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# Demonstrating a Technology-Mediated Intervention to Support Medication Adherence in Community-Dwelling Older Adults in Primary Care: A Feasibility Study

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## Abstract

**Background:** Medication non-adherence can lead to significant morbidity and mortality. This 4-week feasibility study aims to demonstrate that the eDosette intervention can be implemented with older adults in primary care. **Method:** Fifty-six older adults from four primary care sites in Southwestern Ontario, Canada participated. The intervention involved generating, for pharmacist review, weekly medication administration records based on transmitted data captured by the eDosette. The primary outcome is implementation feasibility defined by recruitment, adherence rates, frequency of captured missed and late doses, descriptions of clinical work resulting from the intervention, and participant feedback. **Results:** The recruitment rate was 24% (57/240); one withdrew due to personal reasons. The mean observed adherence rate was 82% (range 49%-100%). Overall, participants missed 505 and took 2,105 doses late; 118 clinical decisions occurred with 72 unique medication changes in 31 participants. Participants found the eDosette easy to use and did not feel that they were viewed negatively because of their potential non-adherence. **Conclusion:** The eDosette intervention could be feasibly implemented in primary care with older adults. Providing information about when an older adult takes their medications could play a role in medication adherence by prompting more informed discussions between the older adult and primary care clinicians.

## Keywords

medication adherence, elderly, drug monitoring, primary care

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## Background

Medication non-adherence is a major health care issue in older adults. Canadian studies in adults report an overall nonadherence rate of 52% and a range of nonadherence rates 35%-56% in a variety of single-disease entities (Montague et al., 2017). More specifically, older Canadian adults have reported nonadherence rates of 31% in depression and psychoactive medications (Sewitch, Cole, McCusker, Ciampi, & Dyachenko, 2008) and rates of 44% to 60% to beta-blockers and diuretic medications, respectively (Lai et al., 2011). Nonadherence rates in older adults from other countries are similar, ranging from 50% in general to 83% in those with dementia (El-Saifi, Moyle, Jones, & Tuffaha, 2018; Roth & Ivey, 2005). In older adults, nonadherence increases with multimorbidity, polypharmacy, regimen complexity, previous adverse drug events (ADEs), and impaired cognition

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(Brundisini, Vanstone, Hulan, DeJean, & Giacomini, 2015; Osterberg & Blaschke, 2005; Vervloet et al., 2012; Wong et al., 2014) and could lead to increased risk of falls, hospitalization, and mortality.

Medication adherence can be described as three processes: initiation, implementation, and discontinuation (Vrijens et al., 2012). There are many interventions aimed at improving medication adherence (Banning, 2008, 2009; George, Elliott, & Stewart, 2008; Nieuwlaat et al., 2014). Current interventions optimize the implementation phase by ensuring patients take medications as close as possible to the regimen prescribed. For example, direct observation or measuring serum drug levels can directly report adherence to prescribed medications, while questionnaires, pill counts, or blister pack and dosette (BP/D) reviews provide indirect evidence of adherence. The former interventions are expensive and clinically impractical (La Caze, Gujral, & Cottrell, 2014); the latter interventions have potential recall biases and can suffer from poor patient engagement (Arnet, Walter, & Hersberger, 2013; Freigofas et al., 2015; Osterberg & Blaschke, 2005).

Often, the adherence measured by these interventions is not communicated with the primary care team (PCT). The PCT, responsible for prescribing and re-prescribing medications, including those initiated by specialist physicians, may therefore be unaware of the extent to which older adults are non-adherent (Brundisini et al., 2015; Osterberg & Blaschke, 2005; Wilson et al., 2007). This knowledge gap, compounded by inconsistent communication between the older adult and the PCT about medications (Julius, Novitsky, & Dubin, 2009; Zolnierek & Dimatteo, 2009), can result in assumptions by the PCT that the older adult has the knowledge, motivation, skills, and the self-efficacy to take medications as prescribed (Kardas, Lewek, & Matyjaszczyk, 2013). These assumptions could negatively impact prescribing and re-prescribing practices.

More recently, technology-mediated interventions (TMIs) integrating technology into medication management devices (e.g., micro-chips in blister packs or pill bottle caps, SMS reminders of dose times, audio-visual reminder devices; Mistry et al., 2015) have been proposed to support medication adherence. Although there is no single type of technology that demonstrates consistent positive impact on adherence, TMIs that promote increased communication and patient feedback were the most successful at positively impacting adherence (Mistry et al., 2015). These findings were central to the development of the eDosette intervention being examined in this study.

In our previous work, it was demonstrated that the hardware components of the eDosette device were functional and the device could be installed in the home of 10 older adults (Siu, Mangin, Howard, Price, & Chan, 2017). Feedback from the participants informed the hardware revisions of the eDosette device. However, this initial study did not demonstrate the feasibility of implementing the entire intervention, and whether the data captured by the eDosette could inform clinical encounters about medications were not examined. Therefore, this 4-week feasibility study was conducted to assess whether the entire eDosette intervention could be feasibly implemented in a primary care setting with older adults. Second, we sought to explore whether the medication regimen complexity index (MRCI) could be used to report on the impact of the eDosette intervention on regimen complexity.

