1 **Evaluation of the prescribing decision support system *Synonyms* in an urban primary care**

2 **setting in Scotland: a mixed-method study**

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12

13 **Author Contributions**

14 The concept of the study originated with MAMcL. MAMcL and CMS designed the study

15 protocol and questionnaires. LR contributed to questionnaire design, and was responsible

16 for undertaking the study, for data collection and for data analysis. GB and AK contributed to

17 the study design and interpretation of results. All authors contributed to the writing of the

18 manuscript.

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25  Procurator Fiscal Service and all the primary care prescribers who participated in the

26  questionnaires and interviews.

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36  **Ethical approval:**

37  The West of Scotland Research Ethics Committee (REC) advised that, as this project was a

38  service evaluation and involved only NHS GG&C staff, it did not require NHS REC review.  As

39  a student (MSc) project, the project was reviewed and approved by the University of Glasgow

40  College of Medical, Veterinary and Life Sciences REC and the University of Strathclyde

41  Institute of Pharmacy and Biomedical Sciences.

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43

44    ABSTRACT

45    **Background**

46    Primary care prescribers must cope with an increasing number and complexity of

47    considerations. Prescribing decision support systems (DSS) have therefore been developed to

48    assist prescribers. Previous studies have shown that although there is wide variance in the

49    different DSS available within primary care, barriers and facilitators to uptake remain. The

50    Drug Synonyms function ("*Synonyms*") is a DSS inherent in the commercial electronic medical

51    record system EMIS.  *Synonyms* functionality has been further developed by the NHS Greater

52    Glasgow and Clyde (GG&C) Central Prescribing Team to promote safe and cost-effective

53    prescribing, however it does not support the collection of usage data. As there is no

54    knowledge on the uptake nor on the perceived effect of using *Synonyms* on prescribing,

55    quantitative and qualitative analysis of *Synonyms* usage is required to ascertain the impact

56    *Synonyms* has on primary care prescribers, which will influence the continued maintenance

57    and/or future development of this prescribing DSS.

58

59    **Aim**

60    To determine the uptake of *Synonyms* and explore users' perceptions of its usefulness and

61    future development.

62

63    **Design and setting**

64    An exploratory sequential mixed-method observational study using quantitative

65    questionnaires, followed by semi-structured interviews with primary care prescribers within

66    NHS GG&C.

67

**68**    **Method**

**69**    An electronic questionnaire (Questionnaire 1) accessible across 218 EMIS-compliant NHS

**70**    GG&C GP practices ascertained *Synonyms* uptake by determining whether prescribers were

**71**    aware of the DSS and if they were aware of it, whether they used it. Prescribers who were

**72**    aware of and used Synonyms were asked to opt in to participating further. This involved

**73**    answering a second electronic questionnaire (Questionnaire 2), with the option of taking part

**74**    in an additional one-to-one interview, to investigate their use and perceptions of *Synonyms.*

**75**

**76**    **Results**

**77**    Questionnaire 1 was completed by 201 respondents from 43.1% of eligible GP practices: 186

**78**    (92.5%) respondents were aware of *Synonyms*, of whom 163 (87.6%) had used it and 155

**79**    (83.3%) continued to use it. Questionnaire 2 was completed by 104 respondents: 90 (86.5%)

**80**    indicated that *Synonyms* informed or influenced their choice of drug prescribed; 94 (90.4%)

**81**    reported that *Synonyms* changed their prescribing choice towards medication on NHS GG&C

**82**    formulary and 104 (100%) reported that they trust *Synonyms*. Six interviews generated

**83**    suggestions for improvements, mainly extending the clinical conditions listed.

**84**

**85**    **Conclusion**

**86**    Most respondents were aware of and continued to use *Synonyms*. Respondents perceived

**87**    *Synonyms* to influence prescribing choices towards local formulary medicines and improve

**88**    adherence to local prescribing guidelines. Respondents trusted the DSS, but there is potential

**89**    to increase awareness and training amongst non-users to encourage usage. Potentially, the

**90**    NHS GG&C *Synonyms* function could be utilised by other health boards with supportive

**91**    clinical systems.

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94

95  INTRODUCTION

96

97  Primary care prescribers must cope with an increasing number and complexity of

98  considerations when making prescribing decisions. By 2013, there had been a 33% increase

