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Health equity monitoring for healthcare quality assurance

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ABSTRACT

Population-wide health equity monitoring remains isolated from mainstream healthcare quality assurance. As a result, healthcare organizations remain ill-informed about the health equity impacts of their decisions – despite becoming increasingly well-informed about quality of care for the average patient. We present a new and improved analytical approach to integrating health equity into mainstream healthcare quality assurance, illustrate how this approach has been applied in the English National Health Service, and discuss how it could be applied in other countries. We illustrate the approach using a key quality indicator that is widely used to assess how well healthcare is co-ordinated between primary, community and acute settings: emergency inpatient hospital admissions for ambulatory care sensitive chronic conditions ("potentially avoidable emergency admissions", for short). Whole-population data for 2015 on potentially avoidable emergency admissions in England were linked with neighborhood deprivation indices. Inequality within the populations served by 209 clinical commissioning groups (CCGs: care purchasing organizations with mean population 272,000) was compared against two benchmarks – national inequality and inequality within ten similar populations – using neighborhood-level models to simulate the gap in indirectly standardized admissions between most and least deprived neighborhoods. The modelled inequality gap for England was 927 potentially avoidable emergency admissions per 100,000 people, implying 263,894 excess hospitalizations associated with inequality. Against this national benchmark, 17% of CCGs had significantly worse-than-benchmark equity, and 23% significantly better. The corresponding figures were 11% and 12% respectively against the similar populations benchmark. Deprivation-related inequality in potentially avoidable emergency admissions varies substantially between English CCGs serving similar populations, beyond expected statistical variation. Administrative data on inequality in healthcare quality within similar populations served by different healthcare organizations can provide useful information for healthcare quality assurance.

1. Introduction

Quality of care and health equity have become two of the key issues on policy agendas worldwide. However, despite the inclusion of equity dimensions in foundational works on healthcare quality (Donabedian, 2002; Institute of Medicine, 2001) and efforts by organisations such as the Institute for Healthcare Improvement (Institute for Healthcare Improvement, 2017) and the English National Health Service (NHS) (NHS England, 2017b) to integrate equity and quality, responses to these issues have often progressed along separate lines. Efforts to improve quality have focused on safety and cost-effectiveness, with improvements in equity largely a by-product of reducing variation in performance between providers (Doran et al., 2008), whereas policy responses to health equity have focused on the wider social determinants of health rather than healthcare delivery (World Health Organization, 2014). Due to this parallel development, quality improvement agencies (for example, the Organisation for Economic Co-operation and Development's (OECD) Health Care Quality Indicators project) (Raleigh and Foot, 2010) and quality improvement frameworks (for example, the Quality and Outcomes Framework in the UK (NHS Digital, 2017b) and accountable care organizations (ACOs) in the US (Centers for Medicare and Medicaid Services, 2017) often overlook equity. Because quality targets tend to be more difficult to achieve for socially disadvantaged populations, there are concerns that quality frameworks penalise providers serving these populations (Delgadillo et al., 2016; Doran et al., 2016; Yasaitis et al., 2016) potentially exacerbating existing disparities in the quality of care (Buntin and Ayanian, 2017). Adjustment for social risk factors is now being

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advocated (Fiscella et al., 2014; Joynt et al., 2017; National Academies of Sciences and Medicine, 2016) but this falls short of providing useful information about equity of care for vulnerable populations, which requires stratification by social risk factors. And whilst there have been isolated examples of quality improvement programs that have explicitly addressed equity (Badrick et al., 2014; Blustein et al., 2011) most are not designed to address this issue.

A major obstacle to improving equity in healthcare has been a lack of appropriate analytical tools. Performance measures in healthcare focus on a mythical "average" patient, providing insufficient information about differences in quality and outcomes that are considered unfair (Cookson et al., 2016; Fiscella et al., 2000). Periodic reports on healthcare inequalities are produced in some countries (Agency for Healthcare Research and Quality, 2016; Harvey et al., 2016; Moy et al., 2005) but these typically focus on large geographical regions (Mayberry et al., 2006) or local government areas without specific responsibility for healthcare (Remington et al., 2015) and lack the more specific equity metrics and benchmarks needed for assessing and improving the quality of healthcare organizations. To hold healthcare decision makers accountable for the equity dimension of quality, new metrics are needed which (1) speak directly to organizations with direct responsibility for healthcare purchasing, planning and delivery, and (2) are responsive to short-term changes in healthcare delivery. Only then will health equity metrics be incorporated into quality assurance dashboards commanding the attention of senior healthcare executives.

To address this challenge, in 2016 the English NHS introduced a new approach to health equity monitoring for internal quality assurance and external public accountability purposes (NHS England, 2016a, 2016b). The initial NHS focus was on equity indicators based on rates of potentially avoidable emergency hospitalization at the neighborhood level, one of which we illustrate in this article, and consideration is being given to adding further indicators in due course. The new approach can be used to construct equity indicators based on many standard indicators of healthcare structure, process and outcome quality including – but not limited to – primary care supply, primary care process quality, hospital waiting times, hospital re-admissions, hospital mortality, and mortality considered amenable to health care (Cookson et al., 2016).

The NHS chose to focus initially on potentially avoidable emergency admissions for two reasons. First, average rates of these admissions are responsive to short-term changes in health care delivery (Harrison et al., 2014; Huntley et al., 2014; Purdy and Huntley, 2013). Second, they rise steeply with neighborhood deprivation, raising concern not only about equity of access to preventive and co-ordinated healthcare (Asaria et al., 2016a) but also about cost pressures on the healthcare system as a whole (Asaria, et al., 2016b). Under the new approach, inequality in potentially avoidable emergency admissions was measured within the populations of "clinical commissioning groups" (CCGs) – care organizations in England with responsibility for purchasing and planning healthcare for patients enrolled with local NHS family practices. Equity within the CCG's enrolled population was then compared against two benchmarks: the national average level of inequality and the average level of inequality within ten CCG populations that are comparable in terms of deprivation, age profile, ethnic mix and rurality (NHS England, 2017a). In this article we illustrate the NHS equity indicator based on the sub-set of potentially avoidable emergency admissions for chronic ambulatory care sensitive conditions. This is an indicator of the quality of ambulatory care services in managing long-term conditions (Herrin et al., 2015; Purdy et al., 2009; Torio and Andrew, 2014) and the equity version of this indicator is intended to provide quality assurance information about the NHS duty to consider reducing inequalities in both access and outcomes of healthcare (Health and Social Care Act, 2012). In this paper, we use this indicator to illustrate the general analytical approach and discuss its potential application to healthcare quality assurance in other countries.