## Method

### *Compliance With Ethical Standards*

The Hamilton Integrated Research Ethics Board granted ethics approval (study number 1823).

### *Study Design and Setting*

This was a multi-center 4-week feasibility study of the eDosette intervention with community-dwelling older adults from four primary care sites in Southwestern Ontario. Recruitment occurred between September 2016 and July 2017, with data collection completed by December 2017. For this study, the PCT includes the most responsible family physician (MRP), nurses, clinical pharmacists, and other allied health professionals. The PCT pharmacists do not dispense medications; their role is to provide education and serve as a knowledge resource for the PCT and their patients.

### *Study Population*

Preliminary sample size calculations indicated that 126 participants would be needed if a randomized control trial were conducted of the eDosette intervention. This sample was calculated based on the following assumptions: 20% standard deviation, 80% power, and two-sided alpha of .05 to detect a 10% difference in medication adherence rate between the intervention versus control groups. Therefore, a target convenience sample size of 60 older adults (i.e., representing half the participant cohort required) was chosen to demonstrate the feasibility of implementing the intervention, test the recruitment strategy, and allow for the reporting of meaningful results over the project timeframe. The inclusion criteria were age 65 years and above, taking five or more medications (including supplements), using or willing to use a BP/D, independently managing their medications, living independently, and English speaking. Patients with a documented diagnosis of dementia, living in any form of assisted living facility, currently palliative, or deemed medically unstable by their PCT were excluded. We did not exclude participants because of recently changed medication regimens; we acknowledge that medication changes could occur at any time in older adults. Blinding was not possible or necessary due to the nature of the study design.

To facilitate recruitment, potential patient lists were first generated for participating practices at each study site using age and number of medications documented in the electronic medical record (EMR). Using the remainder of the inclusion criteria and their clinical discretion, the MRP reviewed these lists and identified the patients to whom a study invitation letter with consent form would be sent. For example, an MRP could exclude a participant for social reasons like the recent death of a spouse. The clinical pharmacists associated with the PCT at each study site were also asked to review their caseloads to identify and approach potential patients for interest in participation based on the inclusion criteria. Recruitment continued until the target sample size was reached. When a consent form was returned, the research assistant (RA) would set up an initial home visit to discuss the study and re-confirm consent.

## Study Intervention

At the initial home visit, the RA installed and provided training on how to use the eDosette device. Internet connection was initially provided through existing home Wi-Fi; however, it was identified early in the study that the use of in-home Wi-Fi varied from participant to participant (i.e., upload speeds, strength of connection based on proximity of the router to the eDosette, disconnecting the modem overnight), which resulted in issues with the regularly scheduled data transmission. Therefore, to mitigate this, cellular hot-spot devices were used to provide Internet connection in all later participants. This also had an additional benefit of allowing eligible participants without Wi-Fi access the option to participate.

Participants received their medications from their own dispensing pharmacies during the study and continued to manage their existing BP/D according to their regular routine (e.g., filling their own dosette or switching out new and old blister packs as they were received from the pharmacy). Participants were asked to store their BP/D exclusively in the eDosette for the duration of the study. When a dose was required, the participant would retrieve the stored BP/D from the eDosette, take the dose, and replace the BP/D into the eDosette. The eDosette captured an image of the stored BP/D every half-hour, which was transmitted securely to an online server, and then manually converted by the RA into a weekly medication administration record (MAR). The MAR reported when a participant took their medications and the weekly average dose administration times (to the closest half-hour), when a dose was missed completely, and provided clarifying information for why a BP/D was not stored in the eDosette for a period of time. The weekly MARs were uploaded to each participant's study personal health record (PHR); participant PHRs were linked to their PCT's pharmacist PHR accounts to facilitate secure information sharing. The pharmacist would receive a weekly notification to review each participant's MAR.

The eDosette was equipped with a backlit side-effect alert (SEA) button. If a potential side effect was experienced, the older adult could push this button to notify their PCT. Any participant generated SEAs would trigger an immediate PHR notification to the pharmacist. The pharmacist would respond to the participant within 24-48 business hours by telephone to determine whether a clinical assessment was required. After reviewing the MAR or any SEAs, office-based encounters could be initiated to discuss any identified issues. The encounters were documented directly into the participant's EMR.

## Outcome Measures

*Primary outcome.* The primary outcome was the feasibility of implementing the eDosette intervention in a primary care setting. The measures describing this outcome are (a) participant recruitment rate, (b) individual and overall medication adherence rate, (c) frequency of missed doses and late doses noted in participant MARs, (d) frequency and description of the clinical work directly resulting from the eDosette intervention, and (e) participant feedback on the eDosette device.

