The cost consequences of the Gold Coast Integrated Care Programme

SUPPORTING TEXT 2. Control group matching process

The following outlines the matching strategy used to identify control participants and is represented as a flow chart in Figure 1.

Step 1.

**Intervention group:** Raw data was received from GCHHS Health Analytics for 1,682 intervention participants. Those with no inpatient admissions (or missing data) during this period were ineligible for matching, therefore 133 participants were excluded. The remaining 1,549 were split into two groups: (a) 993 participants with at least one admission with primary or associative diagnoses of heart disease, diabetes mellitus (DM), renal failure or chronic lower respiratory disease and (b) the remaining 556 participants with at least one admission with other diseases. Matching was undertaken using data at baseline (recruitment) of the intervention group and then matched to hospital records for the control group.

**Passive control group:** De-identified raw data was received for 86,665 passive control candidates. One hundred percent of this group had at least one inpatient admission during this period and were therefore eligible for matching. The group was split into two: (a) 18,207 patients with at least one admission with primary or associative diagnoses of heart disease, DM, renal failure, or chronic lower respiratory disease, and (b) 68,458 who were admitted at least once with a diagnosis other than the above listed four primary or associative diagnoses. Matching of a control to one intervention participant was performed separately by these sub-groups: 1,205 passive controls were matched in the (a) sub-group, and 1,025 were matched in the (b) sub-group.

**Active control group:** The active control group was randomly selected from the control group to provide external validation to the HHS data and other measures such as quality of life. A sample of 20% was selected from the passive controls to recruit at least 600 participants for the active control group. Allowing for some deaths and losses to follow-up, over-sampling by 25% was undertaken (750). Raw data was received for 893 active control participants. Those with no inpatient admissions during this period were ineligible for matching, therefore 25 participants were excluded. The remaining 868 were split into two groups: (a) 781 participants with at least one admission with primary or associative diagnoses of heart disease, DM, renal failure, or chronic lower respiratory disease, and (b) the remaining 87 participants with at least one admission with other than the above listed diagnoses. Matching of a control to one intervention participant was performed separately by these subgroups. One hundred percent of the 868 active controls were matched to an intervention participant.
Figure S1. Control group matching flow chart
Step 2.

a. Direct radius matching was done, which was a multi-step process using the `radmatch` command in Stata. This user-written procedure shuffles the controls in a random order, then selects the required number of matches for each intervention participants based on a list of variables of interest and maximum tolerances (radius) for each. Radius of zero means exact match required.

Matching in sub-group (a) used the following list of variables based on presentations for those with the four main conditions:

1) gender (radius=0),
2) age in years in 2015 (radius=5),
3) heart disease (I20-52) as primary or associative diagnosis (radius=0),
4) chronic lower respiratory disease (J40–J47) (radius=0),
5) diabetes mellitus (E10–E14) as primary or associative diagnosis (radius=0),
6) renal failure (N17–N19) as primary or associative diagnosis (radius=0),
7) number of discharges (radius=0), and
8) percentage of discharges linked to potentially avoidable hospitalisations (radius=20).

The matching process was repeated (with slight adjustments) until 100% of intervention participants in sub-group (a) were matched with exactly two control participants.

b. Matching in the sub-group (b) used the following list of variables (including radius), based on common presentations in patients with other conditions:

1) gender (radius=0),
2) age in years in 2015 (radius=5),
3) diseases of oesophagus, stomach and duodenum (K20-K31) as primary, associative or complication diagnosis (radius=0),
4) hernia (K40-K46) as primary, associative or complication diagnosis (radius=0),
5) other diseases of intestines (K55–K64) as primary, associative or complication diagnosis (radius=0),
6) disorders of gallbladder, biliary tract and pancreas (K80–K87) as primary, associative or complication diagnosis (radius=0),
7) other diseases of the digestive system (K90–K93) as primary, associative or complication diagnosis (radius=0),
8) arthropathies (M00-M25) as primary, associative or complication diagnosis (radius=0),
9) dorsopathies (M40–M54) as primary, associative or complication diagnosis (radius=0),
10) soft tissue disorders (M60–M79) as primary, associative or complication diagnosis (radius=0),
11) osteopathies and chondropathies (M80–M94) as primary, associative or complication diagnosis (radius=0),
12) intentional self-harm (X60-X84) as primary, associative or complication diagnosis (radius=0),
13) complications of medical and surgical care (Y40–Y84) as primary, associative or complication diagnosis (radius=0),
14) supplementary factors related to causes of morbidity and mortality classified elsewhere (Y90-Y98) as primary, associative or complication diagnosis (radius=0),
15) falls (W00-W19) as primary, associative or complication diagnosis (radius=0),
16) number of discharges (radius=2), and
17) percentage of discharges linked to potentially avoidable hospitalisations
(radius=20).