2. Methods

2.1. Data

2.1.1. Organizational geography

In England in 2015 there were 209 clinical commissioning groups (CCGs) – each serving a mean of 272,000 NHS patients registered with a local family practice (range 73,000 to 913,000). CCGs are responsible for purchasing and planning healthcare for the vast majority of their resident populations. However, the registered and resident populations do not fully overlap because residents can choose to register with a practice in a neighboouring CCG. We used registered population data from practice registers, rather than resident population data from the census, to match the legal responsibility of the CCG and to illustrate how the approach can be applied to ACOs in the US and other settings where the enrolled population does not coincide with the resident population. CCGs were introduced in April 2013. There were 211 CCGs initially, falling to 209 in 2015. Before that, there were 152 "Primary Care Trusts" (PCTs). Despite this numerical change, however, there was stability in most areas with 180 of the 211 CCGs being formed from a single PCT or part of a single PCT, and the opening and closing of practices to accommodate local population change does not cause substantial change in CCG boundaries.

2.1.2. Small area geography

Our basic unit of analysis was the "CCG-LSOA" – a block of CCG registered population residing within a neighbourhood census unit called a "lower super output area" (LSOA). Each patient has a neighbourhood or "Lower Super Output Area" (LSOA) in which they live. Each LSOA has a deprivation score. Patients register with a GP practice and these practices belong to CCGs responsible for their hospital care. To calculate the inequality in a CCG, we include everyone who is registered with that CCG's GP practices based on the LSOA where they live. Effectively we split each LSOA into CCG blocks, as illustrated in Fig. 1.

We include all the shaded blocks for each CCG, taking the deprivation score of the LSOA in which they are located. LSOAs have a mean population of 1650 (range 1000 to 3000), while CCG-LSOAs have a mean population of 636 (range 1–2536 from 1st to 99th percentile). Our CCG-LSOA population estimate was based on the fraction of the relevant NHS practice list attributed to the LSOA. The resulting mean number of CCG-LSOAs per CCG was 428 (range 95 to 1972). CCG-LSOAs with smaller-than-resident populations arise near CCG boundaries, where residents of an LSOA are registered in more than one CCG with such LSOAs appearing in the analysis for more than one CCG. However, most LSOAs have a majority of their population registered with a single CCG (95.4% on average). Even among LSOAs whose populations are registered with multiple CCGs, the largest proportion

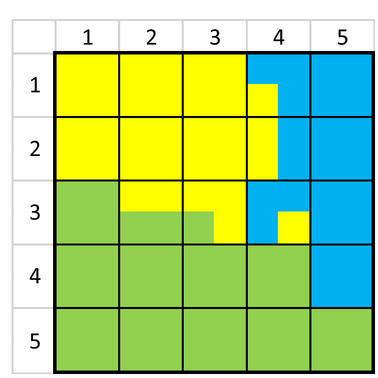

Fig. 1. How CCG-LSOAs are constructed – fictional example.
Note: The 3 shaded areas are CCGs, the 25 (5*5) cells are LSOAs, and the 30 shaded blocks within the cells are CCG-LSOAs.

tends to be registered with a single CCG – for example, 1748 LSOAs have population registered with five different CCGs, but among this group on average 90% of the population are registered with a single CCG.

2.1.3. Hospital admissions

Data on emergency admissions were taken from NHS Hospital Episode Statistics (HES), a data warehouse containing details of all admissions at NHS hospitals in England. We extracted data for 1 October 2014 to 30 September 2015 and calculated the indirectly age-sex standardized admission rate for each CCG-LSOA. Admissions by people with unknown age, sex, LSOA or CCG were excluded, including individuals not registered with a family practice. Approximately 0.2% of admissions had no recorded age or sex, 0.7% had no LSOA (given valid age and sex) and 0.6% had no CCG (given valid age, sex and LSOA). Approximately 1.4% of admissions were excluded.

2.2. Measures

2.2.1. Potentially avoidable emergency hospitalization

We used emergency admissions for chronic ambulatory care sensitive conditions as defined in existing NHS indicators (NHS Digital, 2017a). This includes diagnoses defined using ICD-10 codes for conditions such as asthma, bronchitis, diabetes, dementia and heart disease.

2.2.2. Neighborhood deprivation

The measure of deprivation we used was the Index of Multiple Deprivation 2015, a multi-domain index of deprivation (McLennan et al., 2011). This combines domains of deprivation including low income, unemployment, poor housing and crime.

2.2.3. Similar CCGs

The list of similar CCGs was created by the NHS to aid benchmarking of CCG level information, based on 10 CCGs with the lowest sum of squared differencesce on 12 indicators including age profiles, deprivation, population density and ethnicity, after first normalising the indicators by subtracting the mean and dividing by the inter-decile difference (NHS England, 2017a).

2.3. Analytic approach

Fig. 2 illustrates the general analytic approach to health equity monitoring against national and similar population benchmarks. The solid line is based on a linear regression weighted by population, and illustrates the positive association between the care quality indicator – in this case, potentially avoidable emergency hospitalization – and neighborhood deprivation within the registered population of the selected CCG. The slope of this line represents the CCG inequality "gradient" by level of deprivation within the registered population: the steeper the slope, the larger the degree of deprivation-related inequality in potentially avoidable emergency hospitalization. The dashed line is the gradient within England as a whole, and the dotted line is the gradient within a sub-set of England comprising the registered population of this CCG along with ten other CCGs with similar populations. These benchmark gradients are also based on linear regressions. In this example, the CCG gradient is less steep (better) than both the national and similar population gradients to an extent that is statistically significant, so we can conclude that this CCG is relatively equitable on both benchmarks. We can then monitor change over time against national and similar population benchmarks in response to actions taken by healthcare decision makers.

The benchmark gradients play a crucial role in quality assuring the equity performance of healthcare organizations. Healthcare organizations can be expected to address poor quality and equity of healthcare, but cannot address wider social determinants of the gradient in healthcare outcomes on their own (see Fig. 3). The risk of an acute ill-health event requiring emergency hospital treatment is influenced by individual risk factors (e.g. age, morbidities) and behaviors (e.g. diet, smoking) which in turn are influenced by cumulative long-term environmental risk factors (e.g. childhood circumstances; living and working conditions; and access to resources for investing in health). A residual social gradient in potentially avoidable emergency hospitalization would therefore remain even if the CCG achieved perfect equity by providing equal access to high quality preventive and co-ordinated care.

It is not possible to adjust for all risk factors since detailed information may not be available in administrative data, especially for individuals who have limited contact with health providers. In addition, there is a danger of over-adjustment for risk factors that are highly correlated with deprivation and amenable to modification over time by healthcare services. The danger of over-adjustment increases with the breadth of policy responsibility: the broader the policy toolbox, the greater the ability to modify risk factors. Preventive and long-term care can modify individual risk factors, and wider public health and social policies can modify environmental risk factors which in turn will influence individual risk factors and behaviors.

