Defining Integrated Care Systems Through Patient Data From Referral Networks in the English National Health Service: A Graph-Based Clustering Study.

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Abstract

Background Integrated Care Systems (ICSs) are being introduced into the National Health Service (NHS) in England to replace Sustainability and Transformation Partnerships (STPs). They aim to improve care through place-based collaboration between primary, secondary and community providers. It is important that new organisational configurations adequately reflect existing patterns of patient care to minimise disruption resulting from patients crossing between ICSs.

Methods All planned outpatient hospital clinic appointments from 1st April 2017 to 31st March 2018 for patients resident in England to NHS hospitals in England were identified from Hospital Episode Statistics. Markov Multiscale Community Detection (MMCD), an unsupervised network clustering technique, was used to identify natural communities of GP practices, hospitals and geographic regions according to patterns of GP practice registration and outpatient clinic referral. Two primary measures of care coverage were calculated; the proportion of patients registered to a GP practice in a different community than they reside, and the proportion of outpatient clinic appointments to hospitals in a different community to the referring GP practice.

Results 109,830,647 outpatient clinic appointments were identified for 20,992,695 patients. A configuration of 42 ICSs was identified from MMCD to match the 42 STPs of the current configuration. In the current STP configuration, 534,946 patients (2.6%) were registered to a GP practice in a different STP than their residence, compared to 334,192 (1.6%) in the optimal MMCD configuration. 16,110,267 hospital clinic appointments (14.7%) occurred in a different STP to the referring GP practice, compared to 11,518,735 (10.5%) in the MMCD configuration.

Conclusions Millions of hospital appointments annually occur in hospitals outside of the STP of the referring GP practice. Applying MMCD we derive spatially consistent partitions of NHS Trusts and GPs into ICSs that are more representative of existing patient flows while maintaining the intended population size and number of ICSs. The findings of this study should guide policymakers locally and nationally to determine where ICS boundaries may be redrawn and the extent to which such changes would better reflect the current needs of patients.

Background

The integration of primary and secondary care organisations has been a long-term aim of the National Health Service (NHS) in England. The latest NHS Long Term Plan sets out an ambition for greater collaborative working between commissioners and care providers to provide more joined-up care between primary and secondary care, and an impetus for preventive population health activities.(1,2) Currently, the NHS in England is in the process of transitioning from a looser form of organisational collaboration known as ‘Sustainability and Transformation Partnerships’ (STPs) towards more formal collaborations known as ‘Integrated Care Systems’ (ICS). ICSs are partnerships that bring together the commissioners and providers of primary, secondary and community NHS services alongside local authorities within a geographic area to plan and implement care to meet the needs of local populations of between 1 and 3 million people, including formalised commissioning relationships and payment models.(2,3) ICSs have already formed across many regions of England, largely conforming to the footprints of the STPs they replace, with an expectation that the whole of England will be covered by an ICS by 2021.(3,4)

One of the key organisational building blocks for ICSs are general practices (GPs), in the form of Primary Care Networks (PCNs), working in partnership with hospital Trusts.(1) Almost all general practices have joined a PCN, with population sizes recommended to cover between 30-50,000 patients.(1,5) In contrast, the existing geographical footprints of STPs pre-dated the formation of PCNs, and arose from the agglomeration of Clinical Commissioning Groups (CCGs) and local authorities.(6,7) As a result, given the different constituent organisations, current STP footprints may not represent optimal collaborations of organisations expected of an ICS.

A primary aim of ICSs is to formalise relationships between care providers and defined geographic communities of patients, effectively forming discrete place-based healthcare ecosystems. While such relationships are long established in primary and community care in England, over the last three decades secondary care providers have been encouraged to compete with one another to provide services commissioned from primary care.(8) The NHS Five Year Forward View in 2014 and NHS Long Term Plan in 2019 marked a transition from competition between providers to collaboration, of which the implementation of ICSs are a significant step.(1,9) It is therefore important to understand the extent to which existing organisational divisions within the NHS reflect how care is currently delivered, and the extent to which this varies across the country.