In this study, the term "dose" was synonymous with pill (e.g., two doses equal two pills). Therefore, the participant's observed medication adherence rate was calculated by dividing the total medication doses taken correctly (numerator) by the total doses in the study (denominator). The numerator was defined as the number of doses taken as prescribed (i.e., not missed and not late). Missed doses were defined as pills still present on image data after the next daily scheduled dose time; late doses were doses taken outside a 2-hr time window of the average time of dose administration (e.g., 08:00-10:00 for a 09:00 average dose time). This window was determined by investigator consensus based on (a) a previously published grace period corresponding to 25% of the time between doses (Vrijens, Vincze, Kristanto, Urquhart, & Burnier, 2008) and (b) 84% ($N = 48$) of our sample population had two or more daily dosage times. The total number of pills prescribed for a participant over the study period determined from dispensing pharmacy records. Non-observable dose data (e.g., when no BP/D was observed stored in the eDosette for an extended period of time) were excluded from this calculation; an assumption that all non-observable doses were missed or taken late is overly conservative.

In this study, "clinical work" was defined as any encounter (e.g., in-person or telephone) between the participant and the clinical pharmacist that was formally documented in a participant's EMR.

Participant feedback was captured using the previously developed 18-item exit-feedback questionnaire (Siu et al., 2017) at the end of the 4-week study. This questionnaire was adapted from an existing tool assessing the implementation of a new technology in a health

care setting (Bowcutt et al., 2008) and sought feedback about the eDosette device in six domains: (a) purpose, (b) implementation and usability, (c) impact on daily routine, (d) acceptability for future use, (e) personal opinion, and (f) patient enablement.

*Secondary outcomes.* The MRCI (George, Phun, Bailey, Kong, & Stewart, 2004) is currently not validated to assess the impact of interventions on regimen complexity. Therefore, an exploratory analysis was proposed to determine whether the MRCI could capture the impact of the eDosette intervention on regimen complexity. The MRCI has 65 items in three sections: dosage form, dosing frequency, and additional instructions. The lowest possible score is 1.5 with no maximum score; higher scores indicate increased regimen complexity. The MRCI has acceptable concordance with expert ratings of complexity in those with multi-morbidity (Hirsch, Metz, Hosokawa, & Libby, 2014). A 2-point change has been reported to be clinically significant as this corresponds to the discontinuation or initiation of one medication (Chang, Kowalski, Sorich, & Alderman, 2017).

### Data Collection

At the baseline visit, the RA gathered demographic information including frailty (Edmonton Frail Scale; Rolfson, Majumdar, Tsuyuki, Tahir, & Rockwood, 2006) and baseline health literacy [Rapid Estimate Adult Literacy in Medicine, Short Form; Arozullah et al., 2007].

*MARs.* The eDosette image resolution allowed the RA to determine missed or late dose information at the individual pill level to the closest half hour. The large variety of generic medications currently available precluded the identification of specific medications missed or taken late by name. Information on dose administration, missed doses, average dose administration time(s) for that week, and non-observable doses were reported on the MAR. Individual and overall medication adherence rates were calculated based on MAR information.

*Description of the clinical work resulting from eDosette MARs.* The RA identified all clinical encounters in the participant's EMR that resulted from the eDosette intervention. The encounter text was extracted verbatim. Distinct clinical issues addressed during the encounters were identified. If a medication change occurred during these encounters, the type and frequencies of change were recorded and collated. One participant encounter may contain multiple discussion items and/or medication changes.

*Participant feedback on the eDosette device.* The feedback questionnaire asked participants to rate each item on a 5-point Likert-type scale (−2 = strongly disagree, 0 = neutral, and +2 = strongly agree). Participants also rated their own adherence on a scale of 1 (Not at all) to 10 (All the time). Written feedback for open-ended questions was collated in an electronic spreadsheet.

*MRCI.* The study pharmacist calculated the MRCI scores based on medication lists provided by the participant's dispensing pharmacy at baseline and study completion.

### Statistical Analysis

Results for continuous variables (e.g., medication adherence rates) are presented as mean values (minimum–maximum) and as number or percent of participants for categorical variables. Statistical calculations were performed using SPSS v25.0. For the feedback questionnaire, mean scores for each item are presented as a mean score (minimum–maximum). A positive mean score indicated agreement with the questionnaire item, and a negative mean score indicated disagreement.

### Qualitative Analysis

A simple content analysis was performed on text from pharmacist–participant encounters. Two authors (BD, HS) iteratively identified thematic categories to which each clinical issue was coded. The frequency and types of medication changes observed in this study was also recorded. Resolution of coding conflict occurred by consensus. A formal qualitative analysis was not completed on the participants' written feedback responses; frequency of common statements were collated and reported.

## Results

### Primary Outcomes

*Recruitment and sample population.* The overall recruitment rate for this study was 24% (57/240) across the four sites. Figure 1 describes participant recruitment and retention throughout the study. Three participants withdrew consent at the initial home visit, and one participant ended the study early due to personal reasons unrelated to the intervention.

Our participant cohort was 55% female with a median age of 75 (range 65-92) years and took a median of 9 medications (range 5-20); 27% ($N$ = 15) were deemed apparently vulnerable to frailty. Table 1 presents the demographics of the participant cohort.

*Participant medication adherence rate from eDosette MARs.* A sample of 4-week participant MAR is shown in Figure 2.

