The impact of technology on medication adherence

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ABSTRACT
Medication nonadherence is a large contributor to inadequate therapeutic outcomes, especially among patients with mental illness and carries a high cost. Intervention strategies to increase adherence have incorporated technological advances, including electronic symptom monitoring and communication systems for patients and providers. This article presents a review of several studies demonstrating how technology may affect medication adherence.

KEYWORDS
Technology, medication adherence, review

Adherence is defined as the extent to which a patient follows prescribed health care instructions. Many studies define adherence to a medication as taking 75% to 85% of the prescribed doses. Medication nonadherence is a large contributor to inadequate therapeutic outcomes. The cost of medication nonadherence has been estimated to be $100 billion annually in the United States and one-third to two-thirds of all hospitalizations are attributed to medication nonadherence.

Nonadherence is highly prevalent among patients with mental illness. Among patients with major depressive disorder, 42% discontinue medications within the first 30 days of initial prescribing and 72% discontinue medications within the first 90 days of treatment. Additionally, 40% of patients with bipolar disorder are nonadherent at any given time. Nonadherence is associated with higher relapse rates, hospitalization, and increased health care costs. Among patients with schizophrenia, nonadherence with antipsychotic medications was estimated to be as high as 55% and is associated with psychosis, increased clinic and emergency room visits, and rehospitalization. Not only does nonadherence exacerbate symptoms of psychiatric conditions, but nonadherence to psychotropic medications may increase nonadherence to other prescribed medications.

The reasons for nonadherence are multifactorial. Some patients choose not to take medications as prescribed and other patients forget to take medications. Adherence for a patient may vary depending on the medication or be consistent across all medications prescribed. Patient-related risk factors associated with medication nonadherence include: younger age, male gender, lower education level, and comorbid substance use. Additionally, poor insight into the disease and a negative attitude towards medications may decrease adherence.

Intervention strategies to increase adherence are highly varied and include psychoeducational interventions, cognitive-behavioral therapy, motivational interviewing, and technology. This article presents a review of several studies demonstrating how technology may affect medication adherence.

“Improvehealth.eu” utilizes the internet as an information and communication technology system (ICT system) to increase collaborative patient care and patient engagement in their care. A study by Meglic, et al., used the ICT system to determine whether the eHealth system improves adherence to medications and improves outcomes of depression treatment. Patients with a new diagnosis of depression, mixed anxiety and depression disorder, or a diagnosis of either disorder after a previous remission of at least 6 months were included in the study. Study patients had a Beck-Depression Inventory-II (BDI-II) score greater than 13, indicating mild, moderate, or severe depression. The intervention group utilized the ICT system to determine whether the eHealth system improves adherence to medications and improves outcomes of depression treatment. Patients with a new diagnosis of depression, mixed anxiety and depression disorder, or a diagnosis of either disorder after a previous remission of at least 6 months were included in the study. Study patients had a Beck-Depression Inventory-II (BDI-II) score greater than 13, indicating mild, moderate, or severe depression. The intervention group utilized the ICT system to determine whether the eHealth system improves adherence to medications and improves outcomes of depression treatment. Patients with a new diagnosis of depression, mixed anxiety and depression disorder, or a diagnosis of either disorder after a previous remission of at least 6 months were included in the study. Study patients had a Beck-Depression Inventory-II (BDI-II) score greater than 13, indicating mild, moderate, or severe depression. The intervention group utilized the ICT system to determine whether the eHealth system improves adherence to medications and improves outcomes of depression treatment. Patients with a new diagnosis of depression, mixed anxiety and depression disorder, or a diagnosis of either disorder after a previous remission of at least 6 months were included in the study. Study patients had a Beck-Depression Inventory-II (BDI-II) score greater than 13, indicating mild, moderate, or severe depression. The intervention group utilized the ICT system to determine whether the eHealth system improves adherence to medications and improves outcomes of depression treatment.
side effects, suicidal ideation, and medication nonadherence. The ICT system then allowed for quick response to these patient issues by care managers.

The primary outcomes were adherence to medication therapy and improvement in BDI-II scores from baseline to 24 weeks. Adherence was measured at 24 weeks with a self-assessment questionnaire, where patients were considered to be adherent if they met two of the three following criteria: regular administration of medication over the defined treatment period, taking the medication at the same time of day, and regular use of the correct dose of medication. A clinically significant improvement in BDI-II score was defined as an improvement of eight points or a score less than 14 at 24 weeks.

Adherence to antidepressant medications was significantly higher in the intervention group than the control group (83% [10/12] versus 33% [3/9] respectively, p=0.03). The intervention group and the control group had significant improvement in BDI-II scores at week 24 compared to baseline (intervention group: paired \( t_9=7.23, p<0.01, \) Cohen’s \( d=2.57 \); control group: paired \( t_{11}=3.95, p=0.003, \) Cohen’s \( d=1.23 \)). Some limitations of the study include the lack of randomization, self-assessment of adherence, and a high number of dropouts. Nine patients in the intervention group dropped out due to clinical improvement or dissatisfaction with the intervention (1 patient) and 15 patients in the control group dropped out of the study (reasons for dropout were not discussed). The authors concluded that the eHealth ICT system has a positive effect on medication adherence and outcome measures in depression treatment.

