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1 **Determinants of hospital length of stay for people with**
2 **serious mental illness in England and implications for**
3 **payment systems: A regression analysis**

4
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23

24 **Abstract**

25 **Background**

26 Serious mental illness (SMI), which encompasses a set of chronic conditions such as
27 schizophrenia, bipolar disorder and other psychoses, accounts for 3.4m (7%) total bed
28 days in the English NHS. The introduction of prospective payment to reimburse
29 hospitals makes an understanding of the key drivers of length of stay (LOS)
30 imperative. Existing evidence, based on mainly small scale and cross-sectional
31 studies, is mixed. Our study is the first to use large-scale national routine data to track
32 English hospitals' LOS for patients with a main diagnosis of SMI over time to
33 examine the patient and local area factors influencing LOS and quantify the provider
34 level effects to draw out the implications for payment systems.

35 **Methods**

36 We analysed variation in LOS for all SMI admissions to English hospitals from 2006
37 to 2010 using Hospital Episodes Statistics (HES). We considered patients with a LOS
38 of up to 180 days and estimated Poisson regression models with hospital fixed effects,
39 separately for admissions with one of three main diagnoses: schizophrenia; psychotic
40 and schizoaffective disorder; and bipolar affective disorder. We analysed the
41 independent contribution of potential determinants of LOS including clinical and
42 socioeconomic characteristics of the patient, access to and quality of primary care,
43 and local area characteristics. We examined the degree of unexplained variation in
44 provider LOS.

45 **Results**

46 Most risk factors did not have a differential effect on LOS for different diagnostic
47 sub-groups, however we did find some heterogeneity in the effects. Shorter LOS in
48 the pooled model was associated with co-morbid substance or alcohol misuse (4
49 days), and personality disorder (8 days). Longer LOS was associated with older age
50 (up to 19 days), black ethnicity (4 days), and formal detention (16 days). Gender was
51 not a significant predictor. Patients who self-discharged had shorter LOS (20 days).
52 No association was found between higher primary care quality and LOS. We found
53 large differences between providers in unexplained variation in LOS.

54 **Conclusions**

55 By identifying key determinants of LOS our results contribute to a better
56 understanding of the implications of case-mix to ensure prospective payment systems
57 reflect accurately the resource use within sub-groups of patients with SMI.

58
59 350 words
60

61 **Key words:**

62 Schizophrenia; Bipolar disorder; Psychosis; Serious mental illness; Length of stay;
63 Hospitalisation; Mental health funding; Prospective payment; Resource use

64 **Background**

65 Serious mental illness (SMI) encompasses a range of chronic and frequently disabling
66 conditions including schizophrenia, bipolar disorder and psychoses. These conditions
67 are associated with substantial morbidity and mortality. The life expectancy of SMI
68 patients is 10 to 15 years shorter than the general population in England [1], and 15 to
69 20 years shorter in Denmark, Finland and Sweden [2]. A recent global morbidity
70 study attributed 3.5% of total Years Lost to Disability to schizophrenia and bipolar
71 disorder combined [3]. The two diseases alone are estimated to constitute 1.5% of the
72 total Disability Adjusted Life Year burden of disease for the UK in 2010 [4] and 1.1%
73 in 21 regions worldwide [5]. People with SMI are at higher risk of hospitalisations
74 than the general population [6, 7] as physical comorbidity is more common [8, 9].
75 SMI is associated with increased treatment costs [10] and hospitalisation for this
76 patient group represents a significant proportion of health care resource use. In
77 England, these illnesses account for 3.4 million or 7.2% of total bed days [11]. This
78 paper examines the key patient and local area determinants of inpatient length of stay
79 (LOS) for patients with a main diagnosis of SMI and examines the variation in LOS
80 between hospital providers in England.

81

82 The delivery of mental health services and the incentives that service providers face
83 have changed radically in the last few decades. Most western health care systems have
84 deinstitutionalised care for patients with mental health problems and shifted treatment
85 from secondary care settings into the community [12]. This has led to significant
86 reductions in average LOS and also in overall numbers of psychiatric beds. More
87 recently, policy shifts have focused on changes in funding arrangements for mental
88 health care as a response to pressure to contain costs. Whereas most health care
89 systems reimburse the full costs for providers of inpatient care, several are
90 considering the use of activity-based prospective payment systems, similar to those
91 already in use in the acute physical care setting, in order to reduce costs [13]. Canada
92 (Ontario), Australia and New Zealand have developed case-mix classification systems
93 for mental health services which have included information on diagnosis. In Australia
94 and New Zealand provider factors were shown to significantly drive cost variations
95 making the classification systems unsuitable for provider payment [13].

96

97 In England, the National Health Service (NHS) is moving away from traditional block
98 contracts towards a more transparent prospective funding for providers called the
99 National Tariff Payment System (NTPS) (formerly known as Payment by Results
100 (PbR) [14]). Under the NTPS, patients are classified into one of 21 care clusters based
101 on need and severity, rather than diagnostic coding. These clusters are in turn grouped
102 into three super-classes corresponding to non-psychotic, psychosis and organic mental
103 illness. The intention is that each cluster will have a fixed national price based on the
104 national weighted average cost of admitted and non-admitted care. Each cluster has a
105 specific review period attached to it with payments made to cover all care during the
106 cluster review period. Whilst the current implementation of NTPS focuses on the
107 development of locally negotiated cluster prices, the move towards a national fixed
108 price payment system would provide a strong incentive to control costs and should
109 therefore encourage providers to reduce LOS. Evidence from the US has reported
110 reductions in LOS following the introduction of a prospective payment system in
111 psychiatric care, as well as reductions in LOS due to anticipatory effects prior to
112 payments starting [15, 16]. LOS for inpatient care is a major driver of resource use
113 and is highly correlated with hospital costs, especially when care is labour-intensive
114 as is the case in mental health [17]. Reductions in LOS may reduce the very high
115 psychiatric bed occupancy rates observed in the English NHS and the associated
116 difficulties in accessing acute psychiatric beds for severely ill patients in crisis [18],
117 although driving down reductions in LOS too far can impact on quality and outcomes
118 and may increase readmission rates [19-21].

119

120 Differences in LOS across providers can reflect differences in patient needs, but can
121 also be indicative of differences in treatment philosophies and practice patterns [22]
122 and in efficiency of care provision. A better understanding of the factors which
123 determine LOS is imperative for the design of payment systems, e.g. by identifying
124 high cost casemix profiles. Estimates of how LOS varies between providers after
125 allowing for differences in case-mix can also provide measures of the extent to which
126 LOS may be amenable to potential reductions by high cost providers in response to
127 the introduction of a prospective payment system. Given the high proportion of bed
128 days and the high cost associated with the care of people with psychotic disorders, as
129 well as the fact that psychosis is one of the three super-classes in the NTPS, this study
130 focuses on the determinants of LOS for people with SMI.

131

132 There is conflicting evidence about the key determinants of hospital LOS for people
133 with SMI. This may in part reflect the methodological weaknesses in many previous
134 studies. Many studies are cross-sectional with small samples split into case-control
135 groups by mean or median LOS in order to examine the difference between long and
136 short-stays, typically using logistic regression. Comparing sub-populations in this way
137 leads to inconsistent findings as LOS is typically skewed and sub-populations may be
138 small [12]. Single site studies are not generalisable to other settings with a different
139 patient case-mix [23]. Finally, SMI covers a range of clinical sub-groups with
140 different treatment requirements. Studies to date have typically pooled clinical sub-
141 groups to increase their sample size, making the untested assumption that risk factors
142 will have the same effect on all sub-groups.