A 4-week MAR was created successfully for 93% ($N$ = 52) of the participants in the study. In the four participants without a 4-week MAR, image transmission was verified, but they could not be downloaded from the online server. The median number of doses taken over 4 weeks was 280 (range 140-580). The median number of

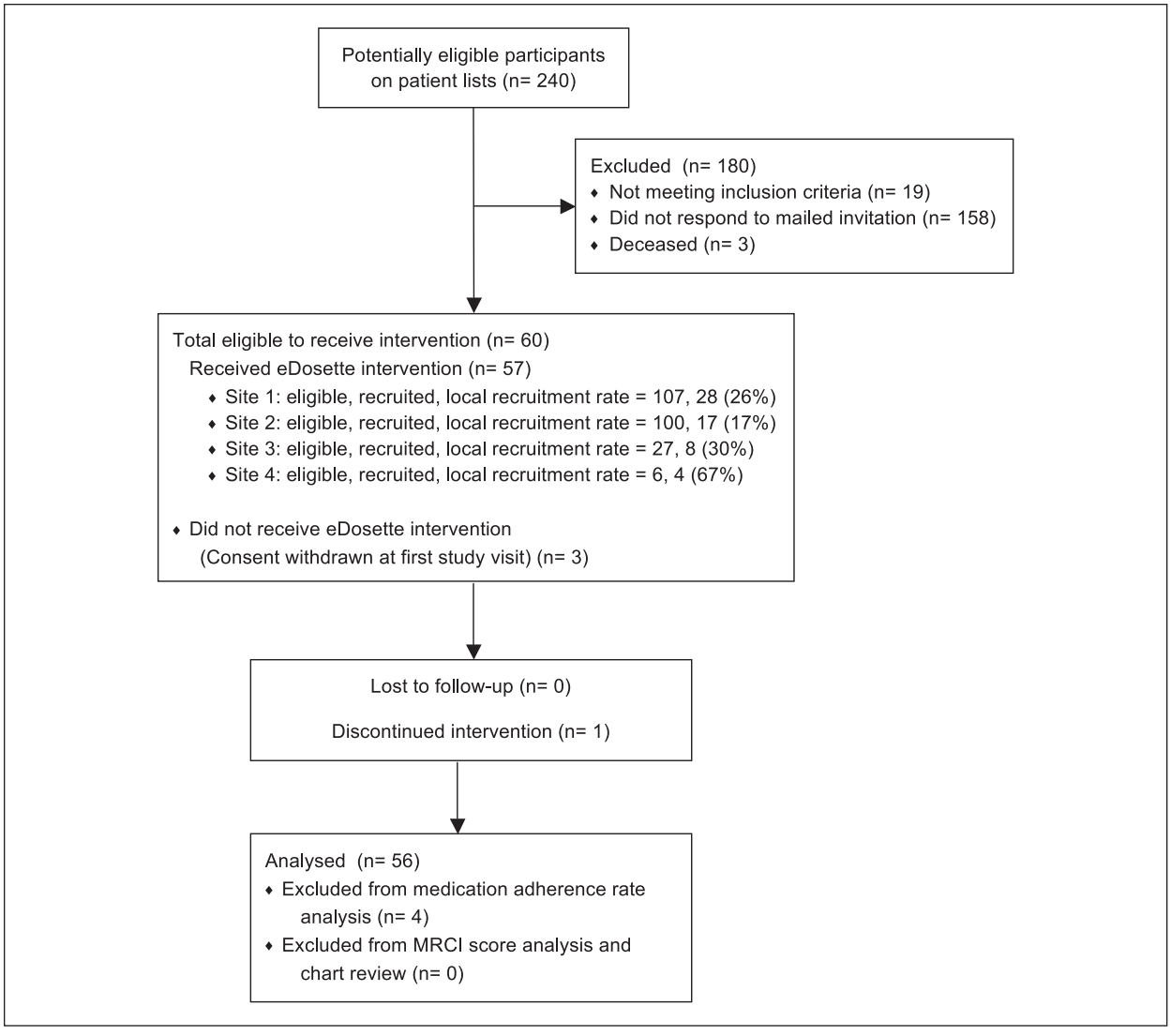


**Figure 1.** Participant flow diagram for the eDosette study.
*Note.* The main reasons for declining participation include the lack of time and a general disinterest in participating in research. Four participants were excluded from medication adherence rate analysis due to irretrievable image data from the secure online eDosette server. One participant withdrew from the study after using the eDosette for 2 days; the participant felt that their existing routine was adequate and sufficient and did not want to continue using the eDosette. MRCI = medication regimen complexity index.