The appropriate quality assurance benchmark is therefore not zero inequality, but the residual degree of inequality expected for a similar population with a similar social patterning of unobserved risk factors. Two key benchmarks are the national gradient and the similar population gradient, which assume that the social patterning of unobserved risk factors in a CCGs is the same as, respectively, the country as a whole or as a cluster of CCGs serving similar populations. We selected ten similar populations based upon a standard analysis by the NHS of CCG population "similarity" in terms of twelve variables reflecting deprivation, health, population size and age profile, population density and ethnicity (NHS England, 2016c). The monitoring of time trends in relation to these benchmarks allows an assessment of how equity performance is responding to healthcare initiatives.

We measured the slope of the gradient using the "absolute gradient index" (AGI). This is the coefficient from the population-weighted linear regression of age-sex standardized avoidable hospitalization rates against fractional deprivation rank on a scale of 0–1, using all neighborhoods registered to the CCG. It is the same as the conventional slope index of inequality except that the AGI indices use the national deprivation rank rather than the local deprivation rank. This difference allowed us to compare CCG inequality on a like-for-like basis with the national inequality benchmark and the similar population benchmark, even though different CCG registered populations can have different deprivation profiles. For a CCG serving a relatively affluent population, for example, the most deprived fifth of neighborhoods might all be fairly affluent in national terms. A low rate of hospitalization in these neighborhoods would then not reflect the same equity achievement as a low rate among nationally deprived neighborhoods. The AGI can be interpreted as the simulated gap in potentially avoidable emergency hospitalization between the most and least deprived neighborhood in England, allowing for the gradient in between, if England had the same gradient as the registered population of the CCG.

To help decision makers interpret the AGI and assess the scale of their inequality challenge, we also derived an approximate estimate of the excess hospitalizations associated with inequality, drawing on the epidemiological concept of population attributable risk. This concept represents the number of emergency hospital admissions that would hypothetically be avoided if all neighborhoods had the same admission rate as the most affluent. We estimated this using the AGI multiplied by the relevant population and divided by two. This formula is a simple approximation, based on the assumptions of a linear relationship between deprivation and admissions and an evenly distributed population across the deprivation spectrum (Asaria et al., 2016b).

The analysis was carried out using R statistical software. (version 3.2.4). Full analysis code can be found at: https://github.com/miqdadasaria/ccg_equity.

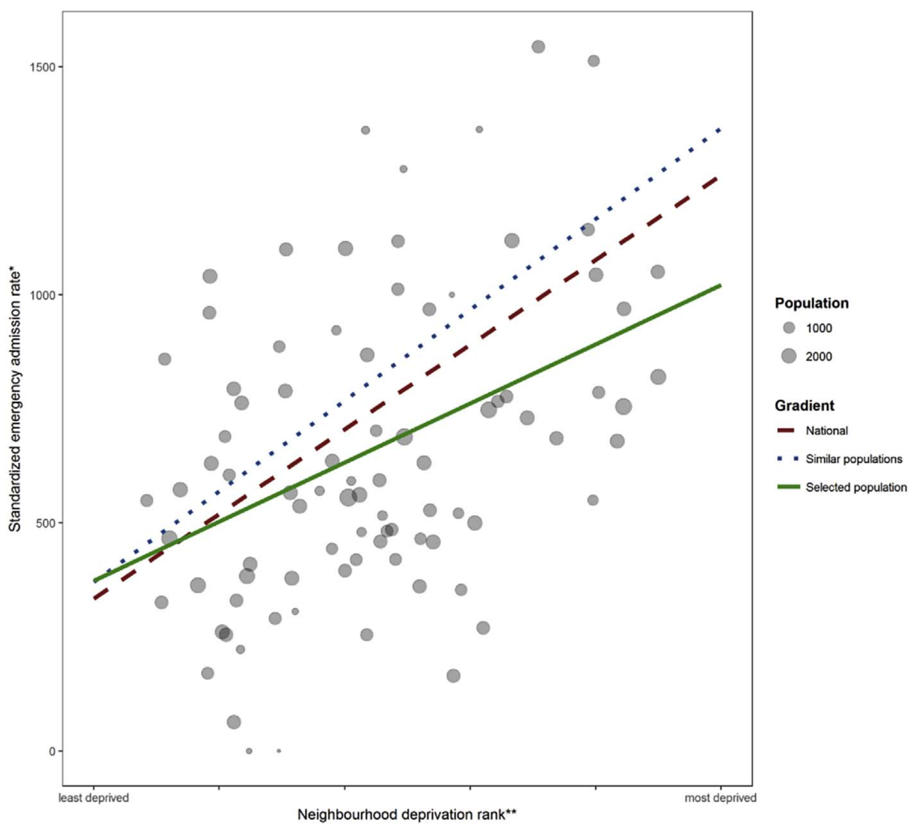

Fig. 2. Healthcare equity against national and similar population benchmarks – hypothetical scatterplot showing potentially avoidable emergency hospitalization and deprivation for all neighborhoods within a clinical commissioning group.
*Neighborhood rate of potentially avoidable emergency hospitalization, indirectly standardized for age and sex.
**Neighborhood national deprivation rank from the Index of Multiple Deprivation 2015, converted into a fraction between 0 (least deprived) and 1 (most deprived).
Note: Dots represent neighbourhoods registered to the clinical commissioning group. This example shows a clinical commissioning group with an inequality gradient that is shallower than both the national benchmark gradient and the similar area benchmark gradient, indicating better-than-benchmark equity.

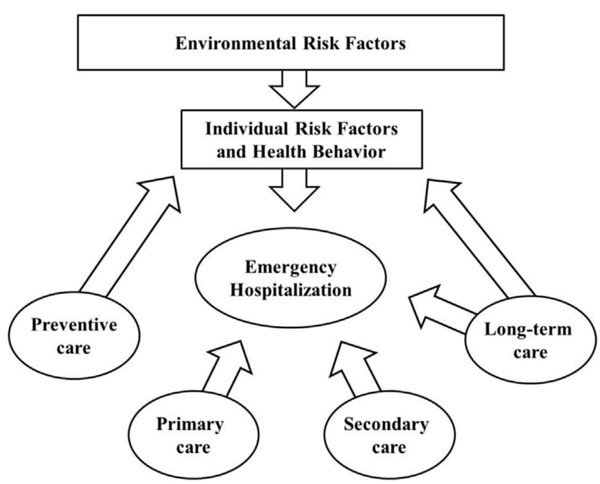

Fig. 3. The healthcare and non-healthcare determinants of emergency hospitalization.
Note: Long-term care can include various medical and non-medical services for people with chronic mental or physical illness or disability who cannot care for themselves for long periods, including help with normal daily tasks like dressing, feeding and housekeeping.