Given the focus of ICSs on collaborative working between primary and secondary care organisations to provide care to a defined geographic population of patients, understanding the patient-sharing relationships between providers is critical. The population using NHS services are not restricted to attendance at a particular provider: GPs may register patients outside of their 'catchment' area, refer patients for elective care at any hospital, and no restraints exist on patient self-presentation to emergency care providers.(10) As a result, patients may attend multiple providers for different services outside existing organisational boundaries, creating potential difficulties for GPs and PCNs to identify a single ICS to which they ‘belong’, with few tools to guide them. ICS boundaries are not prescribed or fixed: some may retain existing STP boundaries, while others may redraw boundaries with little reference to the STPs that preceded them.(3) Understanding the extent to which the redrawing of ICS boundaries may better represent patterns of clinical activity is important to determining the additional benefit, if any, of such a change.

The aim of this article is to define an optimised grouping of population geographies, GP practices and hospital trusts into communities of a similar size and scale to the current 42 STP footprints. These communities are akin to *data-driven ICSs* and are solely based on what is known about prior patient activity, i.e., where patients live based on their Lower Layer Super Output Area of residence (LSOA), their registered GP practice, and the Hospital Trust they attend for planned outpatient clinical care. LSOAs are mutually exclusive, collectively exhaustive geographic units of census, of which there are 32,844 in England with a mean population of 1704 people.(11)

To find the communities, we construct a network that encodes patient usage data linking LSOAs, GP practices and hospital trusts. We then apply Markov Multiscale Community Detection (MMCD) to detect robust partitions of this network, without imposing *a priori* the number of communities that should be produced.(12–14) These techniques the have previously been applied in healthcare to understand organisation of Primary Care Networks in London, to examine mismatches between supply and demand for planned surgical care in England,(7,15) and in other disciplines, to identify the underlying structure of metabolic networks, transport systems and power grids.(16,17) We then compare an optimal arrangement consisting of 42 communities to the pre-existing configuration of 42 STP organisations, in terms of the coverage of the population within the community registered at a GP practice within the same community, and the proportion of outpatient clinic appointment provided by hospitals in the same community as the referring GP practice. In doing so, we examine the extent to which existing organisational configurations capture patterns of patient activity, and compare this to data-driven, optimised configurations produced from MMCD.

Methods

Setting and Data Sources

All planned outpatient hospital clinic appointments from 1st April 2017 to 31st March 2018 for patients resident in England to NHS hospitals in England were identified from Hospital Episode Statistics.(18) Hospital trusts were identified from the NHS Digital Estates Returns Information Collection.(19) Trusts defined as Acute Trusts or Mental Health and Learning Disability Trusts were included. Patients were defined as being resident in England if their Lower Layer Super Output Area (LSOA) of residence was in England. GP practices with fewer than 100 patients attending hospital appointments were excluded. Patients may change their registered GP or LSOA of residence during the study period; we assigned to each patient their LSOA of residence and registered GP practice on their first appointment during the study period.

Construction of Weighted Network from Patient Data

For each LSOA, the proportion of residents registered to each GP practice was calculated in **Equation 1** where p_{ij} is the proportion of patients resident in LSOA *i* that are registered to GP practice *j*:

$$p_{ij} = \frac{n_{ij}}{\sum_{j=1}^{J} n_{ij}} \qquad (1)$$

Similarly, for each GP practice, the proportion of appointments of their registered patients at each hospital trust was calculated in **Equation 2** where p_{jk} is the proportion of hospital clinic appointments for patients registered to GP practice *j* to hospital trust *k*:

$$p_{jk} = \frac{n_{jk}}{\sum_{k=1}^{K} n_{jk}} \qquad (2)$$

A weighted, undirected network was built where the nodes are the LSOAs, GP practices and hospital trusts, and the edges were added as follows. For all pairs of LSOAs and GP practices, edges of weight p_{ij} were added between LSOA *i* and GP practice *j*, where $p_{ij} > 0$. For all pairs of GP practices and hospital trusts, edges of weight p_{jk} were added between GP practice *j* and hospital trust *k*, where $p_{jk} > 0$.