143

144 This study has two aims. First, we aim to assess the independent effects of patient
145 characteristics (case-mix) and local area characteristics on LOS and study whether
146 there is heterogeneity in those effects across patient sub-groups with SMI. We
147 improve on previous work by using large scale administrative datasets to investigate
148 factors associated with LOS. Second, we aim to assess the degree of unexplained
149 variation in provider LOS i.e. the variation which remains after controlling for the
150 patient and local area characteristics in our model. The residual unexplained variation
151 in LOS may be interpreted as the element most amenable to influence by
152 policymakers and providers. Thus it may help to define the limits on the extent to
153 which a prospective payment system for providers may be successful in reducing LOS
154 and costs.

155 **Determinants of length of stay for patients with** 156 **serious mental illness**

157 We searched the literature for key determinants of LOS for patients with SMI to
158 identify a relevant set of explanatory variables for subsequent analysis. We searched
159 several bibliographic databases (e.g. PubMed, EMBASE, PsycINFO) to identify
160 relevant literature published between 1946 and 2014. Our search strategy (see
161 Appendix 1) included terms for schizophrenia, psychotic disorders, bipolar disorder;
162 for trials, cohort studies or systematic reviews; and length of stay. Titles were
163 screened and abstracts were checked for relevance from 132 articles. We found 15

164 studies with LOS as the primary or secondary outcome for patients with SMI
165 specifically. We also identified 5 studies from alternative sources such as suggestions
166 from experts.

167

168 Most studies consider 3 groups of predictor variables: (a) socio-demographic
169 characteristics of patients (e.g. age, gender, living arrangements, degree of social
170 support, ethnicity, insurance status); (b) clinical characteristics (e.g. psychiatric
171 diagnosis, severity, legal status/compulsory admission, psychiatric or physical co-
172 morbidities, measure of functioning, previous admissions, medication); and (c)
173 characteristics of hospitals or the health care system (e.g. type of hospital, measures of
174 quality of care).

175

176 While some studies covered a wide array of determinants, many of these were found
177 not to be significant and the results for some factors differed across studies. Socio-
178 demographic characteristics which were associated with increased LOS for patients
179 with SMI include being single / not married [24-26], having accommodation or
180 housing problems [12, 26-28], having no educational qualification [12, 29], being on a
181 national health insurance plan [30, 31], and being in receipt of welfare [29], whilst
182 higher deprivation was associated with shorter LOS in another study [32]. There is
183 limited evidence of an effect for ethnicity [25]. Being a foreigner was associated with
184 increased LOS in one study [29] while being a migrant was associated with reduced
185 LOS in another [12]. Having family ties or social support was also associated with
186 reduced LOS [33, 34]. Older age was associated with increased LOS in some studies
187 [25, 30, 32, 33, 35], and reduced LOS in others [29, 31, 36]), while male gender was
188 associated with increased LOS in some studies [24, 30, 31], and reduced LOS in
189 others [25, 26, 32, 37]).

190

191 Clinical characteristics which were associated with increased LOS for patients with
192 SMI include: a primary diagnosis of schizophrenia or psychosis [25-27, 29, 31, 32,
193 35, 36, 38, 39] or a mood disorder [35] although some studies found diagnosis to be a
194 poor predictor of LOS [39, 40]. Other characteristics associated with increased LOS
195 were higher severity as measured by e.g. the Brief Psychiatric Rating Scale (BPRS)
196 [24, 41, 42] or the Global Assessment of Functioning (GAF) [37] or other severity
197 indicators [28, 39]. Co-morbidities were associated with increased LOS in some

198 studies [24, 29], while having no secondary diagnoses increased LOS in other studies
199 [30]. A diagnosis of co-morbid substance abuse was associated with a reduced LOS
200 [35, 37, 39] as was personality disorder [37]. Prior hospitalisation was associated with
201 increased LOS in some studies [32, 35, 38] but with lower LOS in other studies [29].
202 Previous violence / forensic history was positively associated with LOS [28, 33] as
203 was use of seclusion or restraint [12, 37]. Legal status/compulsory admission as a risk
204 factor was positively associated with LOS in some studies [23, 38], but negatively in
205 others [25, 26]. Being on an open rather than a locked ward was associated with
206 reduced LOS [29] as was having an emergency admission or weekend admission [32]
207 and being discharged against medical advice [26]. Receiving psychopharmacological
208 medication, such as neuroleptics, antidepressants and lithium was associated with
209 reduced LOS in one study [29] and increased LOS in another [27]. Being admitted
210 from another institution was positively associated with LOS in one study [34] and
211 negatively in another [12].

212

213 Finally, characteristics of hospitals and the healthcare system which were positively
214 associated with LOS include the patient being treated at a psychiatric hospital, rather
215 than another type of hospital [30, 31], a higher number of beds [25, 30, 31], a higher
216 proportion of male patients [31], and a higher proportion of elderly patients [31]. The
217 number of health care professionals employed was associated with reduced LOS [30,
218 31] as was a shorter distance from patient's place of residence to hospital [24]. There
219 was also evidence of marked regional variation in LOS [12, 38].

220 **Methods**

221 **Study population**

222 Our study population was all patients aged 18 or over and admitted with a primary
223 diagnosis of SMI to a mental health hospital in England during the study period April
224 2006 to October 2010. All patients were followed until March 2011. SMI patients
225 were identified using ICD-10 diagnostic codes in the primary diagnosis field of their
226 admission record. Many studies focus on a wide range of mental health conditions and
227 thus tend to group the primary diagnoses according to type of disorder by ICD-10
228 code (e.g. F2, F3) which also reflects severity to some degree [12, 43]. We focussed
229 on individual conditions within SMI to more accurately assess the impact on resource
230 use for each condition. In addition to considering the effects of patient and local area

231 characteristics on LOS for all SMI patients in a pooled model (1), we also examined
232 patients with three types of SMI: (2) schizophrenia (F20); (3) schizoaffective
233 disorders, and schizotypal and delusional disorders (F21- F29); and (4) bipolar and
234 mood affective disorders (F30-F31) (see Table 1).

235 Table 1 about here

236 **Data sources**

237 Our study combined several datasets. Record-level data on hospital admissions were
238 obtained from the Hospital Episodes Statistics (HES) which covers all NHS-funded
239 secondary care in England. These data are reported as Finished Consultant Episodes
240 (FCEs) and we converted these to continuous inpatient spells (CIPS) (admissions).
241 Using CIPS has the advantage that it reduces coding errors e.g. where patients leave
242 hospital for a weekend but are not discharged, they may otherwise be coded as a new
243 admission on their return. We used HES to derive our dependent variable (LOS) and a
244 range of demographic and clinical characteristics. Individual patient records were
245 linked over time through a unique patient identifier, based on the patient's NHS
246 number. Data on local area-level characteristics (i.e. the number of people resident in
247 an NHS community psychiatric establishment, and urban status) were sourced from
248 the Office of National Statistics (ONS). These data were derived from the 2001
249 Census and were available at small area level (Lower Super Output Area (LSOA)).
250 Data on the number of incapacity benefit claimants at small area level were obtained
251 from the Department of Work and Pensions. Data on access to and quality of care for
252 patients with SMI received in primary care were extracted from the Quality and
253 Outcomes Framework (QOF) dataset and the GP Patient Survey (GPPS) dataset and
254 linked to HES through the practice identifier and the year. Appendix 2 provides a full
255 list of datasets and sources. As confirmed by the University of York Research Ethics
256 Committee, no ethical approval was required for this study since it is classed as low
257 risk due to minimal burden or intrusion for participants as it is based on the analysis
258 of anonymised secondary data.