**Table 1.** Demographics of Participants Enrolled in the Study, *N* = 56.

| Variable | |
|---|---|
| Gender | |
| Female, *n* (%) | 31 (55%) |
| Male, *n* (%) | 25 (45%) |
| Age (years), median (min-max) | 75 (65-92) |
| Number of medications, median (min-max) | 9 (5-20) |
| Number of daily doses > 2, *n* (%) | 48 (84%) |
| Number of comorbidities, *n* (min-max) | 3 (1-6) |
| Frailty (Edmonton Frail Scale [EFS]) | |
| Not frail—EFS score 0-5, *n* (%) | 41 (73%) |
| Apparently vulnerable—EFS score 6-11, *n* (%) | 15 (27%) |
| Severe frailty—EFS score 12-17, *n* (%) | 0 (0%) |
| Health literacy score, median (min-max) | 7 (6-7) |
| Baseline medication regimen complexity index (MRCI) score (mean, min-max) | 30 (5-72) |

nonobservable dose data was 16 (range 0-156), representing 6% of the median dose number taken during the study. Altogether, participants missed a total of 505 doses (median = 1, range 0-127) and took 2,105 doses late (median = 35, range 0-136). The participant who missed the most doses did not also take the most doses late. The distribution of participants by proportion of missed doses and late doses is shown in Figure 3. The mean overall adherence rate was 82% (range 49%-100%). No SEAs were generated.

The median self-rated medication adherence was nine (range 3-9). There does not appear to be a strong correlation between observed medication adherence and self-perception of adherence (Pearson coefficient $r$ = .3, coefficient of determination $r^2$ = .09). This finding has been observed in older adults solely taking cardiovascular medications (Zeller, Ramseier, Teagtmeyer, & Battegay, 2008). The range of observed adherence rates

| Actual Day | Feb-14 | Feb/15 | Feb/16 | Feb/17 | Feb/18 | Feb/19 | Feb/20 | Average |
|---|---|---|---|---|---|---|---|---|
| Dosette Day | Tue | Wed | Thu | Fri | Sat | Sun | Mon | |
| AM | Taken prior | 8:30 | 10:00 | 10:30 | 10:00 | 10:30 | 9:00 | **10:00** |
| Noon | x | x | x | x | x | x | x | x |
| PM | x | x | x | x | x | x | x | x |
| HS | 19:30 | 20:30 | 22:00 | 19:00 | 20:00 | 21:00 | 20:30 | **20:30** |
| Actual Day | Feb/21 | Feb/22 | Feb/23 | Feb/24 | Feb/25 | Feb/26 | Feb/27 | Average |
| Dosette Day | Tue | Wed | Thu | Fri | Sat | Sun | Mon | |
| AM | 12:00 | 9:00 | 8:30 | 10:30 | 12:30 | Not taken | 11:30 | **10:30** |
| Noon | x | x | x | x | x | x | x | x |
| PM | x | x | x | x | x | x | x | x |
| HS | 19:30 | 19:00 | 21:00 | 19:30 | 18:30 | Not taken | 20:30 | **19:30** |
| Actual Day | Feb/28 | Mar/01 | Mar/02 | Mar/03 | Mar-04 | Mar-05 | Mar-06 | Average |
| Dosette Day | Tue | Wed | Thu | Fri | Sat | Sun | Mon | |
| AM | 9:00 | 11:00 | 8:30 | 11:00 | 10:30 | Not seen* | 10:30 | **10:00** |
| Noon | x | x | x | x | x | x | x | x |
| PM | x | x | x | x | x | x | x | x |
| HS | 21:00 | 19:00 | 20:00 | 22:00 | 20:00 | Not seen* | 18:30 | **20:00** |
| Actual Day | Mar-07 | Mar-08 | Mar-09 | Mar-10 | Mar-11 | Mar-12 | Mar-13 | |
| Dosette Day | Tue | Wed | Thu | Fri | Sat | Sun | Mon | |
| AM | 9:30 | 9:00 | 10:30 | 9:30 | 9:30 | 11:00 | Not seen* | **9:30** |
| Noon | x | x | x | x | x | x | x | x |
| PM | x | x | x | x | x | x | x | x |
| HS | 19:30 | 18:30 | 17:30 | 19:30 | 21:00 | 19:00 | 21:00 | **19:30** |

**Figure 2.** A sample of 4-week participant medication administration record from one of the participants in the study.
*Note.* The times reported in 24 hr time (e.g., 20 = 20:00 = 8:00 p.m.) and reflect the time of the image when the blister pack or dosette compartment is noted to be empty or partially empty (i.e., a dose administration). Times are reported to the closest half hour. The average time for each dose administration was calculated weekly and also shown to the nearest half-hour. The MAR indicates to the reviewing pharmacist missed doses (red cells) and doses with research assistant clarification (orange cells with asterisk). In this particular example, the research assistant clarified that the patient had forgotten to replace their blister pack into the eDosette after the evening dose on March 4 and March 12. The "x" = no doses scheduled during this time slot; AM = morning dose; PM = afternoon dose; HS = evening dose; MAR = medication administration record.