Nonadherence to inhaled corticosteroids (ICS) is common among patients with asthma and results in treatment failure, hospitalization, and death. A randomized trial by Vollmer et al., was completed to determine whether health information technology (HIT) improves adherence with inhaled corticosteroids. The HIT utilized interactive voice recognition (IVR) technology, which provided telephone calls to patients consisting of three types: a refill reminder call, a tardy refill call, and an initiator/restart call. The refill reminder call was for patients who last filled an ICS greater than 1 month ago with less than 1 month of medication remaining. The tardy refill call was for those patients who were at least 1 month late in refilling an ICS; the call reminded patients to refill their medication and assessed asthma control, adherence barriers, and provided educational messages. Patients who were determined to have poor asthma control and who did not choose to refill their ICS prescription had the option to talk to a pharmacist. The initiating/restart call was for patients who were newly starting ICS or restarting therapy (no ICS use in the previous 6 months) and assessed asthma control, adherence barriers, and provided educational messages.

A total of 8,517 patients with asthma (6,905 current users and 1,612 new users of ICS) were included in the study and randomized to receive usual care or HIT utilizing IVR technology. Baseline adherence was 42%, 34% of patients were male, and the mean age was 54 years. The primary outcome was change in adherence from baseline to 18 months as calculated by a modified medication possession ratio (mMPR, the days supply of medication dispensed during a time period divided by the time between the first dispensing in the time period and the end of the window). The study found a statistically significant improvement in adherence among the IVR technology group compared to the control group (change in mMPR=0.02, 95% confidence interval 0.01-0.03). The authors concluded that the use of IVR modestly improves adherence among users of ICS. Some limitations of the study include that the caller was only able to leave a detailed message or speak to the patient in 54% of the IVR calls and that the study utilized pharmacy dispensing records to measure adherence.

A randomized, controlled trial by Boker, et al., was completed in patients with acne to determine whether daily text messages improved adherence to acne medications. Forty patients were instructed to apply clindamycin/benzoyl peroxide 1%/5% gel every morning and adapalene 0.3% gel every evening. The medication tubes were fitted with an electronic Medication Event Monitoring System (MEMS), which recorded the date and time the medication tubes were opened. Patients were not aware that the MEMS caps were used. The twenty patients in the intervention group received text messages twice daily with instructions to apply medication. The control group did not receive text messages.

The primary outcome was adherence at 12 weeks as measured by the correct number of MEMS openings divided by the expected number of MEMS openings. Fifteen patients in the control group and 18 patients in the intervention group completed the study. Sixty percent of participants were female and the mean age was 22.6 years. There was no statistically significant improvement in adherence rates between the intervention group and the control group (33.9% versus 36.5% respectively, p=0.5). Limitations of the study include the small sample size, a power calculation was not reported, and the MEMS caps recorded opening of the tube, which may not reflect actual medication use.
A randomized, controlled study by Hou, et al., was conducted to determine the effect of the use of text messages on adherence to oral contraceptives. A total of 103 females were prescribed daily oral contraceptives to be used cyclically (21 or 24 active pills of ethinyl estradiol 35 mcg or less with progestin and 7 or 4 inactive pills respectively). Eighty-three patients returned after the initial 4-week follow-up and were enrolled in the study. The median age of patients was 22 years. Adherence was monitored using an electronic monitoring device, SIMPill, which required the oral contraceptive pack to be inserted into the device. Upon opening the device, the device sent a message wirelessly which recorded the date and time. Women were instructed that the device would monitor their pill usage during the study. Patients were also instructed to complete a diary of their pill use, which was used to help determine when the electronic monitoring device was malfunctioning. The first 21 days of each cycle were used in data analysis. Thirty-six and 37 patients completed the study in the text messaging group and control group respectively.

The primary outcome was adherence after three months. The study found no significant difference in adherence rates between the two groups (4.9 missed pills per month for the text messaging group and 4.6 missed pills per month for the control group, p=0.6). The study was adequately powered; in order to reach a power of 90%, a sample size of at least 68 patients was required to detect an improvement in adherence of 1.6 pills per month. Limitations of the study include significantly higher rate of use of alternative reminder systems (such as cell phone alarms) in the control group compared to the intervention group (68% versus 36% respectively, p=0.003). Additionally, since the device measures the opening of the device, patients could open the device and not take their pill, which would cause an overestimate of adherence. Despite these limitations, the study suggests that among users of oral contraceptives, daily text message reminders do not increase adherence.

There is limited evidence for or against the use of technology to improve adherence among patients with psychiatric illness. Only one study has evaluated the use of technology to improve medication adherence among patients with depression, which demonstrated that an information and communication technology system may improve adherence. However, the use of technology to improve medication adherence has been evaluated in other disease states. Among patients with asthma, an interactive voice technology system may improve adherence with inhalers and reminder text messages may not improve adherence among users of acne medications and oral contraceptives. Barriers to medication adherence vary across disease states, which may limit the generalizability of studies evaluating medication adherence in other disease states to mental health conditions.

Measuring adherence in clinical studies is limited by a number of factors. The criteria for the definition of adherence varies between studies. Additionally, the research methods used to measure adherence vary from self-report, caregiver report, physician estimates, pill counts, pharmacy refill records, blood levels, and MEMS.

The effectiveness of medications depends largely on a patient’s medication adherence. Adherence is particularly important among patients with mental illness as nonadherence leads to poor therapeutic outcomes and increased health care costs. The utilization of technology may provide avenues to increase adherence among patients with various medical conditions, including mental illness.

REFERENCES