

1 **Multi-compartment compliance aids (MCAs): Application to the geriatric community**

2  
3 Abstract

4 The prevalence of co-morbidities in older people gives rise to the number of prescribed  
5 medicine increasing the complexity of medicine management. Multi-compartment  
6 compliance aids and dispensing systems have the potential to organise the daily life of an  
7 older person. Various features of currently available compliance aids (such as multi-  
8 compartment design or an automated reminder function) have proved successful in assisting  
9 older patients to take their medication. This in turn enables them to manage their own often  
10 complex drug regimens. Further investigations and collaborations between healthcare  
11 professionals, patients and carers are required for validated and effective use of compliance  
12 aids.

13  
14  
15 Introduction

16 The proportion of the population above the age of sixty is growing (NIH, 2011) as a result of  
17 medical advances and the resulting increase in life expectancy. This combination of factors  
18 is placing pressure on the healthcare professionals and the pharmaceutical industry to meet  
19 this increased demand for healthcare services and improved patient related outcomes.  
20 Studies have shown that older individuals use large numbers of medicines (Ferrini and  
21 Ferrini, 2000) and are at risk of polypharmacy (Wilson et al., 2007). The prevalence of  
22 polypharmacy is high (Haider et al., 2009) leading to potentially inappropriate drug use and  
23 non-adherence in geriatric population.

24  
25 Although multiple definitions for polypharmacy have been identified in the literature (Fulton et  
26 al., 2005; Jorgenson et al., 2001; Veehof et al., 2000), the most commonly used definition is  
27 the concurrent use of five or more drugs (Haider et al., 2009). Concerns regarding  
28 polypharmacy have been raised (Compton, 2013), particularly due to related issues of

29 medicine self-administration, medicine administration timing, supply of medicines and most  
30 importantly patient adherence to medicine taking.

31

32 Adherence as defined by other researchers (Nunes et al., 2009) is the extent to which a  
33 patient's behaviour matches the agreed recommendations of the prescriber. Non-adherence  
34 is a common occurrence with older patients and is characterised in several ways including  
35 hesitancy towards initiating medication taking, skipping doses, dose adjusting, using  
36 unsuitable routes of administration and over-adherence (Oboh, 2011). Unfortunately, these  
37 behaviours are not commonly disclosed to healthcare professionals more specifically the  
38 prescriber.

39

40 The complex medication regimens of older individuals require strategies to assist with  
41 medicine self-management. To overcome medicine management issues related to  
42 polypharmacy, healthcare professionals such as general practitioners (GPs) and  
43 pharmacists, often recommend or assist with the preparation and supply of multi-  
44 compartment compliance aids (MCA) (automated and non-automated) for solid dosage  
45 forms. The community pharmacy contract in England and Wales recommends assessing  
46 and providing MCAs, to individuals who fall within the protection of the Disability  
47 Discrimination Act 1995 (DDA) and require assistance with medicine taking.

48

49 Electronic health technologies have shown great potential to improve patient quality of life as  
50 observed in the outcome of the Automated Pill Dispenser Project which was conducted in  
51 the West Midlands region in March 2012. The automated pill dispenser (APD) used in this  
52 study comprises of a movable carousel with divisions containing the precise amount of oral  
53 medicine to be taken at a specific time. An auditory alarm reminds the patient to take the  
54 medicine and an electronic alert provides feedback to carers.

55

56 A digital wireless personal information system developed by Proteus Biomedical has recently  
57 become available in the United Kingdom (UK). This system consists of a sensor-enabled  
58 tablet and sensor patch which detects each time the patient takes their medicine (Lancet,  
59 2012). This system is also able to notify the caregiver and/or healthcare professional about  
60 the patient's daily activities as well as their medicine management. Whilst electronic  
61 dispensing systems have the potential to improve medicine management for older  
62 individuals, further work is required to ensure their designs promote patient adherence.

63

64 As the population ages, it is likely that older individuals will receive solid, orally administered  
65 medicines in MCAs (Adams et al., 2013). Recent observations (Orlu-Gul et al., 2014)  
66 identified that some community pharmacists do not find the currently available MCAs  
67 'pharmacist friendly' in terms of ease of dispensing and accuracy checking. To assist  
68 pharmacists in their delivery of efficient and effective medicine services, MCAs should be  
69 designed to support this and should be compatible with current dispensing practices whilst  
70 maintaining the stability of the repackaged medicines once removed from their original  
71 packaging. An evaluation of commonly used adherence aids and future considerations  
72 concerning pharmacists in particular community pharmacists involved in the dispensing of  
73 MCAs are presented in this paper.