3. Results

The mean indirectly age-sex standardized rate of potentially avoidable emergency hospitalization in England was 792 per 100,000 people. The national absolute gradient index (AGI) – the estimated gap between the most and least deprived neighborhoods in England – was 927 (95% confidence interval 912 to 942), or 117% of the mean neighborhood level CCG-LSOA rate. The modelled rates for the most and least deprived neighborhoods were 1261 and 334, respectively.

Fig. 4 shows healthcare equity in 2015 for all 209 CCGs in England, with 95% confidence limits. The horizontal line is the national AGI benchmark of 927; the similar ten benchmark is not shown as it varies by CCG. Against the national benchmark, 17% of areas (35 of 209) exhibited equity that was statistically worse-than-benchmark at a 95% confidence level – i.e. CCG inequality was larger than national inequality – and 23% (48 of 209) exhibited significantly better-than-benchmark equity. Against the similar population benchmark, the corresponding figures were 11% worse-than-benchmark and 12% better-than-benchmark. Against both benchmarks, 9% of areas show worse-than-benchmark equity performance and 10% show better-than-benchmark equity performance.

There was moderate negative correlation between the average deprivation of a CCG and its equity performance against the relevant similar population benchmark, as measured by the similar population inequality gap minus the CCG inequality gap (Pearson's r −0.57). This means that English CCGs serving relatively deprived populations generally performed worse on health equity than those serving relatively affluent populations, and that about one third of the variation in CCG equity performance (Pearson's r squared 0.32) was associated with average deprivation. This correlation reduced but persisted when using relative rather than absolute measures of inequality, such as the absolute gap as a proportion of the CCG modelled mean for an individual with the national average level of deprivation.

Fig. 5 illustrates healthcare equity in six selected CCGs. We have selected pairs of organizations serving populations with different average levels of deprivation, with each pair illustrating better-than-benchmark versus worse-than-benchmark equity ("Horsham and Mid Sussex" versus "Windsor, Ascot and Maidenhead" with low deprivation, "Ashford" versus "North Lincolnshire" with medium deprivation, and "Brent" versus "Liverpool" with high deprivation). In five of these six examples both benchmark comparisons were statistically significant. However, the comparison for "Windsor, Ascot and Maidenhead" was not statistically significant against either national or similar population benchmarks – in this dataset, there was no example of an CCG serving a low deprivation population that had significantly worse-than-

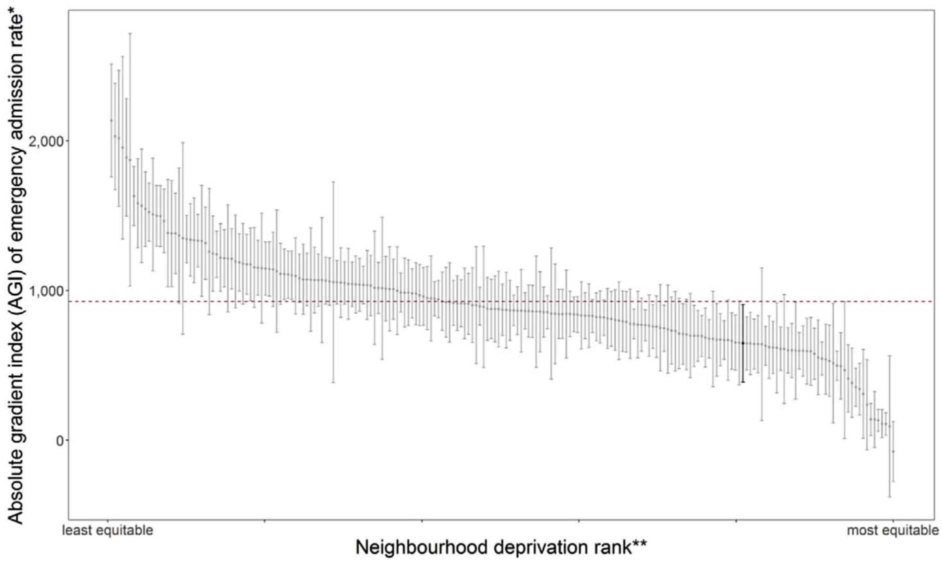

Fig. 4. Variation in equity between clinical commissioning groups in 2015–Absolute Gradient Index (AGI) of inequality in potentially avoidable emergency hospitalization.
Notes
a) The caterpillar legs show AGI estimates with 95% confidence intervals for 209 clinical commissioning groups in England.
b) The dotted horizontal line is the national benchmark AGI.
c) The clinical commissioning group highlighted in black, illustrating better-than-average equity against the national benchmark, is Ashford.

benchmark equity.

Fig. 6 illustrates how similar-ten benchmarking works and can be presented to decision makers. It shows a CCG – Liverpool – with worse-than-benchmark equity performance. It shows the AGI for Liverpool and its ten similar CCG populations, along with the average AGI pooled across all eleven populations. Inequality is significantly worse than the similar population benchmark in Liverpool and in one other CCG (South Manchester), and significantly better in two CCGs (Brighton & Hove and Sheffield). The AGI in Liverpool was 1523 compared with a similar population benchmark AGI of 1177. This equates to 3840 excess hospitalizations a year associated with inequality among the Liverpool population.

Full results for every clinical commissioning group can be found online in our interactive inequality explorer: http://www.ccg-inequalities.co.uk/

4. Discussion

4.1. Summary of findings

We have illustrated the new analytical approach to health equity equity monitoring for healthcare quality assurance introduced in England in 2016, using the example of potentially avoidable emergency hospitalization. The approach aims to provide healthcare purchasing and planning organizations – in this case, English CCGs – with detailed, up-to-date information on the equity dimension of healthcare quality within their enrolled populations. It measures inequality in key indicators of healthcare quality within the enrolled population and then assesses equity against two benchmarks – national inequality, and inequality within a group of care organizations with similar populations. Inequality is measured on a comparable basis using population-weighted models of the neighborhood-level relationship between healthcare quality and deprivation, allowing for differences between neighborhoods in their demographic makeup.

Using data for 2015 on potentially avoidable emergency hospitalization, we found that 9% of the 209 CCGs in England showed significantly worse-than-benchmark equity against both national and similar population benchmarks, and 10% showed significantly better-than-benchmark equity. This is considerably more than the 5% in each category expected due to chance.