Markov Multiscale Community Detection

MMCD is an unsupervised graph-based clustering method that exploits how a diffusion process spreads on a network to identify communities of nodes that consistently share information over different time scales. In this case, the nodes are LSOAs, GP practices and Hospital Trusts and the network communities correspond to groupings of LSOAs, GP practices and Hospital Trusts that have stronger connections with one another than to other nodes in the network. Each of these partitions therefore represents a 'natural' community derived directly from the registration and referral data. The constructed network of geographic units (LSOAs), GP practices and hospital trusts was partitioned using linearised MMCD to produce partitions that capture strong patterns of shared patient registration and clinic referral. MMCD was performed over a range of scales, from fine to coarse (as parameterised by the Markov time). At each scale, the Louvain optimisation within the MMCD algorithm was repeated 200 times and the partition with the highest Markov stability was selected. The average pairwise difference between the 200 optimised partitions was computed using the 'Variation of Information' as a quantitative measure of the similarity of partitions produced at each scale.(20) For further details on the methodology see Refs.(12,21)

Comparison of the Current STP Configuration to MMCD Partitions

Currently, the NHS in England consists of 42 STPs.(22) To focus on partitions of a similar scale, MMCD partitions consisting of between 2 and 100 communities were examined further. The median and interquartile range of the number of LSOAs, GP practices and hospital trusts in each community were calculated and compared to the current STP configuration for each partition. The extent to which communities produced by MMCD contained primary care and secondary care activity was examined. The percentage of patients registered to a GP practice contained within the same community as their LSOA of residence was calculated for each partition and compared to that of the current STP configuration. Similarly, the percentage of hospital appointments to hospital trusts located in the same community as the referring GP practice was calculated for each partition and for the current STP configuration. To provide a direct comparison with the 42 STPs in the current NHS configuration, the partition consisting of 42 communities produced from MMCD (MMCD_42) with the highest Markov Stability was identified and studied in more detail. The percentage of patients resident in the same community as their GP Practice was

calculated for each LSOA and for each community according to the current STP configuration and MMCD_42. Similarly, the percentage of hospital appointments made to hospital trusts in the same community as the referring GP practice was calculated for each GP practice and for each community according to the current STP configuration and MMCD_42.

This study received local ethical approval through the Imperial College Research Ethics Committee (17IC4178). All methods were performed in accordance with the relevant guidelines and regulations.

Results

A total of 109,830,647 outpatient clinic appointments to 199 NHS hospital trusts were identified for 20,992,695 unique patients between 1st April 2017 and 31st March 2018. Included patients were resident in 32,844 LSOAs and registered to 10,745 GP practices.

Markov Multiscale Community Detection Output

MMCD was performed across scales by computing optimised partitions at 400 Markov times over the range of 0.01 to 100, encompassing partitions consisting of between 100 and 2 communities. Robust partitions were identified as minima (or dips) of the Variation of Information corresponding to partitions consisting of 57, 31, 10, 7, and 4 communities (**Additional file 1**). The geographic footprints of these partitions are shown in **Figure 1**. The partition consisting of 42 communities, the same number as the current STP configuration, is also shown in **Figure 1** (Panel B).

Comparison of Community Sizes

Panel A of **Figure 2** shows the median number of LSOAs, GP practices and hospital trusts in each MMCD partition of between 2 and 100 communities. There is no significant difference between the STP configuration and MMCD_42 in the number of LSOAs (684 vs 640, two-tailed MWU, $p = 0.67$), GP practices (151 vs 133, two-tailed MWU, $p = 0.60$) and hospital trusts (4 vs 4, two-tailed MWU, $p = 0.85$) in each community. Panel B of **Figure 2** also shows the proportion of communities in each partition above, below and within the intended ICS population size of 1 to 3 million people.(3) For the current STP configuration, 27 out of 42 STPs (63.4%) had a patient population between 1 and 3 million people, with the remaining 15 STPs (35.7%) having a population less than 1 million people. In the MMCD partitions, the proportion of communities of between 1 and 3 million people increases steadily from 8.0% at 100 communities to a maximum of 83.3% of communities in the 24-community partition.

Comparison of Community Coverage for GP Practice Registrations

In the current STP configuration, 534,946 patients (2.6%) are registered to GP practices located in a different STP to their STP of residence. At LSOA-level (**Figure 3**, Panel A), lowest coverage is observed in LSOAs located on the boundaries of STPs, while coverage approaches 100% in areas located centrally within STPs. At STP-level (**Figure 3**, Panel B), regional variation is seen in the extent to which patients are registered to GP practices in the same STP as they reside. In predominantly rural areas in the North of England, such as the Cumbria and North East STP, coverage was 99.6%, while in STPs around London, such as the South West London Health and Care Partnership, coverage fell to 94.2%.

