Published in final edited form as:

J Gerontol Nurs. 2009 October ; 35(10): 17–21. doi:10.3928/00989134-20090903-06.

Medication Adherence and Older Renal Transplant Patients' Perceptions of Electronic Medication Monitoring

Cynthia L. Russell, PhD, RN, Sarah Owens, MSSW, LMSW, Karen Q. Hamburger, MSSW, LMSW, Denise A. Thompson, PhD, Rebecca R. Leach, MSPH, RN, Muammer Cetingok, PhD, Donna Hathaway, PhD, FAAN, Vicki S. Conn, PhD, RN, FAAN, Catherine Ashbaugh, RN, ACNS-BC, CCTC, Leanne Peace, MSW, LCSW, MHA, Richard Madsen, PhD, Rebecca P. Winsett, PhD, RN, and Mark R. Wakefield, MD

Dr. Russell is Associate Professor, and Dr. Conn is Associate Dean of Research and Potter Brinton Professor, Sinclair School of Nursing, and Dr. Madsen is Emeritus Professor of Statistics, University of Missouri; Ms. Ashbaugh is Advanced Practice Nurse and Certified Clinical Transplant Coordinator, Transplant Department, and Dr. Wakefield is Director, University of Missouri Renal Transplant Program, University of Missouri Health Care; and Ms. Peace is Director, Missouri Kidney Program, Columbia, Missouri. Ms. Owens and Ms. Hamburger are Medical Social Workers, Methodist University Hospital Transplant Institute; Dr. Cetingok is Professor, University of Tennessee, Knoxville, and College of Social Work, Memphis Campus; Dr. Hathaway is Dean and Ruth Neil Murry Endowed Chair in Nursing, and Dr. Winsett is Associate Professor, Retired, University of Tennessee Health Science Center, College of Nursing, Memphis, Tennessee. At the time this article was written, Ms. Leach was a BSN student, Sinclair School of Nursing, University of Missouri, and Dr. Thompson was Research Consultant, University of Missouri, Columbia, Missouri, and Research Leader, University of Tennessee Health Science Center, Memphis, Tennessee

Abstract

This study evaluated older renal transplant recipients' perceptions of electronic medication monitoring and the influence of these perceptions on medication adherence. A sample of 73 older adult renal transplant recipients who used the Medication Event Monitoring System (MEMS®) TrackCaps for 12 months provided their perceptions of device use. Participants perceived that the MEMS had a neutral effect on their medication-taking routine (65%), believed the MEMS was practical (56%), and could not describe any instances in which using the MEMS was difficult (56%). No significant difference in medication adherence was found between those who perceived the MEMS's influence negatively/neutrally and those who perceived the MEMS positively ($p = 0.22$). Medication adherence data from older adult renal transplant recipients can be used regardless of their perceptions of the MEMS's influence on their medication taking without biasing medication adherence data.

Renal disease with resulting transplantation is increasing in older adults. For individuals age 65 and older, the percentage of renal transplants has increased from approximately 7% in 1999 to nearly 16% in the first 5 months of 2009 (Organ Procurement and Transplantation Network, 2009). Older renal transplant (RT) patients are faced with the same challenges as other transplant patients, including multiple chronic illnesses and complex, long-term, and

© 2009 Aardex Ltd.

Address correspondence to Cynthia L. Russell, PhD, RN, Associate Professor, Sinclair School of Nursing, University of Missouri, S423, Columbia, MO 65211; RussellC@missouri.edu.

The authors disclose that they have no significant financial interests in any product or class of products discussed directly or indirectly in this activity.

expensive medication regimens; however, additional issues such as social isolation; changes in vision, memory, and manual dexterity; and other physical limitations may increase the burden of therapy (McGraw & Drennan, 2001).