259 **Data**

260 LOS for each admission was calculated as the difference between the dates of
261 admission to and discharge from hospital. All patients were admitted and discharged
262 from the same hospital. Patients with unfinished episodes were dropped from the
263 sample.

264

265 For each admission, we also extracted information from HES on socio-demographic
266 variables such as age (we categorised patients' age into seven 10-year bands and used
267 the first band (18-24) as a reference category), gender, ethnicity, and carer support;
268 clinical variables including main and secondary diagnoses, previous history of
269 psychiatric care, legal status - whether the patient was detained under the Mental
270 Health Act; and the mode of discharge (discharged by clinician, self-discharged, or
271 died in hospital).

272

273 In relation to co-morbidity, previous studies adopt a range of different approaches,
274 with many studies including co-morbidity in terms of secondary diagnoses of a mental
275 health condition, rather than other clinical conditions. Some ignore this aspect
276 completely [31]; others record whether a secondary diagnosis was present or absent
277 [29]; and many tend to focus only on a secondary diagnosis related to substance or
278 alcohol misuse or personality disorder [23, 35, 37].

279

280 We counted the total number of co-morbidities for a patient up to a maximum of 13,
281 including secondary diagnoses for mental health and non-mental health conditions.
282 We imposed a limit of 13 to account for the change in the number of available fields
283 in HES for recording secondary diagnoses (ranging from 13 in 2006 to 19 in year
284 2010). We also derived a set of indicator variables for a secondary diagnosis of co-
285 morbid alcohol and substance misuse (F10-F19) [35, 37] and co-morbid personality
286 disorder (F60) [37].

287

288 We derived a number of neighbourhood level characteristics to account for the local
289 context, e.g. the deprivation profile. We extracted data on the proportion of the local
290 population who resided in NHS community psychiatric establishments. Ideally, we
291 would have used a measure based on the number of beds available each year (rather
292 than occupancy at one time point). However, as long as demand for community beds
293 is at least equal to supply, the measure was considered a reasonable approximation of
294 capacity and therefore a likely proxy for local area need. Socio-economic status was
295 approximated by the percentage of the local population claiming incapacity benefit for
296 a mental disorder. Since the LSOA population (i.e. denominator) changed over time,
297 we estimated moving averages for both these variables. We then categorised the

298 deprivation measure (i.e. incapacity claimants) into quintiles. Finally, we accounted
299 for whether the local area was ‘urban’ (defined as having a population above 10,000),
300 using a dummy variable based on the ‘Rural and Urban Area Classification for Super
301 Output Areas, 2004’ (from ONS). This variable was assumed to be time-invariant.

302

303 Effective primary care may shorten patients’ LOS in two ways: firstly, if hospitals can
304 be confident that the patient will be followed up by the GP practice they may decide
305 to discharge the patient more quickly. Secondly, patients with better access to primary
306 care prior to admission may require a shorter stay once admitted.

307

308 The Quality and Outcomes Framework (QOF) is a pay-for-performance scheme in
309 primary care which includes a set of indicators for SMI against which practices score
310 points according to their level of achievement. We extracted data on the proportion of
311 SMI patients with a comprehensive care plan documented, which we interpreted as a
312 measure of quality and continuity of care. To approximate accessibility of primary
313 care services, we extracted the proportion of patients reported to have been seen by
314 their GP within 48 hours, derived from the annual GP survey. Both variables were
315 measured at GP practice level and linked to the HES record through unique practice
316 and year identifiers.

317 **Exclusions**

318 We excluded admissions with very long LOS, defined as stays over 180 days
319 (approximately 6 months), to reduce the effect of unusually long stay patients on the
320 stability of the estimates and focus on a more homogeneous patient population that
321 reflects the majority of cases seen in the inpatient setting. These long-stay patients
322 tend to be different with respect to observable characteristics. For example, those
323 patients staying longer than 180 days are twice as likely to be detained and 1.5 times
324 as likely to have a main diagnosis of schizophrenia (ICD-10: F20). To ensure our
325 analysis included all patients who could have stayed in hospital up to the upper
326 threshold, we excluded admissions that occurred after the 2nd October 2010
327 calculated as 31st March 2011 minus 180 days.

328

329 We also excluded admissions to mental health providers which treated fewer than 10
330 admissions for the particular clinical diagnosis sub-category over our study period

331 (see study population). Finally, patients were excluded if they were recorded as living
332 outside of England.

333 **Analysis**

334 Poisson regression models were estimated to relate observed LOS to patient
335 characteristics, neighbourhood characteristics and indicators of primary care. All
336 models included hospital fixed effects to account for unobserved differences in
337 hospital policies, efficiency, and case-mix. Hence, coefficients are estimated from
338 within-hospital variation only. We included time fixed effects to account for common
339 temporal trends. No exposure term was defined. Poisson regression was appropriate
340 for these data due to the skewed distribution of LOS. It was also preferable to
341 logarithmic transformations, which are commonly used to analyse LOS, because it
342 estimated the conditional mean on the scale of interest and did not suffer from re-
343 transformation bias [44, 45]. Poisson regression is increasingly used to analyse length
344 of stay and cost data, and has been found to fit those data at least as well as for
345 example, Weibull or Cox proportional hazard survival models [46, 47]. Since
346 censoring was not a major concern in this study - only 2.7% of patients self-
347 discharged or died in hospital - we decided to model these factors as covariates. The
348 Poisson estimator produces unbiased point estimates as long as the conditional mean
349 is correctly specified. We obtained robust Huber-White standard errors to account for
350 over-dispersion or other misspecification of the variance function [48].

351

352 Estimated effects are reported as average partial effects (APEs), which represent the
353 expected change in LOS for a unit change in the independent variable. APEs were
354 calculated conditional on hospital fixed effects, which we recovered after estimation
355 using the procedure outlined in [48] (p.281). We also calculated Incidence Rate Ratios
356 (IRRs) with two-sided 95% confidence intervals, where values greater than 1 indicate
357 an increase in relative risk of incurring an additional inpatient day.

358

359 All models were estimated on the pooled sample of all SMI admissions and separately
360 for the three groups of SMI admissions. We compared the estimated effects across
361 groups to explore heterogeneity in the effect of risk factors. We also correlated the
362 hospital fixed effects estimates across groups to examine whether unobserved hospital
363 characteristics had a similar effect on LOS for the different patient groups.

364

365 All analyses were conducted in Stata 13.

366 **Results**

367 **Descriptive analysis**

368 Our sample included 89,510 admissions for patients treated in 67 hospitals and who
369 were registered with 7,792 GP practices. Across all five years, the median annual
370 volume of admissions with a primary diagnosis of SMI was 270.

371

372 Approximately 42.7% of admissions had a recorded primary diagnosis of
373 schizophrenia, and another 33.4% were diagnosed with bipolar disorder or a manic
374 episode (Table 1). However, there was substantial variation in intake across providers.
375 Figure 1 shows the proportion of patients in each of the three sub-groups by provider.
376 For some providers, 55% of the SMI patients were diagnosed with schizophrenia,
377 whereas the proportion in other providers was less than 30%. Similarly, the proportion
378 of patients with bipolar or mood affective disorder was around 40% (and one as high
379 as nearly 60%) in some providers, but was just over 20% in other hospitals.