4.2. Strengths of the approach

The strengths of this approach include the ability (i) to incorporate equity metrics into mainstream quality assurance processes for organizations with direct responsibility for healthcare purchasing, planning and delivery for enrolled populations as small as 100,000 people; (ii) to assess the equity dimension of quality against two relevant benchmarks: national inequality and inequality within similar enrolled populations; and (iii) to assess the scale of the health inequality challenge facing the organization using the epidemiological concept of population attributable risk. Particular strengths of potentially avoidable emergency hospitalization as a key equity indicator include the ability to address the equity dimension of a high profile quality issue with substantial cost implications, and to incorporate data on the quality of care for disadvantaged people who are relatively unlikely to participate in household surveys but relatively likely to suffer emergency hospital admission.

This approach can also be used to monitor how equity changes over time in response to short-term changes in healthcare delivery by particular care organizations (Sheringham et al., 2016). For example, Liverpool has recently introduced policies to improve the coordination of care and reduce avoidable emergency hospitalization, including integrated primary and long-term care services, “step down” hospital beds for non-acute care, and tele-monitoring in the home (Devlin et al., 2016). Monitoring how equity indicators respond to policy changes of this kind may help to refine policy implementation and learn lessons about more and less cost-effective ways of reducing health inequality. Our approach can also be used to examine which neighborhoods in which parts of the gradient see the biggest impacts, providing insights into who gains most from the initiatives and why.

4.3. Limitations of the approach

Our indicator is designed for quality assurance and public accountability purposes, and for use in future research, rather than for performance pay. Our finding that CCGs with more deprived populations tend to score worse on the equity indicator suggests that linking remuneration to equity indicator scores could systematically disadvantage these CCGs. We would therefore caution against attaching financial incentives to this indicator until more is known about cost-effective ways for healthcare organisations to reduce health inequality as measured by this indicator. We do not yet have evidence about whether or how this new equity indicator is responsive to short-term changes in health care delivery, and further research using quasi-experimental designs is needed to provide this evidence.

Another limitation is the reliance on administrative data, which are prone to measurement error. In particular, although hospital data in

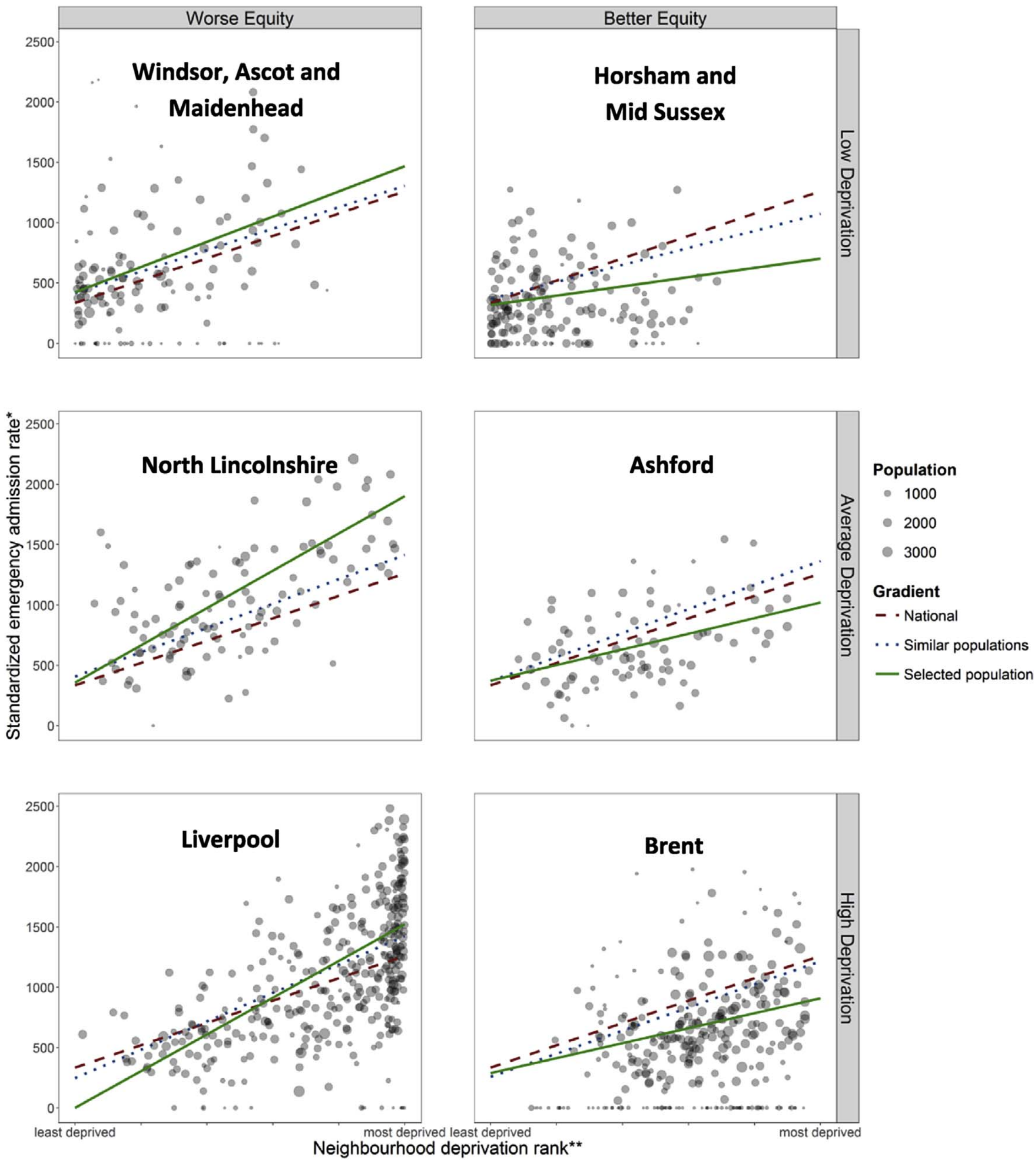

Fig. 5. Healthcare equity in 2015 within six illustrative clinical commissioning groups, showing neighborhood level scatterplots of potentially avoidable emergency hospitalization versus deprivation.
Note: The dots show standardized neighborhood rates of potentially avoidable emergency hospitalization within each clinical commissioning group.

England offers reasonably complete coverage of all patients admitted for emergency inpatient treatment, population denominator data are less complete due to gaps in NHS patient registration. This is a bigger problem in areas that are more deprived and have more recent immigrants and homeless people, some but by no means all of whom are not registered with the NHS, leading to inflation of admission rates in those areas and thus potentially exaggerating the gradient. The Department of Communities and Local Government estimated the number of "rough sleepers" as 4134 in autumn 2016 (Department for Communities and Local Government, 2016). This was less than 0.01% of the England population. The number of people classed as "statutory homeless" is larger but most of these are in temporary accommodation and would therefore be registered and included within our data.