The matching process was repeated (with slight adjustments) until 100% of intervention
participants in (b) were matched with exactly two control participants.

**Step 3.**

As recommended by Billot et al (2016), matching performance was investigated by
comparing the baseline characteristics, healthcare utilisation and disease profile between
the two study groups as shown in Table 1. Standardised difference was used as this is not
influenced by sample size [43, 44]. Table 2 presents the participant characteristics by sub-
group (a) and sub-group (b).

Table S1. Measures of equivalence: intervention and controls

|                                | INTV n=1549 | Control n=3042 | Total N=4591 | Std. diff. |
|--------------------------------|-------------|----------------|--------------|------------|
| Gender: females                |             |                |              |            |
| females                        | 822 (53%)   | 1608 (53%)     | 2430 (53%)   | 0.004      |
| Age (years in 2015) a          | 70 (14)     | 69 (14)        | 69 (14)      | 0.040      |
| No. of inpatient admissions (per patient) b | 4 (2-8)     | 4 (2-7)        | 4 (2-7)      | 0.007      |
| Potentially avoidable hosp. (%) per patient b | 0 (0-25)   | 0 (0-25)       | 0 (0-25)     | 0.010      |
| Primary/associative diagnoses: |             |                |              |            |
| diabetes mellitus (E10–14)     | 491 (32%)   | 972 (32%)      | 1463 (32%)   | 0.006      |
| renal failure (N17–19)         | 320 (21%)   | 636 (21%)      | 956 (21%)    | 0.006      |
| heart disease (I20–52)         | 528 (34%)   | 1004 (33%)     | 1532 (33%)   | 0.023      |
| chronic lower respiratory disease (J40–47) | 225 (15%) | 450 (15%)     | 675 (15%)    | 0.008      |
| Prim./assoc./compl. diagnoses (ICD-10): |             |                |              |            |
| diseases of oesophagus, etc. (K20–K31) | 236 (15%) | 358 (12%)    | 594 (13%)   | 0.102      |
| hernia (K40–K46)               | 88 (6%)     | 164 (5%)       | 252 (5%)     | 0.013      |
| other diseases of intestines (K55–K64) | 439 (28%) | 782 (26%)    | 1221 (27%)  | 0.059      |
| disorders of gallbladder, etc. (K80–K87) | 86 (6%)   | 150 (5%)       | 236 (5%)     | 0.028      |
| other digestive system diseases (K90–K93) | 109 (7%) | 214 (7%)      | 323 (7%)     | <0.001     |
| arthropathies (M00–M25)        | 266 (17%)   | 495 (16%)      | 761 (17%)    | 0.024      |
| dorsopathies (M40–M54)         | 174 (11%)   | 308 (10%)      | 482 (10%)    | 0.036      |
| soft tissue disorders (M60–M79) | 126 (8%)   | 217 (7%)       | 343 (7%)     | 0.038      |
| osteo- and chondropathies (M80–M94) | 341 (22%) | 608 (20%)     | 949 (21%)    | 0.050      |
| complications of care (Y40–Y84) | 536 (35%)  | 1033 (34%)     | 1569 (34%)   | 0.013      |
| supplementary factors (Y90–Y98) | 746 (48%)  | 1489 (49)      | 2235 (49%)   | 0.016      |
| falls (W00–W19)                | 252 (16%)   | 568 (19%)      | 820 (18%)    | 0.064      |