Adherence to immunosuppressive medications for RT patients is integral in ensuring kidney survival and positive post-transplant health outcomes. Poor medication adherence may lead to rejection, graft loss, return to dialysis, and in extreme cases, death (De Geest et al., 1995; Nevins, Kruse, Skeans, & Thomas, 2001). Medication adherence can be monitored directly through blood or urine drug assays, use of drug markers with the target medication, and observation of the patient ingesting the medication, or indirectly through patient self-report, medication measurement (i.e., pill count), electronic monitoring device use, and prescription record and claim reviews (Farmer, 1999). Patient self-report is inadequate because patients tend to tell health care providers what they think the provider wants to hear (Cramer, 1995). Pill counts and rates do not address use but simply count the number of pills returned by the patient or track the frequency of refills at a pharmacy (Cramer, 1995); they do not account for pill dumping or long periods of poor medication adherence.

Monitoring poor medication adherence is a challenge for clinicians; monitoring a patient every time the medication dosage is due is impractical. An alternative is the use of electronic monitoring devices (EMDs), which have been described as the gold standard in monitoring medication adherence (Cramer, 1995). EMDs are highly regarded in the literature because of the reliable and valid data they provide and the ability of those data to show medication adherence patterns, which can identify whether the patient is on time, early, late, or missing daily medication. These data reports show promise as an intervention tool as well (De Geest, Denhaerynck, Schäfer-Keller, Bock, & Steiger, 2007).

The most widely used EMD is the Medication Event Monitoring System (MEMS®) cap (AARDEX® Ltd., Geneva, Switzerland), which has been used to measure medication adherence in more than 300 published studies (Riekert & Rand, 2002). The MEMS is a medication container fitted with a cap that contains a microprocessor that records the date and time the cap is opened. The MEMS cap records each opening of the cap as a presumptive dosage. The cap is then inserted into a computer downloading device, which retrieves data that are displayed on a computer screen and provide clinicians with medication adherence behavior, including dosage frequency, time, interval, and timing. The MEMS medAmigo program, which also includes a Web-based dosing behavior analysis and intervention tool, is also available to help patients manage their medications.

Although many studies have used the MEMS cap, very little information in the literature relates to how patients perceive the EMDs and how this technology affects medication adherence. A recent 12-month study examined patients' perceptions and acceptance of EMDs and the affect on medication adherence in 138 community-dwelling African American individuals with hypertension (Schoenthaler & Ogedegbe, 2008). Seventy percent liked using the MEMS, 59% stated that the MEMS helped them remember to take their medications, 93% reported that the MEMS was easy to open, 85% did not find it stressful, and 75% used the MEMS every day. Significantly better medication adherence was found in those who used the MEMS every day, were comfortable using the MEMS in front of others, and remembered to refill the MEMS ($p \leq 0.05$).

The purpose of this study was to understand RT patients' perceptions of using the MEMS cap, including its impact on their medication-taking routines, its practicality, and difficulty with MEMS use. We also sought to examine the patients' perceptions of the device on their medication adherence.

METHOD

This study, which is part of a larger descriptive study to examine the patterns, predictors, and outcomes of medication adherence, included a convenience sample of 85 adult RT recipients who were at least age 55 from two U.S. transplant centers and who were currently self-administering at least one immunosuppressive medication prescribed for every 12 hours dosing, who could speak and understand English, and who were cognitively intact as evidenced by a score of 24 or higher on the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). Twelve participants were excluded from the analysis because they did not complete MEMS Use Surveys. Their medication adherence scores did not differ significantly from those who did complete the survey ($p = 0.22$).

The MEMS 6 TrackCap (see **Photo** on page 17) was used to measure medication adherence. A cumulative record of cap openings was compiled, beginning the day after the patient was instructed on use of the cap. Since cap openings occasionally occur without drug ingestion, the MEMS diary was used. Participants documented the date, time, and circumstances under which the MEMS cap was opened and a medication was not administered. The MEMS cap data were corrected using the MEMS diary data to increase data validity. Each cap removal was presumed to represent ingesting one dosage of the prescribed immunosuppressant agent.

Participants were asked to provide short answers to MEMS Use Survey questions, which included:

- Do you think the MEMS cap had a negative, neutral, or positive effect on your medication-taking routine?
- How practical do you think using the MEMS on a daily basis was for you?
- Were there any instances when you thought using the MEMS as directed was difficult?