A third limitation is the assumption that organizations serving apparently "similar" populations are comparable in terms of their levels and gradients in unmeasured individual risk factors and behaviors. Given the long-term cumulative impacts of social factors on gradients in health risk, particular caution is required when comparing populations with similar current sociodemographic characteristics but importantly different historical patterns of deprivation. For example, a population drawn from a region that has suffered from decades of industrial decline might have a steeper unmeasured risk factor gradient than an otherwise similar population. Liverpool, for example, has a high prevalence of drug misuse, resulting in England's highest rate of hospital admissions with a diagnosis of drug-related mental health or behavioral disorder – a rate of 419 per 100,000 general population in 2015/16 (Office for National Statistics, 2017). This unmeasured risk factor may partly explain why Liverpool's gradient is steeper than some of its similar areas, such as Brighton and Hove with a drug-related admissions rate of 194 per 100,000. More research is needed on heterogeneity in unmeasured risk factors between CCGs and their "similar areas", and where large and important differences are found it may not be appropriate to hold

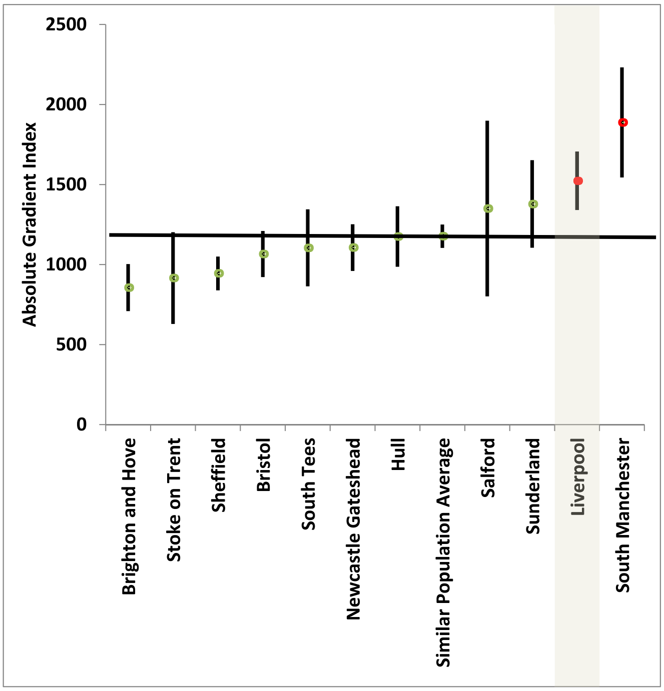

Fig. 6. Equity assessment against the similar population benchmark for Liverpool in 2015–Absolute Gradient Index (AGI) of inequality in potentially avoidable emergency hospitalization.
Notes
a)The vertical lines show AGI inequality estimates with 95% confidence intervals for Liverpool and ten similar clinical commissioning groups in England.
b)The horizontal line shows the similar populations inequality benchmark, based on pooling the registered populations within this group of clinical comissioning groups with similar populations.

health care managers accountable for their baseline equity score. In such cases, however, it may still be appropriate to hold health care managers accountable for changes in their equity score over time. This is because recent trends in unmeasured risk factors may be similar between the CCG and its currently similar areas, even if the baseline levels differ for long-term historical reasons. Research is therefore needed to find better methods of risk adjustment by making creative use of administrative data on particular risk factors, for example using historical data on ICD-10 codes for neighborhood level hospital admissions. Until more accurate forms of risk adjustment are found, therefore, the most important use of these equity indicators may lie not so much in spotting poor equity performance in cross section as in identifying systematically improving and worsening equity performance over time.

Another potential issue relates to the application of these indicators in more geographically fragmented health systems like those in the USA, where no accountable care organization provides anything close to universal coverage for their local population. In such settings, accountable care organizations may potentially "cream skim" enrollees who are healthier in terms of unmeasured risk factors than suggested by their age, sex and neighborhood deprivation characteristics. Further research is needed in such countries to assess the potential for "gaming" of equity indicators through cream skimming of relatively healthy deprived individuals, and to find solutions such as additional risk adjustment and population imatching techniques to ensure that benchmark gradients from apparently similar populations are genuinely comparable.

A limitation of using potentially avoidable emergency hospitalization as an equity indicator is that aggregating emergency admissions for many different chronic conditions may mask varying influences of different conditions. Without further disease-specific analysis, therefore, we cannot tell whether equity performance reflects organization-wide performance across all disease areas, or particular issues in particular disease areas. It is possible to make equity comparisons using disease-specific hospitalization rates for broad disease categories such as cardiovascular disease (Vanasse et al., 2014). However, we would caution against doing so unless there are sufficiently large counts of events within each neighborhood to make statistically valid comparisons, which will typically require pooling data over several years. Our approach therefore provides an overall indicator of health equity for accountable care organizations which can be compared over time and then supplemented by disease-specific analysis of pooled years to pinpoint long-term problems within specific disease areas and specialties.

A final limitation is that we used straightforward linear regression methods to facilitate communication of our findings to decision makers. We performed sensitivity analysis using more sophisticated methods, including non-linear models and empirical Bayes estimation of confidence intervals, but found this makes little difference to the identification of better-than-benchmark and worse-than-benchmark equity (Cookson et al., 2016). The gradient in potentially avoidable emergency hospitalization is in fact curved rather than linear, with an increasing slope towards the most deprived end of the spectrum. A single-parameter power transform prior to estimation fits better than either a linear or exponential model, and results in higher estimates of the gap between most and least deprived neighborhoods. This is because the linear approach flattens out the "uptick" in hospitalization towards the most deprived end of the spectrum. However, this does not substantially alter the pattern of equity comparisons. Different inequality indices use different assumptions and value judgements and we would recommend sensitivity analysis using alternative indices – in particular, the Relative Gradient Index, which measures the corresponding relative concept of inequality. Use of both absolute and relative indices is particularly important in time series equity comparisons when the mean is changing, since in those cases relative and absolute inequality can move in different directions (Kjellsson et al., 2015).