74

#### 75 Defining MCAs

76 'Medicine compliance aids' including MCAs and monitored dosage systems (MDS) are  
77 devices capable of enhancing patient adherence. There are numerous aids which have been  
78 designed to improve patient adherence however, there is limited clinical evidence to  
79 demonstrate MCA increase the compliance (Fowells et al., 2013). Most MCAs comprise of  
80 compartments which correspond to a single medicine administration time and all of an  
81 individual's solid, orally administered medicines prescribed for that time are dispensed into  
82 that compartment by pharmacy staff. Where frequency of administration does not exceed  
83 four times a day, a 28 compartment MCA provides a seven day dosing regimen for their

84 medicines. MCAs can be purchased by individuals or supplied by pharmacists and can be  
85 disposable or reusable. These devices can also assist with managing medicines when a  
86 formal or informal carer is involved.

87

88 Medicines are packed into MCAs by removing them from original medicine containers and  
89 organising them into the MCA. As this process occurs between pharmacy medicine  
90 dispensing and administration, correct MCA preparation is a prerequisite for patient medicine  
91 adherence. National institutional regulations outline those responsible for preparing MCAs in  
92 healthcare settings; in most cases the responsibility falls to nursing staff or pharmacists and  
93 other pharmacy staff (Nunney et al., 2001). As removing medicines from their original  
94 container and packing them into a MCA invalidates the manufacturer's stability guarantee,  
95 the healthcare professional should make an informed judgement as to the effect on the  
96 quality and safety of this repackaging process (Haywood et al., 2011). Original medicine  
97 containers provide medicine protection to appropriate pharmacopoeia and quality standards  
98 for a variety of criteria including prevention of moisture and light exposure. However, a  
99 compliance aid cannot guarantee the same level of protection (Donyai et al., 2010).

100

101 A unanimous set of aims for the general use of MCAs have been identified (Wick, 2011):

- 102 • to provide easily accessible medicine storage;
- 103 • to reduce the complexity of medicine adherence;
- 104 • to minimise errors associated with administration incorrect doses at incorrect times;
- 105 • to act as a memory aid;
- 106 • to show whether medicine doses have been administered or taken.

107

108 The Royal Pharmaceutical Society (RPS) (Fowells et al., 2013) suggests that the patient or  
109 carer should be involved in the decision making process and educated on the advantages,  
110 uncertainties and risks of MCA use. Assessment for MCA use should include consideration

111 of the patient characteristics, benefit versus risk of supplying medicines in a MCA and the  
112 equality and disability discrimination legislation during the assessment (PSNC, 2013).

113

#### 114 Comparison of MCAs

115 While MCAs can decrease the complexity associated with polypharmacy (George et al.,  
116 2008), there is no universal awareness of the most effective and easy-to-use compliance  
117 aid, additionally, no single MCA is suitable for all individuals. Moreover the information  
118 about the cost-effectiveness of various compliance aids is limited. In the UK, Boots MDS<sup>®</sup>,  
119 Nomad<sup>®</sup>, Dossette<sup>®</sup>, Medidos<sup>®</sup> and 7-day Venalink<sup>®</sup> systems are commonly used (Oboh,  
120 2011).

121 A Healthcare Compliance Packaging Council of Europe has been developed, to represent  
122 the pharmaceutical industry, the packaging industry and representatives of patient  
123 organisations in Europe, with the aim of advising the healthcare sector on how to improve  
124 patient adherence with packaging solutions (Council HCP, 2014). This Council has been at  
125 the forefront of enhancing devices including:

- 126 • multi-dose dispensing systems;
- 127 • alarmed pill boxes;
- 128 • specific medical alarms; and
- 129 • pictograms to act as instruction and reminders.

130 In addition, other equally effective yet simpler methods exist (Oboh, 2013) including

- 131 • Reminder systems such as timed alarms, telephone reminders, fridge stickers, and  
132 positioning medication in visible places.
- 133 • Automatically generated reminder charts are practical and cost effective
- 134 • Simplifying drug regimens and dispensing into appropriate containers
- 135 • Explaining about the personalised importance of their medicines
- 136 • Repeat dispensing, prescription collection and medicines delivery services
- 137 • Patients keeping records of their medicine taking and monitoring their conditions

- 138       • Non-childproof tops, large labels, large prints, medicines administration records  
139           (MAR) sheets (Gujral et al., 2013).