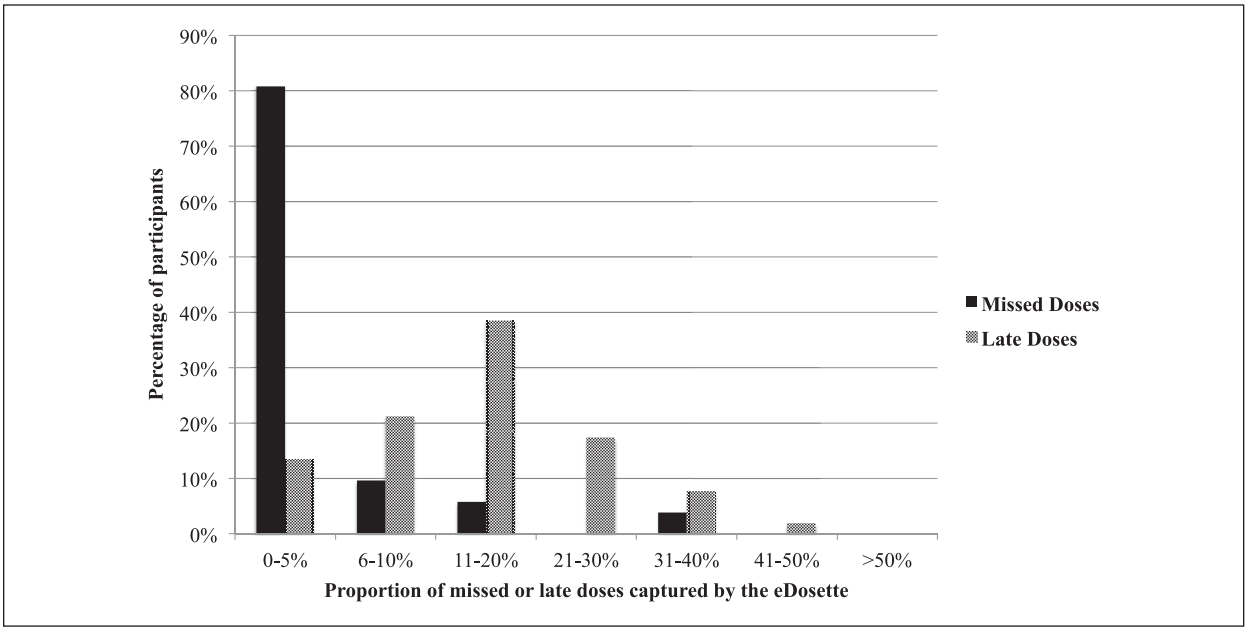


**Figure 3.** The distribution of participants according to the proportion of doses missed or taken late.

**Table 2.** The Nature and Frequency of Discussion Items Occurring During Pharmacist–Participant Encounters Prompted by eDosette MAR Review.

| Clinical discussion item theme | Frequency (*N*, %) | Example(s) |
|---|---|---|
| Changes in medications (e.g., initiation, discontinuation, simplification, dose optimization, alternative medication selection) for improved disease/ symptom management, reduction in side effects or possible interactions or unnecessary medications | 47 (40%) | ". . . the pharmacy was putting medications in the wrong blister pack compartments."<br>". . . discussed cutting back on anti-hypertensives. Best choice would be amlodipine . . . he agreed to stop this *(patient had BP records showing a maximum systolic blood pressure of 105 mmHg)*"<br>". . . grogginess from *[pregabalin]*, changed to BID *[i.e., twice daily]* dosing . . ." |
| Change in medications to improve adherence to regimen | 8 (6.5%) | ". . . change time of supper dosage so it is easier to remember . . ." |
| Patient education (e.g., improve medication literacy, disease awareness, to reduce medication error, etc.) | 14 (12%) | ". . . advised not to take 2 doses at the same time or extra doses . . ."<br>". . . provided tips to remember taking mediations (i.e., alarm or association with an activity) . . ." |
| Identification and addressing clinical concern not directly related to medication adherence (e.g., chronic disease management, mood, pain management, cognition) | 12 (10%) | ". . . patient misses medications due to stress and medication complexity . . . patient does take medication when angry or depressed . . . patient understands importance of taking medications, but mental health making it difficult. *Patient to get referral for mental health* . . ."<br>". . . memory concerns . . . *suggested referral to memory clinic*, enlist a family member for help remembering. . . Doesn't remember if they took pills . . . forgets to pick up blister pack from pharmacy . . ." |
| Increase in PCT awareness of patient medication-taking behaviors | 22 (18.5%) | ". . . taking medications at wrong times, clinically significant . . ."<br>". . . noticeable variation in morning dose . . ."<br>". . . patient made quite a few modifications to the timing of her medications, especially the noon-time slot . . ." |
| No clinical concerns noted by pharmacy review | 15 (13%) | |

*Note.* MAR = medication administration record; BP = blood pressure; PCT = primary care team.

for the 33 participants who indicated that they always took their medications exactly as prescribed was 53%-100%.

*Description of clinical work resulting from the eDosette MARs.* After MAR review, 79 clinical encounters were initiated to address 118 distinct discussion items. Table 2 presents the frequency and themes of the issues identified; 40 (34%) discussion items documented increased PCT awareness about when a participant took their medications or documented a collaborative medication decision that directly resulted from the intervention. In 12 (10%) encounters, while addressing an MAR-related medication issue, the pharmacist facilitated connections with other PCT members to address other concerns in a timely fashion.

Overall, the intervention prompted 72 unique medication changes in 31 participants. Initiating (31%, $N$ = 22), discontinuing (30%, $N$ = 21) and adjusting a medication dose (21%, $N$ = 15) were the top three types of changes made to a participant's medication regimen. The remainder of changes (19%, $N$ = 14) included adjusting dose timing, dose tapering, and patient request. A higher number of unique medication changes ($N$ = 72) versus the number of encounter notes referencing medication change ($N$ = 55) is observed because a single EMR documentation of a dose-time change could have applied to multiple medications.