99  in the quantity of medicines prescribed by General Practitioners (GPs) in Scotland compared

100  with the preceding seven years and, on average, a GP issues 70 prescriptions per day.[1] With

101  medication being the most prevalent form of intervention for many acute and chronic

102  conditions,[2] prescribing decision support systems (DSS) have been developed to assist

103  appropriate prescribing for individual conditions, by including drug and dosing

104  recommendations, and in avoiding drug interactions for multiple conditions.

105

106  There is wide variance in DSS available in primary care in Europe; some offer support in the

107  diagnosis as well as management of the condition, whilst others only cover the management

108  of an individual or a few chronic conditions.[3-5]

109

110  Previous research on the implementation of DSS has found that, although advances have

111  been made over the years, the barriers and facilitators to uptake have remained largely

112  unchanged.[6] Main barriers include limited computer skills of clinicians; level of system

113  integration and relevance of clinical messages.[6] The important facilitators are: clinicians'

114  belief in the usefulness of DSS in enhancing decision making and hence better prescribing

115  practice, and the support of management and senior clinicians.[6, 7] Clinicians' expectations

116  from a DSS include: up-to-date drug recommendations and dose suggestions; aid to decision

117  making; guidance, not steering; save time and increase patient safety.[8] Furthermore, it has

118  been demonstrated that where DSS are integrated with patients' electronic records, they are

119     more likely to be utilised by prescribers.[3, 9] DSS that do not meet the requirements of the

120     clinician's role are perceived as useless.[7]

121

122     Many published studies that evaluated the implementation of DSS used either quantitative

123     or qualitative methods.[3-5, 10-12] One qualitative interview study[3] reported that using a mixture

124     of both methods would provide a more extensive evaluation than either method alone.

125

126     NHS Greater Glasgow and Clyde (GG&C) is the largest health board in Scotland, serving a

127     population of 1.14 million.[13] NHS GG&C utilises an electronic medical record system provided

128     by a commercial vendor EMIS (Egton Medical Information Systems,

129     https://www.emishealth.com/). "EMIS Drug Synonyms", known as "*Synonyms*", is an active

130     primary care prescribing DSS inherent in the EMIS system since 2011 to promote safe and

131     cost-effective prescribing (Box 1).[14] NHS GG&C Central Prescribing Team have adapted and

132     developed the *Synonyms* system to ensure it is relevant to NHS GG&C formulary guidelines.

133     At the point of prescribing, prescribers enter a disease short code, which is a full stop followed

134     by an abbreviation for the condition e.g. .AST for asthma, .TON for tonsillitis, and are

135     presented with prescribing choices based on NHS GG&C guideline and formulary

136     recommendations for the identified condition.[14]

137

138     *Synonyms* functionality does not enable usage data to be collected automatically and manual

139     collection would not be possible, given the number of primary care prescribers (760

140     prescribers across 218 primary care practices) who have access to the system. There is

141     therefore a lack of knowledge on the uptake and effect of this DSS.

142

143    The aim of this study was to determine uptake of the *Synonyms* function by prescribers, users'

144    perceptions of its usefulness and for them to make recommendations on its maintenance

145    and/or future development.

146

147    METHODS

148    This was an exploratory sequential mixed-method observational study of 218 of 240 GP

149    practices within NHS GG&C, each of which uses the EMIS clinical system (the remaining 22

150    use another system that does not support *Synonyms*).  The study targeted GP practice-based

151    primary care prescribers within NHS GG&C (n = 760 prescribers); study respondents were

152    therefore GPs, nurses and pharmacists. NHS Research Ethics Committee (REC) approval was

153    not required as the project was a service evaluation involving only NHS GG&C staff; ethical

154    approval was provided by the University of Glasgow College of Medical, Veterinary and Life

155    Sciences REC and the University of Strathclyde Institute of Pharmacy and Biomedical Sciences

156    for the undertaking of a student (MSc) project. The study consisted of two phases: firstly,

157    quantitative questionnaires to estimate uptake and to understand respondents' perceptions

158    of usefulness; secondly, semi-structured interviews with respondents to the first

159    questionnaire to obtain in-depth understanding of respondents' comprehension of *Synonyms*

160    functionality, suggest improvements to the current system and establish reasons why other

161    primary care prescribers do not use it.