Institutional Review Board approval was obtained. Research assistants obtained informed consent from all participants. The participants were asked to use the MEMS cap for 12 months for one immunosuppressive medication, after which the MEMS cap was collected and the MEMS Use Survey administered by the research assistants. Those participants who used a pillbox were given the option to place a small, colored, low-calorie candy marker in the pillbox chamber, reminding them of the need to remove the immunosuppressive medication from the MEMS.

A medication adherence score, described in detail elsewhere (Russell et al., 2006), was calculated for each participant. A brief explanation follows. Each morning and evening, an individual received a score of 0.5 if an immunosuppressive medication dosage was taken within a 3-hour window, 0.25 if the medication dosage was not taken within the 3-hour window but was taken within a 12-hour window, and 0 if the dosage was not taken within a 12-hour window. An individual could be assigned a score of 0, 0.25, 0.50, 0.75, or 1 point each day. The participant's medication adherence score was the average score over all days in this study. The first 30 days of medication adherence data were deleted because prior research has shown an increase in medication adherence during the first month of MEMS use (De Geest et al., 2006).

Quantitative analyses were conducted using SAS statistical software, version 9. Descriptive statistics were used to summarize sample demographics. Nonparametric statistics were used for statistical inference due to the skewed nature of the medication adherence scores. The MEMS Use Survey question, "Do you think the MEMS cap had a negative, neutral, or positive effect on your medication-taking routine?" was used to divide patients into groups.

Next, medication adherence scores were compared between patient groups perceiving neutral/negative effect and positive effect. Because of the low number of negative responses to this question, the negative and neutral responses were combined. The Wilcoxon rank sum test was used to compare the two groups.

RESULTS

Table 1 delineates the sample demographics ($N = 73$). The mean age of the sample was 61.37 ($SD = 5.6$ years, age range = 55 to 75). Among 72 of the participants, this was the first transplant for 49 (68%), the second transplant for 22 (31%), and the third transplant for 1 participant. Table 2 shows patients' responses to the MEMS Use Survey questions related to the study's purposes of examining perceptions of the impact of MEMS use on medication taking, practicality of MEMS use, and difficulties with MEMS use. The final study purpose was to determine the effect of patients' MEMS perception on their medication adherence score.

Impact of MEMS Use on Medication Taking

The mean medication adherence score for those who perceived the MEMS had a negative/neutral effect on their medication taking ($n = 49$) was 0.76 ($SD = 0.13$, range = 0.42 to 0.97), whereas the mean medication adherence score for those who perceived the MEMS had a positive effect on their medication taking ($n = 23$) was 0.70 ($SD = 0.18$, range = 0.21 to 0.99) ($p = 0.22$).

We categorized any additional comments from participants related to the study purposes. Most participants reflected on the effect the MEMS had on their medication-taking routine with positive comments, such as "It increased my awareness of the importance of taking my medications," "I liked the cap. It was a good reminder," and "It makes me remember to take my medications." However, one participant had a negative comment: "I felt like someone was watching me." Several participants did not like the MEMS cap because using a weekly pillbox organizer simultaneously with the MEMS cap was difficult and interfered with their medication-taking routine.

Practicality of MEMS Use

When asked about the practicality of using the MEMS, positive comments were that the MEMS "didn't interfere with my daily activities at all" and was "just as easy to use as a regular pill bottle." One participant who used a portable box for storing medications noted that the MEMS "fit right into my medication tackle box." Comments related to the impracticality of using the MEMS included difficulties in using it together with their regular pillbox. One participant commented, "I had to get used to using it with my pillbox. I had to keep the MEMS on top of my pillbox to remind me to take it." Another mentioned that the MEMS was "an extra step at pill time." Other comments were that the MEMS cap was bulky, which posed a difficulty when traveling and carrying it to work. One participant noted that the MEMS was "difficult to carry around or travel with due to its large size." Another frequent comment was that the foil-wrapped pills did not fit easily into MEMS cap bottle, making device use difficult.