In the MMCD_42 configuration, 334,192 (1.6%) patients are registered to a GP practice located in a different community to their LSOA of residence. As with the STP configuration, at LSOA-level (**Figure 3**, Panel C), lowest coverage is observed in LSOAs located on the boundaries of communities, while coverage approaches 100% in areas located centrally within communities. At community-level (**Figure 3**, Panel D), regional variation appears less marked than in the current STP configuration. Clearly, the *coverage* (i.e., the percentage of patients registered to a GP practice in the same community as their LSOA of residence) can be increased by making the communities larger, e.g., **Figure 4** shows that in the case of MMCD communities the coverage grows from 97.3% at 100 communities to 100.0% at 2 communities. Further, MMCD partitions achieve greater coverage than the current STP configuration with far less centralisation, i.e. the 97.3% coverage provided by the current STP configuration is attained by MMCD partitions consisting of up to 91 communities. Hence better coverage was achieved even with smaller communities than the current STP configuration.

Compared to the current STP configuration, MMCD_42 configuration results in 200,754 fewer patients (1.0% of the total) being registered to GP practices outside of their community of residence, representing a 37.5% reduction. Panel A of **Figure 5** shows the change in the percentage of patients registered to a GP practice in the same community of residence for each STP under the MMCD_42 configuration. Adoption of the MMCD_42 configuration would increase coverage for 38 STPs (90.5%), and for 10 STPs (23.8%) this increase in coverage exceeds 2 percentage points. Coverage decreased for four STPs (9.5%).

Comparison of Community Coverage for Hospital Clinic Appointments

In the current STP configuration, 16,110,267 hospital appointments (14.7%) took place in hospital trusts in a different STP to a patient's GP practice for a coverage of 85.3%. At GP practice-level (**Figure 6**, Panel A), lowest coverage is observed in practices located on the boundaries of STPs and in the areas around the major conurbations of London and the West Midlands. At STP-level (**Figure 6**, Panel B), STPs located around London have particularly low levels of coverage, with only 60.3% of hospital appointments from GP practices in Hertfordshire and West Essex STP occurring at hospitals within the STP, compared to 99.9% of appointments in the Cumbria and North East STP.

In the MMCD_42 configuration, 11,518,735 hospital appointments (10.5%) took place in hospital trusts in a different community to a patient's GP practice for a coverage of 89.5%. Panels C and D of **Figure 6** show the percentage of appointments made to a hospital trust in the same community as the patient's GP practice for individual GP practices (Panel C) and at community-level (Panel D). Regional variation remains at community-level, with lower coverage in areas around London. Note that the STP coverage of 85.3% can be achieved already at a much less centralised level of 68 communities.

Compared to the current STP configuration, the MMCD_42 configuration results in 4,591,532 (4.2%) fewer appointments to hospitals located in a different community to the referring GP practice, representing a 37.5% reduction. Panel B of **Figure 5** shows the change in the percentage of appointments made to hospital trusts in the same community as the referring GP practice for each STP under the MMCD_42 configuration. For 38 STPs (90.5%), adoption of the MMCD_42 configuration would increase coverage, and in 7 STPs (16.7%) this increase in coverage exceeds 10 percentage points. Coverage decreased for four STPs (9.5%), namely Cumbria and North East STP, Devon STP, Gloucestershire STP and Hampshire and the Isle of Wight STP.

Summary statistics for each STP are provided in **Additional file 2**.

Discussion

This study examines the extent to which the current configuration of STPs represents primary and secondary care activity at a national and local level and considers a data-driven approach based on network analysis tools (i.e., Markov Multiscale Community Detection) to identify alternative, spatially consistent configurations that better reflect patterns of patient registration and referral.

Across the country, 97.4% of all patients included in the study lived within the same STP as their registered GP practice. This is unsurprising given the small number of STPs in relation to the thousands of GP practices in the country. Patients are likely to attend a GP practice close to their home, and even if they are not registered to their nearest practice, unless living near the boundary of an STP, are unlikely to attend a more distant provider across the boundary. This is supported by the reticular appearance of Panel A of Fig. 3 where lower coverage is seen in LSOAs at the boundaries of STPs, indicating that patients living on the boundaries of STPs are more likely to cross STP boundaries to access a nearby GP practice than those who live at the centre of STPs.