162

163    **Phase 1: Questionnaires**

164    Two questionnaires (see Supplemental Material) were designed which encompassed the

165    points outlined by Gendall[16] regarding questionnaire design, question wording and layout.

166    The aim of Questionnaire 1 (Q1) was to establish uptake of *Synonyms* functionality and

167    Questionnaire 2 (Q2) was to understand its usage, usefulness and consequences. The

168    questionnaires were piloted amongst the NHS GG&C Central Prescribing Team collaborators

169    (4 Lead Pharmacists, 2 Senior Prescribing and Information Analysts, 1 GP) whose professional

170    responsibilities included the development and maintenance of the PSS and who were not part

171    of the study cohort,   to assess ease of completion and ensure questions were phrased

172    unequivocally.

173

174    Every GP practice in NHS GG&C has access to a Prescribing Support Pharmacist (PSP), who

175    verbally and electronically informed each Practice Manager (n = 218) of the study. With a

176    total of 760 prescribers, there are, on average, 3-4 prescribers in each of the 218 NHS GG&C

177    primary care practices. The Participant Information Sheet and link to Q1 were distributed

178    electronically by Practice Managers to all prescribers (GPs, nurses and pharmacists) within

179    their practice. Reminders were sent to the PSPs and details of the study were included in a

180    group email and a health board prescribing bulletin. Data collection took place over a 10-

181    week period from November 2017 – January 2018. Completion of Q1 was indicative of

182    consent and was required before Q2 was distributed.

183

184    Q1 asked whether respondents were aware of, had ever used and continued to use

185    *Synonyms*.  Those who were not aware, had never used *or* had discontinued use were asked

186    if they would like to become more aware of, start using and regularly use *Synonyms*.  They

187    were not asked to participate further.

188

189    Respondents who indicated in Q1 that they were aware of the DSS, had used it *and* continued

190    to use it were asked to answer further questions on why and how often it was used, and on

191    the perceived effect of usage on prescribing, by completing Q2 electronically with the option

192    of an *additional* face-to-face interview.

193

194    Q2 was distributed (February 2018) directly via email to users who had opted to participate

195    further at the end of Q1 and had provided email contact details. Two weeks after the initial

196    mailing, a reminder was sent with a second reminder after 4 weeks. The questionnaire closed

197    at the end of March 2018. Depending on the question, respondents were either asked to

198    select one or more pre-defined answers or complete a 5-point Likert scale to indicate their

199    level of agreement with a statement.  Pre-defined answers were originally compiled based on

200    anecdotal feedback and experience. Participants could also specify "Other" responses and

201    provide comments using free-text.

202

203    Both questionnaires were hosted and accessed via Webropol, an online survey tool

204    (http://w3.webropol.com/). All electronic data was anonymised, exported and stored by the

205    lead author. Only the lead author had access to the identifiable data; as other authors are

206    responsible for the content and delivery of the DSS, their access was limited to anonymised

207    data.

208

209    **Phase 2: Interviews**

210    A convenience sample of users (n = 6) completed a supplementary face-to-face, semi-

211    structured interview, lasting approximately 15 minutes. They were selected from those who

212    had opted-in at the end of Q1 to participate in an interview (n = 11). Interviews were

213    undertaken at the respondents' work premises.  Written consent for recording the interview

214    was obtained.   Interviews were audio-recorded, anonymised, and transcribed verbatim.

215 Interviews proceeded until data analysis indicated that data saturation (i.e. when no new

216 information or themes are observed in the data[16]) had been reached.