380

381  Figure 1 about here

382

383 Figure 2 shows a histogram of the distribution of LOS. LOS fell very slightly over
384 time by on average around 0.2 to 0.4 days per year across the three sub-groups (Table
385 2) and LOS was longest for individuals with a main diagnosis of schizophrenia (F20)
386 or schizoaffective disorder (F25) (Figure 3).

387

388  Figure 2 about here

389  Table 2 about here

390  Figure 3 about here

391 **Estimation results - overview**

392 Table 3 shows the average partial effects (APEs) estimates for the pooled model
393 (column (1)) and then separately for the three types of SMI patient (columns (2) to
394 (4)). Table 4 presents the results as Incidence Rate Ratios (IRR). In the pooled model,
395 the majority of diagnostic groups had a shorter LOS than schizophrenia, some as

396 much as 20 days shorter (F22). Diagnosis was a key predictor of LOS in the pooled
397 model. Results were broadly consistent across the three diagnostic groups of patients.
398 However, there were some differences in LOS across diagnoses: F23, F28 and F29
399 had significantly shorter LOS than schizotypal disorder (F21) of between 9 and 17
400 days. People with bipolar affective disorder had a significantly longer LOS of 7 days
401 compared to those suffering from a manic episode (F30).

402

403 Table 3 about here

404 Table 4 about here

405 **Estimation results – individual characteristics**

406 Our findings suggest that most independent risk factors do not have a differential
407 effect for different diagnostic sub-groups. However we do note some heterogeneity in
408 the effects. In terms of patient demographics and clinical characteristics, we found an
409 age gradient with patients from age 65 and above with schizophrenia, and from age 55
410 and above for the other diagnostic subgroups and in the pooled model, exhibiting
411 progressively longer LOS compared to 18-24 year-olds. This age gradient for the 65
412 to 74-year old age group, relative to the 18 to 24-year old age group, was 11 days in
413 the pooled model and ranged from 6 days for the schizophrenia subgroup, 14 days for
414 schizoaffective disorder and 19 days for bipolar disorder. Gender was not a significant
415 predictor of LOS. Longer LOS was associated with formal detention (16 days in the
416 pooled model and between 15 days for schizoaffective disorder and 19 days for
417 schizophrenia) and with black ethnicity (around 4 days), although detained patients
418 with black ethnicity had shorter LOS than detained white patients (see interactions in
419 Table 4). Having an informal carer was associated with longer LOS in the pooled
420 model (3 days) although this was not significant in all models (2) to (4). Patients with
421 schizophrenia who had a previous psychiatric history had a shorter LOS of around 2.5
422 days, but this was not the case in the pooled model or for any of the other sub-groups.
423 In the pooled model, patients from more deprived neighbourhoods had a longer LOS
424 (between 2 and 3 days) and the effect was larger in patients with bipolar disorder (6
425 days). Having a higher number of physical and psychiatric comorbidities was
426 associated with longer LOS (1 day) while shorter LOS was associated with co-morbid
427 substance or alcohol misuse (between 4 and 5 days), and co-morbid personality
428 disorder (between 7 and 9 days) for all types of patient. Patients who decided to self-

429 discharge had shorter LOS (between 19 and 29 days). Patients whose usual place of
430 residence was an urban area did not have significantly different LOS compared with
431 other patients. No association was found between LOS and primary care in terms of
432 either access or quality variables.

433 **Hospital variation**

434 Figure 4 shows histograms of the estimated hospital fixed effects by diagnostic group.
435 These fixed effects could be interpreted as the predicted length of stay for a given
436 patient (here given by the reference category in Table 3). The median hospital effects
437 were 42.8 days (Interquartile range (IQR) = 38.5 - 45.7) for schizophrenia (F20), 42.6
438 days (IQR = 38.0 - 46.0) for schizotypal disorders (F21-F29), and 42.3 days (IQR =
439 38.9 - 46.5) for bipolar and mood affective disorders (F30-F31). The differences
440 amongst hospital fixed effects reflect the average effect on hospital LOS of
441 differences across hospitals in factors that we do not observe.

442

443  Figure 4 about here

444

445 The correlations between the hospital effects for the three sub-groups of patients were
446 high ($\rho > 0.75$) for all pairs of diagnostic groups.

447 **Discussion**

448 To our knowledge, this is the first study to use large-scale national routine data to
449 examine the key determinants of LOS for particular patient sub-groups with serious
450 mental illness in England. Previous literature has tended to produce inconsistent
451 results about factors associated with LOS partly because of small sample sizes and
452 also due to the limitations of the methods employed in some studies. Our main
453 contribution to the existing literature is in terms of our methodology which, compared
454 to other studies, provides results which are more robust. The methodological advances
455 include estimating a Poisson regression model with hospital fixed effects, rather than
456 using a logit model to examine long-stay patients using an arbitrary cut-off point to
457 model case-controls, and taking account of LOS as a continuous variable. Where
458 many previous studies ignore hospital effects, we examined differences in LOS
459 between mental health providers. Our larger sample size enabled us to improve on
460 previous studies by estimating separate models for three key diagnostic sub-groups to
461 analyse the independent contribution of a range of potential determinants of LOS on

462 each of the broad classes of diagnoses. Our study population was everyone admitted
463 to an NHS mental health hospital in England with SMI over the period 2006 to 2010
464 and was considerably larger and more representative than previous studies. There are
465 no reliable estimates of the number of patients seeking care in the private sector, but
466 this is likely to be small as the vast majority of mental health hospital care in England
467 is publicly funded. Specifically, the £143 m market for privately funded mental health
468 hospital care [49] compares with £2 billion of NHS spending on psychotic disorders
469 [50].

470

471 Contrary to some previous studies, we found that diagnosis was a strong predictor of
472 LOS [40, 51]. We found that shorter LOS was associated with co-morbid substance or
473 alcohol misuse, and with co-morbid personality disorder, although recorded
474 prevalence of these co-morbidities may be low due to poor coding. This finding is
475 however consistent with previous literature and may be because when these patients'
476 symptoms resolve following inpatient detoxification, they are more likely to leave
477 against medical advice (self-discharge), and may be motivated to show improvement
478 so they can leave to regain access to drugs or alcohol [35, 37]. Indeed patients who
479 self-discharged had shorter LOS. It may also reflect the transient nature of psychotic
480 symptoms in the context of substance misuse, where there is more rapid resolution
481 upon admission to hospital and removal from the usual environment. While previous
482 literature has been inconsistent with respect to the association with age, reporting
483 positive [30, 33, 35], and negative findings [29, 31, 36]), in our study we found a
484 strong age gradient only for people aged 55 and above (and the effect was not
485 apparent until 65 for those with schizophrenia). We also found, as in previous
486 literature [37, 38], that compulsory admission was positively associated with LOS,
487 increasing it by 16 days overall (19 days for schizophrenia, 15 days for
488 schizoaffective disorder and 17 days for bipolar disorder). While studies have found
489 mixed results on the association between male gender and LOS (positive [24, 30, 31],
490 negative [37]), gender was not a significant predictor of LOS in our analyses.
491 Previous evidence on the association between co-morbidities and LOS has been
492 inconsistent: while some studies found that patients with more co-morbidities had
493 longer LOS [24, 29], others found that individuals with no comorbidity had longer
494 LOS [30]. Our study found that having a higher number of psychiatric and physical
495 comorbidities was associated with longer LOS of around 1 day. Some previous

496 studies have reported positive associations between prior hospitalisation and LOS [35,
497 38] and others found a negative relationship [29]; in our analyses, only schizophrenia
498 patients with a psychiatric history had a shorter LOS of around 2.5 days. This may be
499 because these patients are well known to services and crisis stabilisation can be
500 achieved more swiftly since relapse signatures will be familiar, medication regimes
501 will be tried and tested, and care plans are more likely to be in place.