Across England, over 16 million hospital clinic appointments occurred at a hospital in a different STP to the GP practice to which a patient is registered; the equivalent of over 44,000 appointments each day and representing 14.7% of all outpatient appointments. Unlike primary care registrations, extensive variation in secondary care coverage was identified between STPs. In the MMCD_42 configuration, 4.5 million fewer appointments occurred across community boundaries, a 37.5% reduction in cross-community appointments compared to STPs. Although the number of communities with secondary care coverage below 80% is reduced from 10 STPs to 4 communities in the MMCD_42 partition, there is still an intrinsic limitation in imposing boundaries on a densely connected system of patients and healthcare providers that is not built with such boundaries in mind. The spread of population centres across administrative boundaries, and the centralisation of specialist hospital services represent inevitable barriers to achieving high levels of coverage in the current STP configuration.

In this study, as shown in Figs. 1 and 4, Markov Multiscale Community Detection produced spatially consistent partitions across a range of scales and achieved better representation of patient flows than the current STP architecture. Alternative configurations of ICSs may therefore be explored and trialled either locally or nationally within our framework, affording policymakers the opportunity to adapt a new mode of healthcare organisation as they learn from its successes and failures in implementation. Importantly, MMCD did not produce a single dominant community to which smaller communities steadily combined. Figure 1 shows that the number of LSOAs, GP practices and hospital trusts in each community increase steadily as the coarseness of the optimised partitions is increased. This indicates that the underlying community structure of primary and secondary care in England could be maintained as relatively decentralised, with stable, representative communities comparable to Integrated Care Systems forming and agglomerating regionally, rather than forming large dominant communities centred on the conurbations of London, the North West of England and the West Midlands. We find that partitions with fewer, larger communities are more able to contain a greater proportion of both primary and secondary care activity; however, for partitions consisting of 20 or more communities, this increase in coverage is steady without step-like increases from one configuration to the next. This suggests that none of the configurations of LSOAs, GP practices and hospitals in England produced by MMCD stand out as a clear optimum with respect to patterns of primary and secondary care activity.

The ongoing transition of the NHS in England towards more formal integration of primary and secondary care organisations represents an opportunity to ensure that any new organisational units formed bear reference to existing patterns of patient and physician behaviour. It is crucial that Integrated Care Systems reflect existing patterns of activity within the healthcare system, both in primary and secondary care. In this study we show that no single configuration of LSOAs, GP practices and hospital trusts is overwhelmingly superior, but that the configurations formed through MMCD better reflect the intrinsic patterns of patient behaviour than the current STP architecture. We therefore propose that this point of organisational change in the NHS in England represents an opportunity to redefine how providers collaborate to better reflect the everyday activity of this complex system, rather than relying strictly on inherited and potentially unrepresentative organisational boundaries.

As ICS programmes develop, there will inevitably be tension between their aim of providing population health management and integrated care, which will require primary care providers to refer to specific specialist providers; and government objectives of giving general practitioners flexibility in where they can refer, and patients a choice in where they are treated. Our findings show that the majority of patients are currently treated within an ICS but there are still a large number of episodes of care that cross ICS boundaries. It is essential that the effects of implementing ICS programmes is carefully evaluated to identify both positive and negative consequences.(23)

Limitations

A significant limitation of our analysis is the use of secondary care data to understand patterns of primary care registration. Use of primary care data covering the whole population of England would be preferable, but is not readily available for research purposes. In the secondary care data used, the registered GP practice is known for the 21.0 million patients identified, representing 47.4% of the estimated 44.2 million adults resident in England.(24) Those patients included in the HES outpatient dataset used for the study have, by definition, used secondary care services at least once during the study period, and therefore may have different patterns of healthcare utilisation and different healthcare needs. While this may be a limitation in terms of representing the overall

population of England, it is conveniently biased towards representing those individuals who required outpatient hospital care and therefore may be expected to have higher healthcare needs overall. Additionally, this study focusses on outpatient hospital clinic activity, rather than emergency department or inpatient utilisation, which may produce differing results.