140

141 Current challenges related to MCAs

142 Although MCAs are commonly used, their effectiveness has not been proven in the literature  
143 (Nunney et al., 2001; Rivers, 1992; McGrow et al., 2000). There is on-going debate about  
144 the overreliance of MCAs and there is insufficient evidence to support its benefit in improving  
145 medicine adherence. The analysis of the cost-consequence of a pharmacist-led medication  
146 review service, which included the provision of MCAs, showed that the mean cost saving  
147 was £307 per patient after an intervention was implemented for six months. The resulting  
148 increase in medicine adherence did not lead to a significant change in quality of life  
149 (Desborough et al., 2012).

150

151 An important issue associated with MCA use is the stability of medicines once they are  
152 removed from their original containers and packed into the MCA. The Royal Pharmaceutical  
153 Society advises that medicines should not be stored in a MCA for longer than eight weeks  
154 (RPS, 2013) and have noted that the lack of sufficient stability data to support the  
155 repackaging of medicines into MCAs is an important issue when considering the usefulness  
156 of MCAs. Research conducted to investigate stability has shown little changes to drugs such  
157 as paracetamol after light and temperature alterations within a six week window (Haywood et  
158 al., 2006). However there is a handling process allowing for ruptured seal errors changing  
159 the previous stable conditions before even reaching the patient (Haywood et al., 2006).  
160 Possible interactions between medicines packed within the same MCA compartment is  
161 another consideration. For example, atenolol and aspirin have shown changes to hardness  
162 when packed together, potentially affected their quality. To assist with preserving medicine  
163 stability, time associated with packing medicines should be limited and medicines should be  
164 removed from the original container just prior to packing within a MCA. MCAs should be  
165 sealed and exposure to heat sealing should be limited (Haywood et al., 2011).

166

167 MCAs are also associated with a risk of secondary dispensing errors that may go undetected  
168 (Oboh, 2013; Alldred et al., 2009). This raises the issue of the safety of MCAs. As the usage  
169 increases there is a strain placed on the workload of both GPs and community pharmacists  
170 (Oboh, 2011). MCAs administered by carers also have the potential to lead to errors if  
171 medicine identification is difficult and if the MCA fails to accommodate dose and medicine  
172 descriptions.

173

174 MCAs have limited available space for each medicine dose, are not airtight and offer less  
175 moisture and light protection than original medicine containers. There is a shortage of short-  
176 term stability data for the transfer of medicines into MCAs (Mylrea et al., 2013).

177

178

#### 179 Current considerations on MCAs

180 GPs should promote self-administration where possible in older individuals to facilitate  
181 autonomy in medicine taking. A patient-centred approach to medicine adherence  
182 intervention would involve liaising with local pharmacists and care home staff to understand  
183 reasons for non-adherence, and the suitability of MCAs for individual patients.

184

185 Pharmacists should use their expertise to tailor medicine delivery in the best way to older  
186 individuals through tools such as Medicine Use Review (MUR). MUR is one of the four  
187 advanced services within the NHS community pharmacy contract and assesses whether  
188 individuals are receiving the best possible outcomes from their medicines and can identify  
189 problems associated with medicine taking, such as side-effects, medicine accessibility,  
190 adherence issues (Oboh, 2013). This is only a compulsory procedure in the case of a patient  
191 who qualifies under the DDA (PSNC, 2013). Pharmacist-led interventions for older patients  
192 can be resource intensive which makes their cost-benefit reasoning questionable (Banning  
193 et al., 2009). There is need for a formal and objective approach to making the decision to

194 use an MCA. The RPS states `Although MCA may be of value to help some patients with  
195 problems managing their medicines and maintaining independent healthy living, they are not  
196 the only intervention for all patients and many alternative interventions are available.  
197 Pharmacists need to be empowered to work with patients to find the best intervention that  
198 helps people use their medicines` (RPS, 2013).

199

200 Blister pack MCAs are commonly used by UK community pharmacists, potentially due to low  
201 costs and ease of use when faced with manual dexterity issues. However, it is limited to four  
202 possible times of medicine administration (morning, lunch, evening and night) and may not  
203 easily accommodate medicines designed to be administered outside of these. Examples  
204 include alendronate for osteoporosis which should be taken first thing in the morning or  
205 medicines for Parkinson's disease which requires multiple daily dosing. Although there is a  
206 strong argument to suggest that adherence aids may not be cost-effective (Mahtani et al.  
207 2011), it is necessary to weigh up the advantages and disadvantages of their use, including  
208 the cost of a device compared to the cost of hospital readmission due to poor adherence.  
209 Another issue is how some care companies refuse to administer from MCAs and others help  
210 prompt them. It is expected to be the same policy across all care homes in the UK.