502

503 Having a carer was associated with longer LOS overall in the pooled model and for
504 schizophrenia and bipolar disorder patients, but there was no effect for schizoaffective
505 disorder patients. It is possible that if carers experience a significant carer burden
506 from patients with high levels of need, LOS may be prolonged, in the interests of
507 protecting carers' health and wellbeing. Just less than 7% of patients have an unpaid
508 carer registered in their hospital record. The record may underestimate the actual level
509 of both formal and informal care that this patient population receive. If a record of
510 having a carer is associated with increased patient need, then this may explain the
511 positive association that we observe.

512

513 Patients with manic or bipolar disorders who were from more deprived
514 neighbourhoods had longer LOS whilst this was not the case for schizophrenia
515 patients.

516

517 Although there were similarities in the association between LOS and patient
518 characteristics across the three diagnostic patient groups, there were some noticeable
519 differences. Whilst these should be interpreted with caution, our results suggest that
520 there may be advantages to modelling LOS stratified by diagnostic groupings to more
521 accurately determine associations between case-mix which can be used to ensure
522 prospective payment systems reflect accurately the resource use within sub-groups.

523

524 We found a large degree of variation in case-mix between providers. This will likely
525 have implications for the costs imposed on them by the risk profile of their patient
526 population, particularly if hospitals predominantly treat older patients with complex
527 care needs and detained patients. We also found significant variation in the hospital
528 fixed effects within diagnostic groupings. The interquartile range of the hospital fixed
529 effects for each diagnostic group is around 9 days suggesting a significant spread in

530 the distribution and large differences between providers in the unexplained variation
531 in LOS. We also found a high correlation between the provider effects across the
532 different diagnostic groups. This suggests that hospitals with unexplained high LOS
533 for one diagnostic group will also have high LOS for another sub-group. These
534 hospitals may be systematically different in the way they manage and treat patients.
535 Unobserved hospital characteristics (such as the quality of care, quality of
536 management, unmeasured differences in average case-mix, or differences in
537 efficiency) therefore appear to have similar effects on LOS for different types of
538 patients.

539

540 The proposed NTPS for mental health providers is based on need and, other than
541 assigning patients to the super-classes of non-psychotic, psychosis and organic mental
542 illness, the system does not directly use diagnoses (ICD-10 codes) to cluster service
543 users. The Mental Health Clustering Tool, used to allocate service users to the 21
544 clusters, explicitly states that people with the same diagnosis can be assigned to
545 different clusters, and that individuals can move between clusters as their needs
546 change over time [52]. Our results suggest that the payment system may need to be
547 tailored according to diagnostic group. A prospective payment system should be fair
548 (e.g. paying the same for treating patients with similar needs), but also needs to take
549 account of factors beyond the control of a hospital (e.g. the characteristics of patients
550 such as diagnosis if this affects LOS, age, detention status, local input prices).
551 However, a balance needs to be struck. If some factors make little economic
552 difference, though statistically significant, they should not be used in the payment
553 system as they would add unnecessary complexity. There are also risks of unintended
554 consequences if some diagnoses or detention status attract a higher payment,
555 generating inappropriate incentives. Finally, the argument for paying by diagnosis
556 hinges on the assumption that these are well coded. There are therefore concerns
557 about the feasibility of implementing such a system (coding quality, gaming, etc.).

558 **Conclusions**

559 This study used national administrative data linked to publicly available datasets to
560 produce a large sample with a rich set of potential determinants of LOS for patients
561 with SMI. Our data on individual patients was more limited than in studies adopting
562 retrospective case note review but were comprehensive in that they covered all

563 publicly funded hospital admissions in England. Many of the commonly identified
564 risk factors were captured, although some were an imperfect match for those
565 identified in the literature review. Other factors were omitted entirely due to limited
566 data availability, including psychiatric functioning or severity, the use of seclusion or
567 restraint and psychopharmacological medication. We also did not account for
568 readmissions which may be important in relation to LOS and payment mechanisms,
569 since providers with shorter LOS may benefit from early discharge, and a subsequent
570 new admission for which they could be paid, unless incentives were put in place to
571 discourage a quicker and sicker ‘revolving door’ phenomenon [53].

572

573 We found substantial variation between providers in unobserved hospital
574 characteristics (such as differences in management culture or efficiency). Providers
575 appear to be systematically different in terms of their resource use and this will likely
576 result in some hospitals being ‘winners’ and others ‘losers’ under a prospective
577 payment system. International experience suggests large variations in provider effects
578 with respect to costs or LOS may make a classification system unsuitable for provider
579 payment [13] as it may destabilize local health economies. There is therefore a need
580 for a careful transition to any new payment system.

581

582 The variation in case-mix which we observed may be the result of genuine differences
583 in risk profiles between providers, but may also be due to inconsistent use of
584 diagnostic codes between providers. There are some limitations to the use of
585 diagnostic classifications in HES for psychiatric admissions. Diagnostic coding is
586 often done by administrative staff removed from the nuances of psychiatric diagnosis,
587 rather than by the rigorous application of ICD-10 criteria by clinicians. Whilst we
588 have argued that payment systems may need to be tailored to diagnostic groupings,
589 this would require the consistent and accurate use of diagnostic codes across mental
590 health providers. Whilst some mental health professionals are reluctant to label
591 patients, in part due to stigma, and argue for treating the person rather than the illness
592 [54], diagnostic coding can be helpful to patients, by providing appropriate treatments
593 and access to support and services including benefits [55]. A quality indicator has
594 been recommended for use by commissioners and providers in drawing up contracts
595 as part of the NTPS which incentivises the collection of a valid ICD-10 code [56].
596 Improved data quality on diagnostic coding is imperative for future research purposes

597 to better understand the role of diagnosis as a driver of LOS and resource use as part
598 of a funding system.

599

600 Challenges in future may be not just to reward hospitals properly but also to
601 incorporate incentives for appropriate primary, community and social care to form
602 part of the care package for individuals with SMI, moving towards personalised
603 funding. Future research should therefore focus on examining cost drivers across the
604 full range of services that SMI patients utilise and across the full patient care pathway.
605 This will support the design and reimbursement of more effective and efficient care
606 pathways. Inpatient LOS for SMI patients will remain an expensive but important
607 component of that pathway and therefore understanding the key determinants of LOS
608 is vital as mental health service commissioners and providers grapple with the
609 challenges of continued cost pressures.

610 **Competing interests**

611 The authors declare that they have no competing interests.

612 **Authors' contributions**

613 NG led the data assembly, analysed the data and contributed to manuscript drafting.

614 AM derived some of the key explanatory variables, and contributed to the analysis

615 and manuscript drafting. TK contributed to study design, interpretation of results,

616 providing clinical input and writing of the manuscript. MG and HG contributed to

617 study design and interpretation of results and to the writing of the manuscript. SG

618 contributed to study design, provided clinical input and helped to interpret findings.