*Participant feedback about the eDosette device.* Overall, participants reported that the eDosette easy to use (mean score 1.14 [range: −1, 2]), and adequate training was received prior to use (1.07 [−1, 2]). Participants did not feel excessively monitored by the eDosette (−0.64 [−2, 1]), and they were not concerned of being viewed negatively because of their medication administration patterns (−1.36 [−2, 1]). Table 3 presents all 18 items on the feedback questionnaire. The three most common written negative feedback comments were (a) the eDosette represented a change in existing routines, (b) the eDosette was bulky, and (c) the Wi-Fi connectivity with eDosette was an annoyance.

## Secondary Outcomes

*Medication regimen complexity.* The mean baseline MRCI score was 30 (range: 5-72), and the mean 4-week score

**Table 3.** Participant Feedback Survey Responses for the eDosette Device.

| Mean score (minimum, maximum) | Feedback survey statement |
|---|---|
| −0.1 (−2, 2) | 1. The eDosette helped me to take my medications more correctly than before. |
| −0.6 (−2, 2) | 2. I had problems with the Internet Wi-Fi connection for the eDosette |
| −0.6 (−2, 1) | 3. I had problems setting up my personal health record (PHR) account for the eDosette |
| −0.91 (−2, 1) | 4. I had problems maintaining and taking care of my eDosette |
| −1.02 (−2, 1) | 5. Problems with the eDosette technology would prevent me from using it in the future. |
| −0.54 (−2, 2) | 6. The eDosette made taking my daily medications less confusing. |
| −1.36 (−2, 1) | 7. I worry the eDosette may get me in trouble with my family doctor when he or she finds out I have not taken my medications as prescribed. |
| −0.64 (−2, 1) | 8. The eDosette feels like someone is always watching me when I use medications. |
| −0.04 (−2, 2) | 9. I feel that with the eDosette, I can now be honest with my family doctor about how I feel about my medications. |
| 0 (−2, 2) | 10. The eDosette made my daily medication routine easier. |
| −0.02 (−2, 2) | 11. The eDosette made it easier to remember to take my medications (or whether I had taken them). |
| −0.16 (−2, 2) | 12. The eDosette allowed me to have a more active role in managing my medications. |
| −0.5 (−2, 2) | 13. With the eDosette, I will rely less on my pharmacy to organize my medications administrations. |
| 1.07 (−1, 2) | 14. Training in the use of the eDosette was adequate for me to use the eDosette effectively. |
| 1.14 (−1, 2) | 15. I found the eDosette to be easy to use. |
| 0.13 (−2, 2) | 16. I would use the eDosette in the future if it were offered. |
| 0.91 (−1, 2) | 17. I am satisfied with the eDosette overall. |
| 0.36 (−1, 2) | 18. Please rate the effect the eDosette had on your confidence in managing your medications. |

*Note.* A positive mean response indicates an agreement with the statement, while negative responses indicate a disagreement with the statement.

was 30 (range: 4-67). Eight participants had a greater than 2-point reduction (range: −2 to −13), and three participants had a greater than a 2-point increase in MRCI score over the 4-week study (range +2 to +7). In these three participants, one had vitamin D3 supplementation appropriately initiated; another had metformin increased after glycemic control review; and the last had medications re-initiated by their rheumatologist to improve symptoms. The number of participants with a change in the MRCI score was less than the number of participants noted to have a change made in their medication regimen during the clinical encounters.

## Discussion

In this multi-center study, the eDosette intervention was implemented with community-dwelling older adults in a primary care setting. Real-time MARs were reliably generated and made available to the PCT, which helped to identify participant medication management issues. Targeted assessments were offered to these participants resulting in medication regimen changes; for example, if a medication dose was noted to be consistently missed, the pharmacist and participant engaged in a clinical conversation that discussed barriers and methods to overcome missing this dose (e.g., dose reminders, eliminating a dose if deemed unnecessary, altering dose timing—Table 2). Therefore, this study demonstrates how the eDosette could potentially support the implementation phase of medication adherence.

In addition, these targeted assessments could potentially support the initiation phase of medication adherence by facilitating opportunities for collaborative conversations about medication treatment goals with the PCT. These important clinical conversations could provide opportunities for better education of older adults around making informed choices about starting medications. In this way, the eDosette intervention could potentially address "inappropriate medication adherence" (i.e., adherence to inappropriately prescribed or unwanted medications). In the context of polypharmacy, inappropriate medication adherence could exacerbate existing negative health outcomes and/or possibly decrease appropriate medication adherence (i.e., adherence to needed and necessary medications) through various means such as increased regimen complexity, drug–drug interactions, and ADEs.