217

218 **Data analysis**

219 Descriptive analysis was performed on the quantitative data obtained from the

220 questionnaires using frequency distribution. The qualitative data were analysed thematically

221 supported by software NVivo version 11.0 (https://www.qsrinternational.com/nvivo/home)

222 to facilitate coding of interview transcripts, data organisation and thematic analysis. Data

223 saturation was reached after six interviews when no new themes were generated, indicating

224 redundancy of further data collection. Additional interviews were therefore not undertaken,

225 of which the remaining five volunteers were informed .

226

227 RESULTS

228 **Respondent demographics**

229 Of the 218 GP practices surveyed, 94 (43.1%) responded to Q1; with a minimum of 1 and a

230 maximum of 6 respondents per practice, a total of 201 prescribers (26.4% of 760 prescribers)

231 completed Q1 (Table 1). Of the 201 responding prescribers, 128 prescribers (63.7%) who were

232 aware of and had used *Synonyms* opted in to Q2 (Figure 1), which achieved an 81.3% (n=104)

233 uptake rate. Of these, 11 agreed to interviews; six interviews were conducted (two nurses

234 and four GPs) until data saturation was reached. Completion rates for Q1 and Q2 were 100%;

235 no responses were omitted. Most study respondents were female (>64% for Q1, Q2 and

236 interviews) and the majority (>66%) were GPs. The respondents represented all age ranges,

237 working patterns, types of GP practices and number of years prescribing (Table 1).

238

239 **Q1: Uptake of *Synonyms***

240 One hundred and eighty-six (92.5% of 201) respondents were aware of *Synonyms*, of whom

241 163 (87.6%) had used it and 155 (83.3%) continued to use it. Of the total 46 respondents who

242 were either not aware of *Synonyms* (n=15), were aware but had not used it (n=23) or who did

243 not continue to use it (n=8), most indicated that they wished to become more aware of

244 *Synonyms* (n=32), to start using it (n=28) and use it regularly (n=24).

245

246 **Q2: Awareness of and Training in *Synonyms***

247 Over half of the 104 respondents (n=59, 56.7%) became aware of *Synonyms* from either the

248 NHS GG&C Prescribing Team (n=33, 31.7%) or another clinician in the practice (n=26, 25%). A

249 further 13.5% (n=14) were made aware by either Practice Manager or Practice Staff. The

250 numbers who reported having accessed training on how to use the DSS  were low, with only

251 19.2% (n=20) reporting they had received training and 22.1% (n=23) unable to remember if

252 training had been received.

253

254 **Q2: Reasons for First Use of *Synonyms***

255 The most common levers for uptake are shown in Figure 2.  The main reason (36%) for using

256 *Synonyms* was that it was a potential tool to support rational cost-effective prescribing.

257 "Other" reasons specified by respondents included: wanted to know formulary choices; when

258 medication has failed and another medication is required for the problem; and showing

259 trainee GP how to use EMIS and become familiar with treatment options.

260

261 **Q2: Frequency of Use**

262    Frequency of use of *Synonyms* varied (Figure 3) with the most common use being more than

263    once per week and more than once per day, both 30.8% (n=32).

264

265    **Q2: Usefulness of *Synonyms***

266    The circumstances in which respondents found the DSS most useful was "prescribing for an

267    area I do not prescribe in often" (n=30, 28.9%); "as a shortcut to prescribing for common

268    conditions" (n=29, 27.9%) and "providing pre-populated dose directions and quantities"

269    (n=19, 18.3%).

270

271    Use of the system informed or influenced choice of drug prescribed for 86.5% (n=90) of

272    respondents. For 54.8% (n=57) of respondents, *Synonyms* use changed the dose or quantity

273    of drug prescribed. The majority of respondents (n=94, 90.4%) reported that usage changed

274    their prescribing choice towards NHS GG&C formulary preferred choice. High ratings for

275    definitely (n=47, 45.2%) or slightly more confident (n=40, 38.5%) were reported for the effect

276    of usage on confidence in prescribing. Trust in *Synonyms* was reported by 100% (n=104) of

277    respondents.