619 RJ was the principal investigator, overseeing all aspects of the study. RJ is the

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635 included in our review.

636 **List of abbreviations**

637 APE Average Partial Effect

638 BPRS Brief Psychiatric Rating Scale

639 CIPS continuous inpatient spell

640 GAF Global Assessment of Functioning

641 GPPS GP Patient Survey

- 642 HES Hospital Episode Statistics
- 643 ICD-10 International Classification of Diseases, 10th revision
- 644 IQR interquartile range
- 645 IRR incidence rate ratio
- 646 LOS length of stay
- 647 LSOA lower super output area
- 648 NHS National Health Service
- 649 NTPS National Tariff Payment System
- 650 ONS Office for National Statistics
- 651 PbR Payment by Results
- 652 QOF Quality and Outcomes Framework
- 653 SMI serious mental illness

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692 [ficial+statistics&covdate=APR%2c2013%2cMAR%2c2014&sort=Relevance](http://www.hscic.gov.uk/searchcatalogue?productid=17192&topics=2%2fHospital+care%2fAdmissions+and+attendances%2fInpatients&infotype=0%2foficial+statistics&covdate=APR%2c2013%2cMAR%2c2014&sort=Relevance&size=10&page=1#top)
693 [&size=10&page=1#top](http://www.hscic.gov.uk/searchcatalogue?productid=17192&topics=2%2fHospital+care%2fAdmissions+and+attendances%2fInpatients&infotype=0%2foficial+statistics&covdate=APR%2c2013%2cMAR%2c2014&sort=Relevance&size=10&page=1#top)]
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Tables

Table 1 - Descriptive statistics for admissions contributing to the regression analyses

Variable	Pooled (N=89,510) (1)		Schizophrenia (N=38,216) (2)		Psychotic and schizoaffective disorder (N=21,415) (3)		Manic and bipolar disorder (N=29,879) (4)	
Main diagnosis (n, %)								
Schizophrenia (F20)	38,216	(42.7)	38,216	(100.0)				
Schizotypal disorder (F21)	229	(0.3)			229	(1.1)		
Persistent delusional disorder (F22)	3,605	(4.0)			3,605	(16.8)		
Acute and transient psychotic disorder (F23)	6,446	(7.2)			6,446	(30.1)		
Induced delusional disorder (F24)	66	(0.1)			66	(0.3)		
Schizoaffective disorders (F25)	8,200	(9.2)			8,200	(38.3)		
Other nonorganic psychotic disorders (F28)	268	(0.3)			268	(1.3)		
Unspecified nonorganic psychosis (F29)	2,601	(2.9)			2,601	(12.1)		
Manic episode (F30)	2,777	(3.1)					2,777	(9.3)
Bipolar affective disorder (F31)	27,102	(30.3)					27,102	(90.7)
Age (n, %)								
Age up to 25	8,224	(9.2)	3,893	(10.2)	2,795	(13.1)	1,536	(5.1)
Age 25-34	17,951	(20.1)	9,213	(24.1)	4,623	(21.6)	4,115	(13.8)
Age 35-44	22,116	(24.7)	10,308	(27.0)	5,094	(23.8)	6,714	(22.5)
Age 45-54	17,997	(20.1)	7,298	(19.1)	3,824	(17.9)	6,875	(23.0)
Age 55-64	11,652	(13.0)	4,194	(11.0)	2,281	(10.7)	5,177	(17.3)
Age 65-74	7,110	(7.9)	2,203	(5.8)	1,402	(6.5)	3,505	(11.7)
Age 75 and over	4,460	(5.0)	1,107	(2.9)	1,396	(6.5)	1,957	(6.5)
Gender (n, %)								

Female	42,589	(47.6)	13,217	(34.6)	11,292	(52.7)	18,080	(60.5)
Male	46,921	(52.4)	24,999	(65.4)	10,123	(47.3)	11,799	(39.5)
Detention status (n, %)								
Not detained	72,273	(80.7)	30,554	(80.0)	17,039	(79.6)	24,680	(82.6)
Detained	17,237	(19.3)	7,662	(20.0)	4,376	(20.4)	5,199	(17.4)
Ethnicity (n, %)								
White	67,980	(75.9)	27,330	(71.5)	15,841	(74.0)	24,809	(83.0)
Mixed	1,822	(2.0)	948	(2.5)	443	(2.1)	431	(1.4)
Asian	6,728	(7.5)	3,290	(8.6)	1,684	(7.9)	1,754	(5.9)
Black	8,898	(9.9)	5,051	(13.2)	2,172	(10.1)	1,675	(5.6)
Unknown or missing	4,082	(4.6)	1,597	(4.2)	1,275	(6.0)	1,210	(4.0)
Patient has a carer (n, %)								
No	83,426	(93.2)	35,647	(93.3)	19,958	(93.2)	27,821	(93.1)
Yes	6,084	(6.8)	2,569	(6.7)	1,457	(6.8)	2,058	(6.9)
Patient was previously treated for mental health issues (n, %)								
No	48,126	(53.8)	19,377	(50.7)	12,803	(59.8)	15,946	(53.4)
Yes	41,384	(46.2)	18,839	(49.3)	8,612	(40.2)	13,933	(46.6)
Alcohol and substance misuse (n, %)								
No	84,786	(94.7)	35,797	(93.7)	20,304	(94.8)	28,685	(96.0)
Yes	4,724	(5.3)	2,419	(6.3)	1,111	(5.2)	1,194	(4.0)
Co-morbid personality disorder (n, %)								
No	88,329	(98.7)	37,800	(98.9)	21,077	(98.4)	29,452	(98.6)
Yes	1,181	(1.3)	416	(1.1)	338	(1.6)	427	(1.4)
Number of comorbidities (mean, sd)	0.43	(1.0)	0.39	(1.0)	0.47	(1.1)	0.45	(1.1)
Discharge type (n, %)								
Discharged by consultant	87,063	(97.3)	37,148	(97.2)	20,790	(97.1)	29,125	(97.5)
Self-discharged	2,017	(2.3)	902	(2.4)	525	(2.5)	590	(2.0)
Died in hospital	430	(0.5)	166	(0.4)	100	(0.5)	164	(0.5)

Resident in urban area (n, %)								
No	8,959	(10.0)	2,782	(7.3)	2,251	(10.5)	3,926	(13.1)
Yes	80,551	(90.0)	35,434	(92.7)	19,164	(89.5)	25,953	(86.9)
Percentage mental health benefit claimants in local community (mean, sd)	2	(1.6)	2.51	(1.7)	2.23	(1.6)	2.03	(1.5)
Percentage population of local community resident in NHS psychiatric establishment (mean, sd)	0	(0.3)	0.03	(0.4)	0.02	(0.3)	0.02	(0.3)
GP quality - % practice population with SMI with care plan (mean, sd)	1	(0.1)	0.84	(0.1)	0.85	(0.1)	0.84	(0.1)
GP access - % practice population able to see GP within 48h (mean, sd)	1	(0.1)	0.82	(0.1)	0.82	(0.1)	0.83	(0.1)

Table 2 – LOS by diagnostic group and pooled over time

Financial year	All (F20-F31) (1)		Schizophrenia (F20) (2)		Psychotic and schizoaffective disorder (F21-F29) (3)		Manic and bipolar disorder (F30-F31) (4)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2006/07	44.4	40.0	48.0	43.3	41.6	38.5	41.6	35.7
2007/08	43.3	39.7	47.0	42.7	40.8	38.5	40.2	35.9
2008/09	45.0	40.1	49.0	42.9	42.1	39.1	42.2	36.7
2009/10	43.7	39.6	47.7	42.7	40.6	37.8	41.1	36.3
2010/11	42.7	38.4	46.1	40.9	40.2	37.5	40.5	35.7
Pooled	43.9	39.7	47.7	42.7	41.1	38.3	41.2	36.1