Although medication reviews have been shown to impact medication adherence (Banning, 2008, 2009; George et al., 2008; Nieuwlaat et al., 2014), current community-based medication reviews are often not informed by actual medication administration information. The

proposed eDosette intervention is unique because it actively makes available medication administration data. The eDosette information could be used by the PCT during clinical encounters to supplement the self-report of older adults when engaging in shared decision-making around initiating, re-prescribing, and de-prescribing medications. This could be one method of supporting the individualization of medication regimens in older adults (Julius et al., 2009; Zolnierek & Dimatteo, 2009). In addition, the eDosette intervention is unique because it is not disease-specific, does not require custom medication packaging, and leverages the existing therapeutic relationship with the PCT.

By pragmatically performing this study in the primary care setting, we provide preliminary evidence that the eDosette intervention could be incorporated into routine primary care workflow. However, in order for this intervention to be scalable and truly implementable in primary care, several processes reported in this study should be automated (e.g., automating the MAR generation process through computer software and automatically uploading the weekly MAR to the PHR). This would drastically reduce the amount of time required by clinical staff to operationalize the intervention.

The eDosette device was designed as a BP/D storage unit that tracks when medications are taken; it does not have a dose reminder system, nor does it dispense medications. Therefore, it would be expected that participants would not strongly endorse statements about the eDosette device's ability to make the current routine less confusing, easier, or assist them in remembering their doses. More importantly, however, participants were not worried about the implications of having their PCT aware of their medication taking behaviors. The observed range of participant administration patterns and adherence rates would support this and would indicate that participants did not change how they took medications when using the eDosette.

The exploratory analysis of the MRCI score revealed that this tool would not be able to capture the full impact of the eDosette intervention. The MRCI preferentially assigns scoring based on the number of medications; discontinuing one medication will result in a 2-point reduction, while no score change is observed for more nuanced reduction in complexity such as a reduction in the number of daily doses or medication strength. The quantitative nature of the MRCI underrepresents the work done by the pharmacist in eliciting patient opinion and values on their prescribed regimens and optimizing medication regimens. This was highlighted in the chart encounter notes where the pharmacists clearly documented conversations eliciting participant values and goals for medications.

### Limitations

First, because each site was tasked with identifying their own participants, different site recruitment rates and a lower overall recruitment rate were observed (Figure 1). Study sites with lower recruitment rates relied more on mailed generic invitation letters, while higher recruitment rates were observed from study sites where the clinician directly recruited an eligible participant. Furthermore, the participant cohort had high health literacy and was also less frail. Because of these factors, our cohort may not represent all older adults taking multiple medications and could have preferentially select older adults that were more adherent to their medications. However, as the primary outcome of this study was to demonstrate the feasibility of the eDosette intervention in primary care, a random and representative sample was not vital to achieve this goal. Second, our reported observed adherence rate may also be higher than the true adherence rate in our sample population because we have excluded unobservable doses from our calculations. As there is no literature to support the assumption that unobserved doses are taken incorrectly (i.e., completely missed or late), unobservable doses were not treated in an intention-to-treat fashion.

### Future Considerations

Vrijens, Urquhart, and White (2014) proposed defining adherence interventions and their potential impact in relation to their new taxonomy framework for medication adherence (Vrijens et al., 2014). Doing so could lead to the development and standardization of outcomes to measure and report adherence and a clearer picture of which interventions have the largest effect on adherence behaviors (Vrijens et al., 2014). Because the eDosette intervention could impact initiation and implementation phases, and incorporates previously identified successful aspects of TMIs, we hypothesize that our intervention could positively impact medication adherence in community-dwelling older adults. This hypothesis will be tested in a planned future randomized control trial in a more representative participant cohort than was recruited for this study. Therefore, the inclusion criteria for this future study would need to be expanded to include older adults with dementia and/or living in assisted living settings. This would allow for future findings to be generalizable to the broader older adult population. There is also future potential for the eDosette intervention to be implemented with other patient populations where knowledge about medication taking behaviors would be of particular importance (e.g., severe mental health diagnoses or chronic pain).

Second, impact of the eDosette intervention on patient engagement and empowerment around medication self-management was not formally assessed in this study. Because improving patient empowerment has a positive effect on medication adherence (Kardas et al., 2013), the planned future randomized control trial (RCT) will formally assess empowerment with a generic enablement tool (i.e., the Patient Enablement Instrument; Howie, Heaney, Maxwell, & Walker, 1998) and a

specific self-efficacy tool in medication management (i.e., Self-efficacy for Appropriate Medication Use Scale; Risser, Jacobson, & Kripalani, 2007).

## Conclusion

The eDosette intervention can be feasibly implemented into the primary care setting to provide PCTs with previously unavailable information on when an older adult takes their medications. The intervention could play a role in supporting medication adherence through early identification of adherence issues and by prompting more collaborative therapeutic discussions between the older adult and the PCT. A formal RCT would be required to determine whether this intervention model could impact medication adherence in older adults. Dedicated qualitative studies to understand how the intervention supports adherence and empowerment would also be necessary. Other key outcomes of interest would include assessing the impact of the intervention on patient-related health outcomes, quality of life, and cost-effectiveness over a sustained time frame. These results could provide the evidence required for policymakers and knowledge users to support a broader implementation of the eDosette intervention in older adults.

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