Conclusion

In this study we quantify the extent to which the current STP configuration of the NHS in England reflects patterns of patient registration to GP practices and hospital clinic appointments. We find that current STP footprints variably represent patterns of hospital clinic referral, with over 16 million outpatient appointments in a single year occurring at a hospital located in a different STP to the referring GP practice. Applying Markov Multiscale Community Detection, we produced spatially consistent ICS configurations across a range of scales and demonstrate that this data-driven approach better reflects patterns of care delivery in England. The implementation of ICSs in England presents the opportunity to ensure this new configuration better represents existing patterns of patient care, rather than inherit potentially unrepresentative pre-existing organisational boundaries.

List Of Abbreviations

NHS: National Health Service

STP: Sustainability and Transformation Partnership

ICS: Integrated Care System

LSOA: Lower Layer Super Output Area

GP: General Practitioner

MWU: Mann-Whitney U test

PCN: Primary Care Network

CCG: Clinical Commissioning Group

MMCD: Markov Multiscale Community Detection

Declarations

Ethics approval and consent to participate

This study received local ethical approval through the Imperial College Research Ethics Committee (17IC4178).

Consent for publication

Not applicable

Availability of data and materials

The data that support the findings of this study are available from NHS Digital but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. The community assignments derived during this study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JC and TB were involved in all aspects of the study. MB was involved in the development of the methodology and assisted in the formal analysis. MB, AM and AD were involved in the conceptualisation of the study and in the reviewing and editing of the draft. JC has had access to all the data in the study and all authors had final responsibility for the decision to submit for publication. JC attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Figures