Table 3 - Factors determining hospital length of stay – regression results, Average Partial Effects (APEs)

Variable	Pooled (F20-F31) (1)		Schizophrenia (F20) (2)		Psychotic and schizoaffective disorder (F21-F29) (3)		Manic and bipolar disorder (F30-F31) (4)	
	APE	SE	APE	SE	APE	SE	APE	SE
<i>Main diagnosis</i>								
Schizophrenia (F20)	<i>(base category)</i>		<i>(base category)</i>		<i>(base category)</i>			
Schizotypal disorder (F21)	-4.16	0.71 ***						
Persistent delusional disorder (F22)	-19.56	1.04 ***			-2.12	2.86		
Acute and transient psychotic disorder (F23)	-11.57	4.69 *			-17.20	2.15 ***		
Induced delusional disorder (F24)	0.75	0.52			-9.34	5.65		
Schizoaffective disorders (F25)	-11.67	2.32 ***			3.78	3.18		
Other nonorganic psychotic disorders (F28)	-11.42	1.10 ***			-9.29	3.79 *		
Unspecified nonorganic psychosis (F29)	-6.36	0.48 ***			-9.03	2.69 ***		
Manic episode (F30)	-3.02	2.80					<i>(base category)</i>	
Bipolar affective disorder (F31)	-12.57	1.01 ***					7.42	1.27 ***
<i>Patient demographics and clinical characteristics</i>								
Age 25-34	-1.63	0.61 **	-1.72	0.81 *	-0.93	1.13	-2.64	1.44
Age 35-44	-3.54	0.53 ***	-3.84	0.76 ***	-3.68	1.10 ***	-3.65	1.37 **
Age 45-54	-2.25	0.59 ***	-3.22	0.98 ***	-2.25	1.00 *	-0.66	1.42
Age 55-64	1.64	0.63 **	-0.49	0.98	4.56	1.35 ***	4.31	1.80 *
Age 65-74	10.88	1.23 ***	6.21	1.60 ***	14.39	2.33 ***	18.55	3.01 ***
Age 75 and over	18.64	1.57 ***	11.60	2.45 ***	25.57	3.84 ***	27.45	3.73 ***
Male	-0.41	0.38	-1.35	0.53 *	-0.62	0.62	0.72	0.77
Detained	15.98	1.17 ***	19.48	1.81 ***	14.72	2.26 ***	16.51	1.76 ***
Ethnicity: mixed	2.31	0.99 *	0.57	1.49	3.65	1.80 *	7.74	3.45 *
Ethnicity: Asian	0.69	0.64	0.68	0.82	1.92	1.42	-0.45	0.89

Ethnicity: black	4.46	0.63	***	5.28	0.93	***	3.99	1.25	**	4.88	1.70	**
Ethnicity: unknown or missing	-0.77	0.72		0.10	1.21		-0.81	1.17		-2.31	1.87	
Patient has a carer	3.16	1.14	**	3.19	1.35	*	1.44	1.64		5.50	2.22	*
Patient was previously treated for mental health issues	-1.00	0.76		-2.51	0.94	**	0.15	0.94		0.41	1.22	
MH benefit claimants - 2nd quintile	0.63	0.41		-0.07	0.62		1.12	0.94		1.32	0.75	
MH benefit claimants - 3rd quintile	1.41	0.47	**	0.59	0.67		1.24	1.00		3.14	0.97	**
MH benefit claimants - 4th quintile	2.43	0.78	**	1.41	0.99		1.75	1.28		5.76	1.09	***
MH benefit claimants - 5th quintile	2.65	0.68	***	1.11	0.88		3.03	1.34	*	6.08	1.13	***
Number of comorbidities	1.17	0.33	***	1.04	0.35	**	1.29	0.36	***	1.53	0.53	**
Alcohol and substance misuse	-4.21	0.67	***	-4.96	1.05	***	-2.40	1.38		-5.10	1.50	***
Co-morbid personality disorder	-7.81	1.30	***	-9.14	2.19	***	-7.18	2.91	*	-9.46	2.19	***
<u>Discharge</u>												
Self-discharged	-19.99	1.85	***	-19.24	2.48	***	-20.37	3.11	***	-29.17	2.76	***
Died in hospital	-3.30	1.64	*	-3.56	2.73		-0.96	4.12		-6.03	3.09	
<u>Access to care</u>												
Urban	0.41	0.61		-0.10	0.91		0.67	1.02		1.20	1.06	
% residents of local community in psychiatric establishment	-0.04	0.41		0.11	0.52		0.01	1.30		-0.41	0.87	
Ability to access GP within 48h	-0.54	1.12		0.10	1.73		-2.74	2.68		0.10	2.79	
Care plan developed in primary care	-1.01	0.95		-2.18	1.57		2.92	2.16		-1.70	2.23	
<u>Time effects</u>												
Year 2007	-1.18	0.97		-1.25	1.17		-1.27	1.45		-1.77	1.34	
Year 2008	0.22	0.86		0.49	1.06		-0.44	1.19		0.43	1.37	
Year 2009	-1.47	0.99		-1.34	1.33		-2.30	1.20		-1.79	1.33	
Year 2010	-3.08	1.15	**	-3.50	1.45	*	-3.67	1.44	*	-3.22	1.78	
Pseudo-R ²	0.061			0.046			0.091			0.050		
N	89,510			38,216			21,415			29,879		

Note: Evaluated at the mean of the estimated hospital effects. Interaction effects are subsumed into main effects. Pseudo-R2 are based on model with standard errors clustered at hospital level but no hospital fixed effects.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 4 - Factors determining hospital length of stay – regression results, Incidence Rate Ratios (IRRs)

Variable	Pooled (F20-F31) (1)		Schizophrenia (F20) (2)		Psychotic and schizoaffective disorder (F21-F29) (3)		Manic and bipolar disorder (F30-F31) (4)	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
<i>Main diagnosis</i>								
Schizophrenia (F20)	<i>(base category)</i>		<i>(base category)</i>		<i>(base category)</i>			
Schizotypal disorder (F21)	0.91	(0.88 ; 0.94)						
Persistent delusional disorder (F22)	0.64	(0.62 ; 0.66)			0.96	(0.84 ; 1.08)		
Acute and transient psychotic disorder (F23)	0.77	(0.62 ; 0.95)			0.69	(0.61 ; 0.78)		
Induced delusional disorder (F24)	1.02	(0.99 ; 1.04)			0.82	(0.63 ; 1.05)		
Schizoaffective disorders (F25)	0.77	(0.69 ; 0.85)			1.09	(0.96 ; 1.23)		
Other nonorganic psychotic disorders (F28)	0.77	(0.74 ; 0.81)			0.82	(0.68 ; 0.98)		
Unspecified nonorganic psychosis (F29)	0.87	(0.85 ; 0.88)			0.82	(0.72 ; 0.94)		
Manic episode (F30)	0.93	(0.82 ; 1.06)					<i>(base category)</i>	
Bipolar affective disorder (F31)	0.75	(0.72 ; 0.78)					1.14	(1.10 ; 1.18)
<i>Patient demographics and clinical characteristics</i>								
Age 25-34	0.99	(0.93 ; 1.04)	1.00	(0.91 ; 1.10)	1.01	(0.93 ; 1.10)	0.96	(0.89 ; 1.03)
Age 35-44	0.94	(0.90 ; 0.99)	0.95	(0.88 ; 1.03)	0.94	(0.86 ; 1.02)	0.95	(0.88 ; 1.02)
Age 45-54	0.99	(0.94 ; 1.03)	0.98	(0.91 ; 1.07)	0.98	(0.91 ; 1.05)	1.00	(0.93 ; 1.08)
Age 55-64	1.10	(1.05 ; 1.16)	1.06	(0.97 ; 1.15)	1.17	(1.07 ; 1.27)	1.12	(1.04 ; 1.21)
Age 65-74	1.32	(1.25 ; 1.39)	1.23	(1.12 ; 1.34)	1.40	(1.30 ; 1.52)	1.37	(1.26 ; 1.48)