278

279    No differences in results were evident between the demographic and professional

280    characteristics of the study population.

281

282    **Q2: Advantages of using *Synonyms***

283    Figure 4 shows the ratings of the advantages of using *Synonyms*. High ratings were given for

284    "helps me to make prescribing choices which are more aligned with NHS GG&C formulary

285    choices" (n=92, 88.5%) and "helps me to follow local guidelines for prescribing" (n=77, 74%).

286 "Other" advantages specified by respondents were: prepopulated dose directions should

287 reduce prescribing errors; extremely useful for paediatric doses and training resource *e.g.* FY2

288 Doctors.

289

290 **Q2: Disadvantages of Using *Synonyms***

291 The most reported disadvantage (Figure 5) at 44.2% (n=46) was "I cannot remember the

292 shortcut to the condition I am looking for". "Other" disadvantages specified by respondents

293 were: risk of reliance on the prescribing decision support system and it did not include travel

294 vaccines. A number of respondents used the "Other" section to note that there were no

295 obvious negatives.

296

297 **Interviews: Perceptions of *Synonyms***

298 Semi-structured interviews were conducted with two nurses and four GPs. Box 2 illustrates

299 the themes identified in relation to respondents' perceptions of the *Synonyms* functionality

300 and role. Most described the function as providing formulary medicines for common

301 conditions. Prescribing tool, resource to reduce wrong prescribing and enables quicker

302 prescribing were commonly cited as its role.

303

304 **Q2 and Interviews: Changes to the current system**

305 Among all respondents, the name *Synonyms* was not agreeable, with indications that the

306 name did not reflect the intended purpose of the function. However, suggestions proposed

307 for an intuitive name were limited.

308

309     Several potential improvements to the system were identified. Common themes were

310     extending the disease short code list, making the short codes more easily identifiable and

311     organised more efficiently.

312

313     It was perceived that other respondents did not use *Synonyms* due to lack of awareness of

314     both its existence and function, caused by a lack of promotion.

315

316

317     DISCUSSION

318     **Summary**

319     This study has shown that the vast majority of respondents were aware of and continued to

320     use *Synonyms*. The aim of *Synonyms* is to promote safe and cost-effective prescribing[14] and

321     this was cited as the prevalent lever for its use. Although only a quarter of respondents who

322     continue to use *Synonyms* reported that one positive consequence was that prescribing at

323     health board level would be improved, improvements in formulary compliance will

324     undoubtedly improve health board prescribing.

325

326     Low numbers of respondents received training, which may indicate that the system is easy to

327     use and can be used effectively even without training. Every respondent who continued to

328     use *Synonyms* reported trust in it*.*

329

330    New areas for the development and improvement of the current system were identified. By

331    increasing the number of conditions included and clarifying the short codes for conditions,

332    there is potential for uptake to be increased.

333

334    **Strengths and limitations**

335    This is the first study of primary care prescribers' views and perceptions of a "disease based"

336    prescribing formulary system that is accessible from the usual clinical prescribing screen.

337

338    Although a large number of GPs (n = 160, Table 1) responded to Q1, they represented less

339    than half (43.1%) of eligible GP practices in NHS GG&C (n = 218).[17]  Possible reasons for this

340    include: reliance on practice managers to disseminate Q1 by electronic means; and reluctance

341    of prescribers to complete a questionnaire regarding a system that they had limited

342    experience of.  It is possible that many non-respondents were not aware of, had never used

343    or had a negative experience of using the DSS.  There is therefore a potential non-response

344    bias in the results. In addition, the perceptions of nurse and pharmacist prescribers are under-

345    represented, as the proportion (10%) of each in our sample are low

346

347    Only respondents who were aware of and continued to use *Synonyms* were invited to

348    complete Q2 to further comment on its advantages and disadvantages.  This meant that 22%

349    of respondents who were either unaware of, had never used or did not continue to use it

350    were not eligible to participate in further qualitative analysis at this stage.  Although this

351    indicates a response bias for Q2, this evaluation exercise intended to assess the perceptions

352    of consistent users, which must be inherently positive, otherwise they would not continue to