4.4. *Communicating the equity dimension of quality to healthcare managers*

It is important to find ways of communicating equity information clearly to healthcare decision makers. In consultations with healthcare managers and policymakers we found strong support for one-page "equity dashboards" combining information on quality and equity for a suite of key quality indicators (Cookson et al., 2016). Dashboards help decision makers visualize complex underlying inequality patterns, place equity information in context, identify how far particular quality problems have an equity dimension, and avoid the problem of equity indicators being isolated from mainstream quality indicators. Examples of equity dashboards and visualization tools developed by the authors are available at: http://www.york.ac.uk/che/research/equity/monitoring/

4.5. *Applicability to other countries*

The NHS approach to equity monitoring could be adapted for use in other countries with well-developed data systems for civil registration and healthcare quality assurance, in which data on healthcare access and outcomes can be disaggregated to small area or individual levels. In principle, inequality in avoidable hospitalization can be measured for any group of healthcare purchasing and planning organizations within any jurisdiction with data on hospitalization and socioeconomic disadvantage, so long as (i) each of the care organizations serves a sufficiently large numbers of individuals with a sufficiently broad range of socioeconomic backgrounds for reliable statistical estimation of the gradient, and (ii) the marker of disadvantage is sufficiently reliable (for example, the small areas are sufficiently small and homogeneous in terms of socioeconomic composition for meaningful comparisons). In our study the 209 clinical commissioning groups served 272,000 registered patients on average (range 73,000 to 913,000), residing within an average of 428 neighborhoods (range 95 to 1972). What counts as a sufficient number of individuals and neighborhoods will vary from one setting to another, since statistical reliability and the accuracy of area deprivation markers depend upon contextual factors including the prevailing rates of avoidable hospitalization and the degree of residential segregation.

Although administrative health data in low-income countries are often incomplete (World Health Organization, 2013), our approach should be applicable in many middle- and high-income countries with well-developed administrative data systems capable of disaggregating data on social factors to small and homogenous neighborhoods.

4.6. Further research

This approach to equity monitoring can be used as a data platform for future research to evaluate the health equity impacts of healthcare initiatives using quasi-experimental designs. Research is also needed to refine and improve the analytical approach, for example by analyzing the determinants of variation in care organization gradients, and applying statistical process control theory to separate common statistical variation in gradients from special cause variation attributable to healthcare quality. Another important refinement will involve adapting this approach to monitor the equity performance of hospitals, including investigation into the appropriate hospital unit – e.g. site, local organization, regional network – and the appropriate catchment population denominator – e.g. actual or potential patients. This is an important avenue for research, since equity is directly relevant to hospital quality assurance in many countries and settings. For example, hospital managers in England have a direct interest in preventing costly emergency hospitalization from disadvantaged populations, to free up their capacity to reduce waiting times and improve performance on other high profile quality indicators, and hospital staff could work more closely with community providers to achieve this. The approach may also be applicable to areas of healthcare policy other than quality assurance. For example, decomposition of the national gradient into between- and within-organization components could provide useful information about geographical resource allocation between and within administrative areas. Finally, research is needed to tailor this approach to other countries with well-developed data infrastructure for civil registration and healthcare quality assurance. One key issue is the selection of healthcare administration boundaries that are small enough to be useful for healthcare quality assurance yet large enough to allow robust statistical comparisons of social gradients; another is how to tailor the indicator definitions to different national policy contexts and data systems.

5. Conclusion

The production of equity indicators for organizations with direct responsibility for purchasing and planning healthcare is an essential first step for policy makers who are serious about reducing social inequalities in healthcare access and outcomes. The next step is to use these indicators to evaluate organization-wide initiatives and help decision makers learn how to reduce costly emergency admissions associated with deprived populations. As evidence accumulates on the most cost-effective ways of improving health equity, policy makers can then start encouraging healthcare organizations to scale-up the best approaches.

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References

Agency for Healthcare Research and Quality, 2016. National Healthcare Quality & Disparities Reports. [accessed on July, 2016]. Available at: http://www.ahrq.gov/research/findings/nhqrdr/index.html.

Asaria, M., Ali, S., Doran, T., Ferguson, B., Fleetcroft, R., Goddard, M., Goldblatt, P., Laudicella, M., Raine, R., Cookson, R., 2016a. How a universal health system reduces inequalities: lessons from England. J. Epidemiol. Commun. Health: jech 2015–206742.

Asaria, M., Doran, T., Cookson, R., 2016b. The costs of inequality: whole-population modelling study of lifetime inpatient hospital costs in the English National Health Service by level of neighbourhood deprivation. J. Epidemiol. Commun. Health 70 (10), 990–996.

Badrick, E., Hull, S., Mathur, R., Shajahan, S., Boomla, K., Bremner, S., Robson, J., 2014. Health equity audits in general practice: a strategy to reduce health inequalities. Prim. Health Care Res. Dev. 15 (01), 80–95.

Blustein, J., Weissman, J.S., Ryan, A.M., Doran, T., Hasnain-Wynia, R., 2011. Analysis raises questions on whether pay-for-performance in Medicaid can efficiently reduce racial and ethnic disparities. Health Aff. 30 (6), 1165–1175.

Buntin, M.B., Ayanian, J.Z., 2017. Social risk factors and equity in medicare payment. N. Engl. J. Med. 376 (6), 507–510.

Centers for Medicare & Medicaid Services, 2017. Quality Measures, Reporting and Performance Standards. [accessed on 9 March, 2017]. Available at: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/sharedsavingsprogram/Quality-Measures-Standards.html.

Cookson, R., Asaria, M., Ali, S., Ferguson, B., Fleetcroft, R., Goddard, M., Goldblatt, P., Laudicella, M., Raine, R., 2016. Health Equity Indicators for the English NHS: a longitudinal whole-population study at the small-area level. Health Serv. Deliv. Res. 4 (26).

Delgadillo, J., Asaria, M., Ali, S., Gilbody, S., 2016. On poverty, politics and psychology: the socioeconomic gradient of mental healthcare utilisation and outcomes. Br. J. Psychiatr. 209 (5), 429–430.

Department for Communities and Local Government, 2016. Rough Sleeping: Autumn 2016 Statistical Release. [accessed on 2016]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/585713/Rough_Sleeping_Autumn_2016_Statistical_Release.pdf.

Devlin, A.M., McGee-Lennon, M., O'Donnell, C.A., Bouamrane, M.-M., Agbakoba, R., O'Connor, S., Grieve, E., Finch, T., Wyke, S., Watson, N., 2016. Delivering digital health and well-being at scale: lessons learned during the implementation of the dallas program in the United Kingdom. J. Am. Med. Inf. Assoc. 23 (1), 48–59.

Donabedian, A., 2002. An Introduction to Quality Assurance in Health Care. Oxford University Press.

Doran, T., Fullwood, C., Kontopantelis, E., Reeves, D., 2008. Effect of financial incentives on inequalities in the delivery of primary clinical care in England: analysis of clinical activity indicators for the quality and outcomes framework. Lancet 372 (9640), 728–736.

Doran, T., Maurer, K.A., Ryan, A.M., 2016. Impact of provider incentives on quality and value of health care. Annu. Rev. Publ. Health 38 (11).