Difficulties with MEMS Use

When asked about any difficulties using the MEMS as directed, one participant mentioned, "When the situation differs from my routine, it gets in the way and is hard to accommodate." Another noted that he "had to remember that I had taken the med out of the bottle." On the other hand, participants who had no difficulties noted, "If anything, it was easier because the

cap was easier to open” and “I liked the size of the bottle and cap. It made it easier to remember to take it with me when I was away from home.”

DISCUSSION

To our knowledge, this is the first study to examine older participants’ perceptions of using the MEMS and the correlation of these perceptions with medication adherence. We found that the majority of participants perceived the MEMS had a neutral effect on their medication-taking routine, believed the MEMS was practical, and could not describe any instances in which using the MEMS was difficult. Other studies have found that the majority of participants have favorable perceptions of the MEMS (Schoenthaler & Ogedegbe, 2008; Wendel et al., 2001).

We found concerns in this older group of MEMS users that were similar to those found in two studies with younger adults with HIV who used the MEMS for 12 months (Bova et al., 2005; Schoenthaler & Ogedegbe, 2008). The issues were related to the MEMS’s large size, which limited portability, and difficulty using the MEMS concurrently with a pillbox.

We also found no statistically significant difference in medication adherence scores between those who perceived the MEMS changed their medication-taking routine and those who did not. Our findings suggest that medication adherence data can be used from older adult RT recipients who perceived the MEMS’s influence on their medication taking positively, neutrally, or negatively without biasing medication adherence data. These findings are inconsistent with the only other study that examined the correlation between perceptions of MEMS use and medication adherence (Schoenthaler & Ogedegbe, 2008). In this study of 138 community-dwelling, younger adults with HIV who used the MEMS for 12 months, those who used the MEMS every day, felt comfortable using it in front of others, and remembered to put their refills in the MEMS bottle were more adherent to their medications, compared with those who did not agree with these statements. Those who thought the MEMS was too bulky and inconvenient were less adherent with their medications. These findings could also be due to differences in participants’ medical conditions, ages, and medication adherence calculations.

Although we did not assess pillbox use in our study, those who declined to participate in our larger study frequently cited use of an alternative medication organization method (e.g., pillbox use) as the reason. This is consistent with previous studies that concluded use of the MEMS may exclude pillbox users (Schoenthaler & Ogedegbe, 2008; Wendel et al., 2001).

CONCLUSION

This study documented that older adult RT recipients described mostly positive responses to using the MEMS and that perceptions of the device were not related to medication adherence. Perceived difficulties with using the MEMS were related to its size, portability, and use with other medication dispensers such as a pillbox. Medication adherence data can be used from older adult RT recipients regardless of their perceptions of the MEMS’s influence on their medication taking without biasing medication adherence data. Although further research is indicated with other chronically ill populations of varied ages from different countries, our findings provide preliminary information that perceptions of using the MEMS may not influence medication adherence.

Acknowledgments

This study was supported by grants from the Building Academic Geriatric Nursing Capacity Initiative of the John A. Hartford Foundation and The Atlantic Philanthropies and the National Institute of Nursing Research (1R15NR8703).