\* mean (standard deviation) shown; \* median (25\%/75\% percentiles) shown; data period: 01jul2012 to 30sep2016;
hosp = hospitalisation; INTV = intervention; std. diff. = standardised difference; prim. = primary; assoc. = associative; compl. = complication;
| Table S2. Matched participant characteristics | Main diseases | Other diseases |
|---------------------------------------------|---------------|---------------|
|                                             | Intervention  | Control       | Intervention | Control       |
| Gender: females                             | n=993         | n=1954        | n=556        | n=1088        |
|                                             | 487 (49)      | 956 (49)      | 335 (60)     | 652 (60)      |
| Age group (years):                          | n=1954        | n=1088        |
| up to 50                                    | 70 (7)        | 135 (7)       | 77 (14)      | 157 (14)      |
| 51 to 60                                    | 111 (11)      | 229 (12)      | 73 (13)      | 176 (16)      |
| 61 to 70                                    | 247 (25)      | 490 (25)      | 130 (23)     | 264 (24)      |
| 71 to 80                                    | 340 (34)      | 678 (35)      | 174 (31)     | 321 (29)      |
| 81 or higher                                | 225 (23)      | 422 (22)      | 102 (18)     | 170 (16)      |
| Utilisation outpatient appointments:        |               |               |
| nil                                         | 33 (3)        | 165 (8)       | 199 (18)     | 33 (6)        |
| 1 to 3                                      | 62 (6)        | 187 (10)      | 167 (15)     | 51 (9)        |
| 4 to 11                                     | 151 (15)      | 392 (20)      | 254 (23)     | 106 (19)      |
| 12 to 22                                    | 223 (22)      | 370 (19)      | 178 (16)     | 115 (21)      |
| 23 to 44                                    | 258 (26)      | 427 (22)      | 156 (14)     | 135 (24)      |
| 45 or more                                  | 266 (27)      | 413 (21)      | 134 (12)     | 116 (21)      |
| Utilisation emergency presentations:        |               |               |
| nil                                         | 30 (3)        | 94 (5)        | 41 (7)       | 127 (12)      |
| 1                                           | 126 (13)      | 284 (15)      | 97 (17)      | 299 (27)      |
| 2                                           | 136 (14)      | 293 (15)      | 105 (19)     | 206 (19)      |
| 3 to 4                                      | 211 (21)      | 389 (20)      | 137 (25)     | 200 (18)      |
| 5 to 7                                      | 214 (22)      | 404 (21)      | 92 (17)      | 147 (14)      |
| 8 or more                                   | 276 (28)      | 490 (25)      | 84 (15)      | 109 (10)      |
| length of stay (hours)\(^{a,c}\)            | 3.7 (3.1-4.6) | 3.8 (3.0-4.7) | 3.8 (2.9-4.8)| 3.7 (2.8-4.6)|
| Utilisation inpatient admissions:           |               |               |
| nil                                         | 0 (0)         | 2 (0)         | 1 (0)        | 2 (0)         |
| 1                                           | 57 (6)        | 201 (10)      | 76 (14)      | 273 (25)      |
| 2                                           | 212 (21)      | 438 (22)      | 148 (27)     | 340 (31)      |
| 4 to 5                                      | 190 (19)      | 326 (17)      | 127 (23)     | 173 (16)      |
| 6 to 10                                     | 258 (26)      | 523 (27)      | 128 (23)     | 181 (17)      |
| 11 or more                                  | 276 (28)      | 464 (24)      | 76 (14)      | 119 (11)      |
| length of stay (days)\(^{a,c}\)            | 2.2 (1.1-3.9) | 2.2 (1.0-4.4) | 1.3 (0.7-3.2)| 1.1 (0.5-2.8)|
| - PPH\(^{bc}\)                              | 21%           | 20%           | 7%           | 6%            |
| Chronic diseases (ICD-10 codes):            |               |               |
| diabetes mellitus (E10–E14)                 | 499 (50)      | 985 (50)      | 22 (4)       | 16 (1)        |
| heart (I20–I52)                             | 570 (57)      | 1062 (54)     | 34 (6)       | 39 (4)        |
| lower respiratory (J40–J47)                 | 249 (25)      | 485 (25)      | 10 (2)       | 12 (1)        |
| kidney (N17–19)                             | 375 (38)      | 708 (36)      | 22 (4)       | 32 (3)        |
| Number of above chronic diseases:           |               |               |
| nil                                         | 2 (0)         | 24 (1)        | 484 (87)     | 1008 (93)     |
| 1 of 4                                      | 506 (51)      | 1021 (52)     | 55 (10)      | 63 (6)        |
| 2 of 4                                      | 301 (30)      | 570 (29)      | 15 (3)       | 9 (1)         |
| 3 of 4                                      | 151 (15)      | 269 (14)      | 1 (0)        | 6 (1)         |
| 4 of 4                                      | 33 (3)        | 68 (3)        | 0 (0)        | 0 (0)         |

\(^{a}\) median (25\(^{th}\) and 75\(^{th}\) percentiles) shown; prev. = preventable; \(^{b}\) mean; sample period 01jul2012 to 30sep2017; frequencies and column percentages shown unless otherwise noted; \(^{c}\) excluding patients with no events; PPH=potentially preventable hospitalisations
Reference
Billot, L., Corcoran, K., McDonald, A., Powell-Davies, G., & Feyer, A. M. Impact Evaluation of a System-Wide Chronic Disease Management Program on Health Service Utilisation: A Propensity-Matched Cohort Study. PLoS Med. 2016; 13(6), e1002035. doi:10.1371/journal.pmed.1002035