efforts to improve adherence can positively impact patient care and generate substantial clinical and financial rewards.

Finally, medication adherence is a very important matter in the health care sector that greatly impacts the outcomes and planning of the entire treatment. Medication adherence assessment is multi-dimensional, examining not only a patient's behavior but also the intricate web of socioeconomic, ethnic, and psychosocial determinants. HCPs, patients, and support networks suggest that strategies to improve adherence should be implemented after a collaborative effort. Successful implementation requires individualized interventions, the use of emerging technologies, and transparency in provider-patient communication.

The benefits of better medication adherence extend beyond merely following a drug regimen; it also leads to improved therapeutic effects, decreased healthcare costs, and overall health benefits for the patients. Having said that, it's important to keep in mind that medication adherence is a continuous process that needs to be monitored and addressed accordingly. More research and innovation are required to refine and validate innovative measures and strategies for effective adherence to medications.

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