353    use *Synonyms*.  The possibility that users' experiences are relatively uniform is evidenced by

354    the fact that only 6 in-depth interviews were required to reach saturation point. The themes

355    identified on analysis were consistent across interviews, indicating that no further interviews

356    were required.  While the small number (n = 6) of in-depth interviews may be considered a

357    limitation, it must be remembered that interviewees answered the same questions as those

358    who completed the electronic version of Questionnaire 2 (n = 104); the interviewees simply

359    had more scope to elucidate on their perceptions of *Synonyms* during a verbal interview as

360    compared to completing a "free text" section in the electronic questionnaire. The answers of

361    the 6 interviewees were therefore supplementary to those of the 104 e-responses.  Raising

362    awareness of the system by increasing training opportunities and reporting the results of this

363    study as evidence of its acceptability and effectiveness could be used to encourage greater

364    usage.

365

366

367    It is important to note that this study took place in an urban health board, where each GP

368    practice has input from a PSP once per week or more, therefore the results might not be

369    directly transferable to more rural health boards or in practices with less PSP support.

370

371    **Comparison with existing literature**

372    Most previous research has explored GP views and experiences of DSS; only one study in 2003

373    included nurses.[3] It reported that nurses may find the content of the DSS clinically more useful

374    then GPs; however, the low level of feedback from nurses in the 2003 study meant the value

375    of the DSS for this professional group could not be assessed.[3] Similarly, only approximately

376    10% of study participants for Q1 and Q2 were nurses. Earlier studies have reported issues

377    where DSS that are not integrated with patients' electronic records are less likely to succeed.[3]

378    This was not a concern in this study as *Synonyms* is integrated into the clinical system.

379

380    Previous research has shown that clinicians want concise, reliable information that underpins

381    everyday prescribing decisions available at the point of prescribing[8], which is what *Synonyms*

382    delivers. They want the DSS to: have up-to-date drug information; aid the prescribing

383    decision; save time; result in better prescribing practices and increase patient safety [6,7,8], all

384    of which was evident in this present study.

385

386    When considered relative to Bates et al's[18] "Ten Commandments" for DSS, the *Synonyms*

387    system encompasses several positive elements: it is fast, simple to use and fits into clinicians'

388    workflow.  In addition, the knowledge underpinning the system is managed and maintained

389    on a regular basis.  While the *Synonyms* system inherently lacks the ability to monitor and

390    feedback on its own usage, the current study is an attempt to overcome this limitation and to

391    use the knowledge gained therein to move towards responding to users' needs.

392

393    **Conclusion**

394    Although the respondents in this study were possibly more aware of the *Synonyms* function

395    than non-respondents, the usefulness of this DSS to primary care prescribers and its influence

396    in promoting safe and cost-effective prescribing has been highlighted. The NHS GG&C

397    Management Team have been made aware of prescribers' suggestions for improving the

398    current system, particularly in relation to increasing the number of clinical conditions and

399    improving the disease short codes so prescribers can identify them more easily.

400

401   Further work to assess the experiences and perceptions of users who did not continue with

402   *Synonyms* may be undertaken at a later date; it would be beneficial to investigate the barriers

403   to using *Synonyms* and in turn may identify further improvements to the current or future

404   DSS. Future research should also examine the effect of usage on actual prescribing practices,

405   using objective comparisons of prescribing patterns between using versus non-using practices

406   and individual prescribers.

407

408   The NHS GG&C *Synonyms* function could be utilised by other health boards, either in its

409   entirety or edited in line with other health boards' formulary. Further development should

410   aim to ensure that this function could be used with commercial clinical systems in addition to

411   that from EMIS.

412 **Additional Information**

413 **Funding:**

414 No funding was required for the study.

415

416 **Competing interests:**

417 The authors have declared no competing interests. The Synonyms system is developed and

418 managed independently of the manufacturers of the EMIS system, who had no input to this

419 study.

420

421 **Author Contributions**

422 Please see "Title Page" document.

423

424 **Acknowledgements:**

425 Please see "Title Page" document.

426

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