Age 75 and over	1.50	(1.41 ; 1.60)	1.34	(1.22 ; 1.48)	1.63	(1.47 ; 1.81)	1.56	(1.41 ; 1.72)
Male	1.06	(1.00 ; 1.12)	1.04	(0.95 ; 1.13)	1.05	(0.96 ; 1.16)	1.06	(0.99 ; 1.14)
Detained	1.41	(1.35 ; 1.47)	1.52	(1.45 ; 1.60)	1.35	(1.28 ; 1.42)	1.31	(1.25 ; 1.37)
Ethnicity: mixed	1.07	(1.01 ; 1.13)	1.05	(0.97 ; 1.14)	1.09	(0.99 ; 1.19)	1.10	(0.99 ; 1.23)
Ethnicity: Asian	1.03	(0.99 ; 1.06)	1.04	(0.99 ; 1.09)	1.04	(0.97 ; 1.12)	1.01	(0.97 ; 1.05)
Ethnicity: black	1.12	(1.09 ; 1.15)	1.15	(1.10 ; 1.20)	1.11	(1.05 ; 1.17)	1.11	(1.04 ; 1.17)
Ethnicity: unknown or missing	0.99	(0.95 ; 1.03)	1.03	(0.96 ; 1.09)	0.97	(0.91 ; 1.04)	0.95	(0.88 ; 1.02)
Interaction: Detained + Ethnicity: mixed	0.94	(0.84 ; 1.06)	0.85	(0.74 ; 0.98)	0.98	(0.80 ; 1.20)	1.14	(0.92 ; 1.41)
Interaction: Detained + Ethnicity: Asian	0.95	(0.89 ; 1.02)	0.91	(0.83 ; 1.00)	1.00	(0.91 ; 1.11)	0.93	(0.83 ; 1.05)
Interaction: Detained + Ethnicity: black	0.93	(0.88 ; 0.98)	0.90	(0.85 ; 0.96)	0.91	(0.84 ; 0.99)	0.91	(0.84 ; 0.98)
Interaction: Detained + Ethnicity: unknown or missing	0.99	(0.92 ; 1.06)	0.91	(0.82 ; 1.01)	1.03	(0.92 ; 1.16)	1.05	(0.90 ; 1.22)
Patient has a carer	1.07	(1.02 ; 1.12)	1.07	(1.01 ; 1.13)	1.03	(0.96 ; 1.10)	1.10	(1.03 ; 1.17)
Patient was previously treated for mental health issues	0.98	(0.94 ; 1.01)	0.95	(0.91 ; 0.99)	1.00	(0.96 ; 1.04)	1.01	(0.97 ; 1.05)
MH benefit claimants - 2nd quintile	1.01	(1.00 ; 1.03)	1.00	(0.97 ; 1.03)	1.03	(0.99 ; 1.07)	1.02	(1.00 ; 1.05)
MH benefit claimants - 3rd quintile	1.03	(1.01 ; 1.06)	1.01	(0.98 ; 1.04)	1.03	(0.99 ; 1.07)	1.06	(1.02 ; 1.09)
MH benefit claimants - 4th quintile	1.06	(1.02 ; 1.09)	1.03	(0.99 ; 1.08)	1.04	(0.99 ; 1.09)	1.11	(1.07 ; 1.14)
MH benefit claimants - 5th quintile	1.06	(1.03 ; 1.09)	1.03	(0.99 ; 1.07)	1.07	(1.01 ; 1.13)	1.11	(1.07 ; 1.15)
Number of comorbidities	1.03	(1.01 ; 1.04)	1.02	(1.01 ; 1.04)	1.03	(1.01 ; 1.04)	1.03	(1.01 ; 1.05)
Alcohol and substance misuse	0.90	(0.88 ; 0.93)	0.89	(0.85 ; 0.93)	0.95	(0.89 ; 1.01)	0.91	(0.86 ; 0.96)
Co-morbid personality disorder	0.82	(0.77 ; 0.88)	0.80	(0.71 ; 0.90)	0.84	(0.73 ; 0.97)	0.84	(0.77 ; 0.91)
<u>Discharge</u>								
Self-discharged	0.55	(0.49 ; 0.62)	0.57	(0.50 ; 0.66)	0.56	(0.48 ; 0.66)	0.50	(0.44 ; 0.57)
Died in hospital	0.93	(0.86 ; 1.00)	0.92	(0.81 ; 1.05)	0.98	(0.82 ; 1.17)	0.90	(0.80 ; 1.01)
<u>Access to care</u>								
Urban	1.01	(0.98 ; 1.04)	1.00	(0.96 ; 1.04)	1.01	(0.97 ; 1.06)	1.02	(0.99 ; 1.06)
% residents of local community in psychiatric establishment	1.00	(0.98 ; 1.02)	1.00	(0.98 ; 1.03)	1.00	(0.95 ; 1.06)	0.99	(0.96 ; 1.02)

Ability to access GP within 48h	0.99	(0.94 ; 1.04)	1.00	(0.93 ; 1.08)	0.94	(0.83 ; 1.06)	1.00	(0.91 ; 1.10)
Care plan developed in primary care	0.98	(0.94 ; 1.02)	0.95	(0.89 ; 1.02)	1.07	(0.98 ; 1.16)	0.97	(0.90 ; 1.05)
<i>Time effects</i>								
Year 2007	0.97	(0.93 ; 1.02)	0.97	(0.92 ; 1.02)	0.97	(0.92 ; 1.03)	0.97	(0.93 ; 1.02)
Year 2008	1.00	(0.97 ; 1.04)	1.01	(0.97 ; 1.06)	0.99	(0.94 ; 1.04)	1.01	(0.96 ; 1.05)
Year 2009	0.97	(0.92 ; 1.01)	0.97	(0.92 ; 1.03)	0.95	(0.91 ; 1.00)	0.97	(0.93 ; 1.01)
Year 2010	0.93	(0.88 ; 0.98)	0.92	(0.86 ; 0.99)	0.92	(0.87 ; 0.98)	0.95	(0.89 ; 1.01)
Pseudo-R ²	0.061		0.046		0.091		0.050	
N	89,510		38,216		21,415		29,879	

Note: Model includes hospital fixed effects (not shown). Age x gender interactions suppressed. Pseudo-R2 are based on model with standard errors clustered at hospital level but no hospital fixed effects.

Additional files provided with this submission:

Additional file 1: BMC HSR additional file - Sept15.docx

Appendix 1 – Literature review search strategy

Appendix 2 – Data sources