Fiscella, K., Burstin, H.R., Nerenz, D.R., 2014. Quality measures and sociodemographic risk factors: to adjust or not to adjust. JAMA 312 (24), 2615–2616.

Fiscella, K., Franks, P., Gold, M.R., Clancy, C.M., 2000. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. JAMA 283 (19), 2579–2584.

Harrison, M.J., Dusheiko, M., Sutton, M., Gravelle, H., Doran, T., Roland, M., 2014. Effect of a national primary care pay for performance scheme on emergency hospital admissions for ambulatory care sensitive conditions: controlled longitudinal study. BMJ : Br. Med. J. 349.

Harvey, J., Hynes, G., Pichora, E., 2016. Trends in income-related health inequalities in Canada. Healthc. Q. 18 (4), 12.

Health and Social Care Act, 2012. London: The Stationary Office.

Herrin, J., St Andre, J., Kenward, K., Joshi, M.S., Audet, A.-M.J., Hines, S.C., 2015. Community factors and hospital readmission rates. Health Serv. Res. 50 (1), 20–39.

Huntley, A., Lasserson, D., Wye, L., Morris, R., Checkland, K., England, H., Salisbury, C., Purdy, S., 2014. Which features of primary care affect unscheduled secondary care use? a systematic review. BMJ Open 4 (5), e004746.

Institute for Healthcare Improvement, 2017. Across the Chasm Aim 6: Health Care Must Be Equitable. [accessed on 3 March 2017, 2017]. Available at: http://www.ihi.org/resources/Pages/ImprovementStories/HealthCareMustBeEquitable.aspx.

Institute of Medicine, 2001. Crossing the Quality Chasm: a New Health System for the 21st Century. pp. 346.

Joynt, K.E., De Lew, N., Sheingold, S.H., Conway, P.H., Goodrich, K., Epstein, A.M., 2017. Should medicare value-based purchasing take social risk into account? N. Engl. J. Med. 376 (6), 510–513.

Kjellsson, G., Gerdtham, U.-G., Petrie, D., 2015. Lies, damned lies, and health inequality measurements: understanding the value judgments. Epidemiology 26 (5), 673–680.

Mayberry, R.M., Nicewander, D.A., Qin, H., Ballard, D.J., 2006. Improving quality and reducing inequities: a challenge in achieving best care. In: Baylor University Medical Center. Proceedings. Baylor University Medical Center, pp. 103.
McLennan, D., Barnes, H., Noble, M., Davies, J., Garratt, E., Dibben, C., 2011. The English Indices of Deprivation 2010. [accessed on 13 March, 2011]. Available at: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015.
Moy, E., Dayton, E., Clancy, C.M., 2005. Compiling the evidence: the national healthcare disparities reports. Health Aff. 24 (2), 376–387.
National Academies of Sciences, E., Medicine, 2016. Accounting for Social Risk Factors in Medicare Payment: Identifying Social Risk Factors. National Academies Press.
NHS Digital, 2017a. CCG Outcome Indicator Set. [accessed on 13 March, 2017a]. Available at: https://indicators.hscic.gov.uk/download/Clinical%20Commissioning%20Group%20Indicators/Specification/CCG_2.6_I00757_S.pdf.
NHS Digital, 2017b. Quality and Outcomes Framework. [accessed on 9 March 2017, 2017b]. Available at: http://content.digital.nhs.uk/qof.
NHS England, 2016a. CCG Improvement and Assessment Framework 2016/17. [accessed on July, 2016a]. Available at: https://www.england.nhs.uk/commissioning/ccg-auth/.
NHS England, 2016b. Challenging Health Inequalities. [accessed on 2016b]. Available at: https://www.england.nhs.uk/about/gov/equality-hub/challenge-health-inequalities/.
NHS England, 2016c. Commissioning for Value: Comprehensive Data Packs to Support CCGs and NHS England in the Regions. [accessed on 23 July 2016, 2016c]. Available at: https://www.england.nhs.uk/resources/resources-for-ccgs/comm-for-value/.
NHS England, 2017a. Clinical Commissioning Groups. [accessed on 13 March, 2017a]. Available at: https://www.learnenv.england.nhs.uk/similar.
NHS England, 2017b. Equality, Diversity and Health Inequalities. [accessed on 3 March 2017, 2017b]. Available at: https://www.england.nhs.uk/about/equality/.
Office for National Statistics, 2017. Statistics on Drug Misuse: England, 2017. [accessed on 28/11/2017, 2017]. Available at: http://digital.nhs.uk/catalogue/PUB23442.
Purdy, S., Griffin, T., Salisbury, C., Sharp, D., 2009. Ambulatory care sensitive conditions: terminology and disease coding need to be more specific to aid policy makers and clinicians. Publ. Health 123 (2), 169–173.
Purdy, S., Huntley, A., 2013. Predicting and preventing avoidable hospital admissions: a review. J. Roy. Coll. Phys. Edinb. 43, 340–344.
Raleigh, V., Foot, C., 2010. Getting the Measure of Quality: Opportunities and Challenges. Kings Fund, London.
Remington, P.L., Catlin, B.B., Gennuso, K.P., 2015. The county health rankings: rationale and methods. Popul. Health Metrics 13 (1), 11.
Sheringham, J., Asaria, M., Barratt, H., Raine, R., Cookson, R., 2016. Are some areas more equal than others? socioeconomic inequality in potentially avoidable emergency hospital admissions within English local authority areas. J. Health Serv. Res. Pol. 22 (2), 83–90.
Torio, C., Andrew, R., 2014. Geographic Variation in Potentially Preventable Hospitalizations for Acute and Chronic Conditions, 2005-2011. HCUP Statistical Brief #178. September 2014. Agency for Healthcare Research and Quality, Rockville, MD.
Vanasse, A., Courteau, J., Asghari, S., Leroux, D., Cloutier, L., 2014. Health inequalities associated with neighbourhood deprivation in the Quebec population with hypertension in primary prevention of cardiovascular disease. Chronic diseases injuries Canada 34 (4).
World Health Organization, 2013. Handbook on Health Inequality Monitoring with a Special Focus on Low-and Middle-income Countries. World Health Organization.
World Health Organization, 2014. Measuring and monitoring intersectoral factors influencing equity in universal health coverage (UHC) and health. In: Summary Report of a Meeting in Bellagio, 6–8 May 2014. World Health Organization, Geneva, Switzerland.
Yasaitis, L.C., Pajerowski, W., Polsky, D., Werner, R.M., 2016. Physicians' participation in ACOs is lower in places with vulnerable populations than in more affluent communities. Health Aff. 35 (8), 1382–1390.