211

212 Many older individuals, particularly those who experience polypharmacy and co-morbidities  
213 will be assisted by carer. There is said to be a large support base for the use of MCAs from  
214 care homes due to their convenience for the staff and stock control. However there is also  
215 concern about providing inadequate information on pharmacological effects and therefore  
216 patient responses to their regime. Carers are allowed to prompt the patient to take a dose for  
217 example which essentially removes the need for an MCA and also educates them of the  
218 patient's personalised routine making it less like a chore. Some carers argue that the need  
219 for an MCA on their behalf is for protection and accuracy of medication administration due to  
220 lack of resources and time to educate all staff about each patient's circumstances. MAR  
221 (medication administration record) charts play a crucial role in the care home delivery of



222 medication to their patients (Alldred et al., 2009). It is a possible suggestion to maintain the  
223 rigorous use of MAR charts but incorporate them into provision of original packs and not  
224 MCAs which currently has good responses in terms of adherence from rural practices.  
225 Documentation and education are advised to be of higher value to safe handling of  
226 medication than use of an MCA (Oboh, 2011).

227

228 For those patients without a carer, the use of an MCA can restore a sense of control to their  
229 lives as adherence does not only require physical capability but also a behavioural  
230 motivation. From research, patients would ideally want these aspects in a compliance aid:

- 231 • Accessibility – matchbox style, reference panels, foam inserts for release
- 232 • Reminder element – display of current week of regime, physical or audible cue
- 233 • Transportable – to accommodate for their own lifestyle
- 234 • Design – accounted for physical, sensory and cognitive issues faced by older  
235 patients

236

237 Furthermore, reasons for non-adherence should be understood carefully as intentional non-  
238 adherence will mean a compliance aid is ineffective.

239

240 There have been developments in enhancing total medication management through the  
241 Biodose® system which looks to be promising for the future of MCAs. It contains 28 sealable  
242 and removable pods with a MAR chart and patient information. These features are targeted  
243 for care home staff and it can cater for liquid as well as oral medications. Other  
244 characteristics of Biodose® include:

- 245 • pictures of the medication;
- 246 • highly accurate and specific measurement devices where liquids are titrated based  
247 on their viscosities;
- 248 • no need for cups and less time wastage;

- 249 • each pod has patient and medicine information;
- 250 • tamper evident, but medicines are still easily accessed by arthritic patients;
- 251 • cannot be resealed, thus ensuring security, safety and accountability; and
- 252 • claims to improve adherence.

253

#### 254 Future Considerations on MCAs

255 Future research into adherence aids for older individuals should consider the opinions of  
256 GPs through surveys and interviews, as well as social care workers. It would be valuable to  
257 consult older individuals to identify what they would desire in an adherence aid and how they  
258 evaluate current devices available. A usability test could be developed to compare  
259 adherence aids, with consideration given to their ease of opening, transportability and  
260 display features. Another aspect of adherence aids which is still quite unclear is the stability  
261 of medicines once removed from original containers. Stability of medicines in MCAs should  
262 be researched in more depth. Future research should assist with the development of MCAs  
263 that are both aesthetically agreeable and account for the physical impairments of older  
264 patients. This will require active research and the collaboration of GPs, patients, pharmacists  
265 and carers.

266

#### 267 Conclusion

268 Due to the large variety of adherence aids available, it is difficult to select one device to suit  
269 all individuals or for the one individual. Further research is required into patient medicine  
270 adherence before MCAs are widely used, particularly concerning older populations. When  
271 considering an older individual's medication regimen, their GP, the carer, and the pharmacist  
272 are important individuals to consider in all decision making.

273

274 What was clear from the research concerning MCAs is the need for a thorough and patient-  
275 centred assessment tool for pharmacists to use when choosing whether MCAs are

276 appropriate for their patient. A tool should be developed to assist with determining if non-  
277 adherence is intentional or unintentional. If unintentional, it should be proceed to utilise  
278 reminders and methods to easily access their medication. The MCA chosen must be tailored  
279 towards the patient considering factors such as accessibility, function as a medication  
280 storage container and convenience for the patient or person responsible for administering  
281 medication.

282

### 283 Disclosure of interest

284 The authors declare that they have no conflicts of interest concerning this article.

285

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