References

- Bova CA, Fennie KP, Knafl GJ, Dieckhaus KD, Watrous E, Williams AB. Use of electronic monitoring devices to measure antiretroviral adherence: Practical considerations. *AIDS and Behavior*. 2005; 9:103–110. [PubMed: 15812617]
- Cramer JA. Microelectric systems for monitoring and enhancing patient compliance with medication regimens. *Drugs*. 1995; 49:321–327. [PubMed: 7774509]
- De Geest S, Borgermans L, Gemoets H, Abraham I, Vlamincx H, Evers G, et al. Incidence, determinants, and consequences of subclinical noncompliance with immunosuppressive therapy in renal transplant recipients. *Transplantation*. 1995; 59:340–347. [PubMed: 7871562]
- De Geest S, Denhaerynck K, Schäfer-Keller P, Bock A, Steiger J. Supporting Medication Adherence in Renal Transplantation—the SMART study. *Swiss Medical Weekly*. 2007; 137(Suppl. 155): 125S–127S. [PubMed: 17874516]
- De Geest S, Schäfer-Keller P, Denhaerynck K, Thannberger N, Köfer S, Bock A, et al. Supporting Medication Adherence in Renal Transplantation (SMART): A pilot RCT to improve adherence to immunosuppressive regimens. *Clinical Transplantation*. 2006; 20:359–368. [PubMed: 16824155]
- Farmer KC. Methods for measuring and monitoring medication regimen adherence in clinical trials and clinical practice. *Clinical Therapeutics*. 1999; 21:1074–1090. [PubMed: 10440628]
- Folstein MF, Folstein SE, McHugh PR. “Mini-mental state.” A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*. 1975; 12:189–198. [PubMed: 1202204]
- McGraw C, Drennan V. Self-administration of medicine and older people. *Nursing Standard*. 2001; 15(18):33–36. [PubMed: 12211960]
- Nevins TE, Kruse L, Skeans MA, Thomas W. The natural history of azathioprine compliance after renal transplantation. *Kidney International*. 2001; 60:1565–1570. [PubMed: 11576374]
- Organ Procurement and Transplantation Network. Transplants in the U.S by recipient age, kidney. 2009. Retrieved August 4, 2009, from <http://optn.transplant.hrsa.gov/latestData/rptData.asp>
- Riekert KA, Rand CS. Electronic monitoring of medication adherence: When is high-tech best? *Journal of Clinical Psychology in Medical Settings*. 2002; 9:25–34.
- Russell CL, Conn VS, Ashbaugh C, Madsen R, Hayes K, Ross G. Medication adherence patterns in adult renal transplant recipients. *Research in Nursing & Health*. 2006; 29:521–532. [PubMed: 17131276]
- Schoenthaler A, Ogedegbe G. Patients’ perceptions of electronic monitoring devices affect medication adherence in hypertensive African Americans. *Annals of Pharmacotherapy*. 2008; 42:647–652. [PubMed: 18397971]
- Wendel CS, Mohler MJ, Kroesen K, Ampel NM, Gifford AL, Coons SJ. Barriers to use of electronic adherence monitoring in an HIV clinic. *Annals of Pharmacotherapy*. 2001; 35:1010–1015. [PubMed: 11573846]

TABLE 1
DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE

Characteristic	<i>n</i> (%)
Gender (<i>N</i> = 73)	
Men	42 (58)
Women	31 (42)
Educational level (<i>n</i> = 69)	
High school graduate/some high school	39 (57)
College graduate/some college	30 (43)
Race/ethnicity (<i>n</i> = 72)	
Caucasian	51 (71)
African American	21 (29)
Marital status (<i>N</i> = 73)	
Married	43 (59)
Divorced/never married/widowed/separated	30 (41)
Employment status (<i>n</i> = 71)	
Disabled	35 (49)
Unemployed/retired	14 (20)
Full-time job/homemaker	11 (15)
Part-time job	11 (15)
Etiology of disease (<i>n</i> = 70)	
Hypertension	23 (33)
Polycystic kidney disease	16 (23)
Diabetes mellitus	15 (21)
Other	10 (14)
Reflux/unknown	6 (9)
Type of transplant (<i>N</i> = 73)	
Deceased donor	63 (86)
Living donor, related or unrelated	10 (14)

Note. Percentages may not equal 100 due to rounding.

TABLE 2**SUMMARY OF MEMS USE SURVEY QUESTIONS**

Question/Response	<i>n</i> (%)
Do you think the MEMS cap had a negative, neutral, or positive effect on your medication-taking routine? (<i>n</i> = 72)	
Negative	2 (2.78)
Neutral	47 (65.28)
Positive	23 (31.94)
How practical do you think using the MEMS on a daily basis was for you? (<i>N</i> = 73)	
Not practical	20 (27.40)
Neutral	12 (16.44)
Practical	41 (56.16)
Were there any instances when you thought using the MEMS as directed was difficult? (<i>n</i> = 71)	
No difficult instances	40 (56.34)
Neutral	1 (1.41)
Difficult instances	30 (42.25)

Note. MEMS = Medication Event Monitoring System.