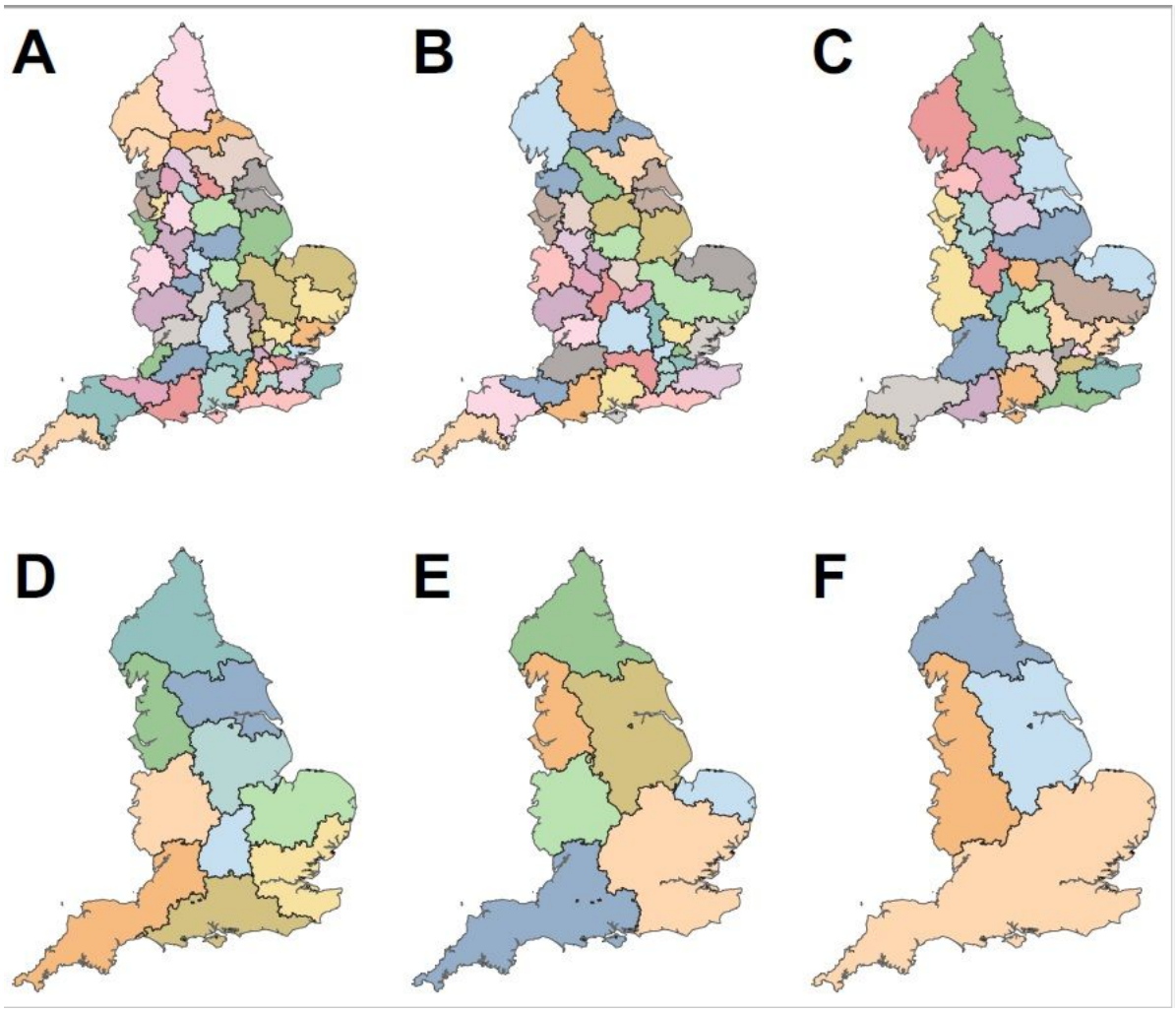

Figure 1

Six Candidate Partitions for Integrated Care System Configurations. Panels A to F show the boundaries of partitions produced from Markov Multiscale Community Detection consisting of 57, 42, 31, 10, 7 and 4 communities respectively. Panel B shows the boundaries of the 42-community partition used for further comparison to the current STP configuration.

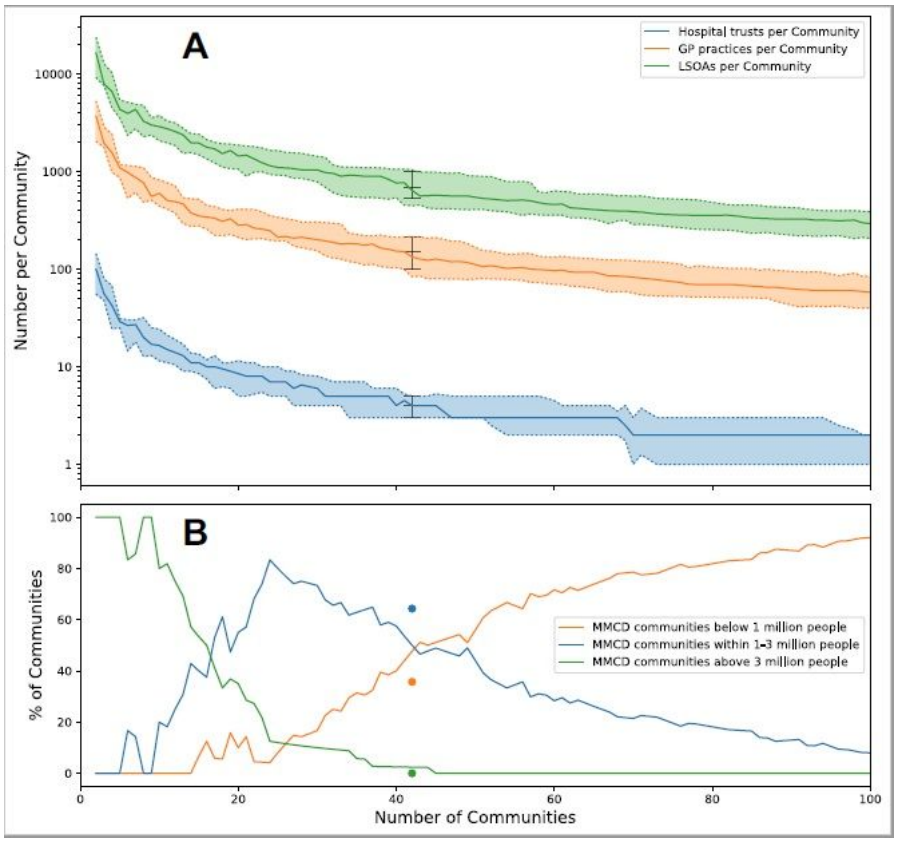

Figure 2

The median number of LSOAs, GP practices and hospital trusts in each community (Panel A) and population size (Panel B) of each community produced by Markov Multiscale Community Detection in the range of 2-100 communities. Where more than one configuration consisting of the same number of communities is produced, the community with the highest Markov stability is shown. In the upper panel, shaded areas represent upper and lower quartiles. The median, upper and lower quartiles of the current STP configuration are overlaid in black. In the lower panel circle markers indicate the corresponding percentage of current 42 STPs below 1 million people, between 1-3 million people and over 3 million people.

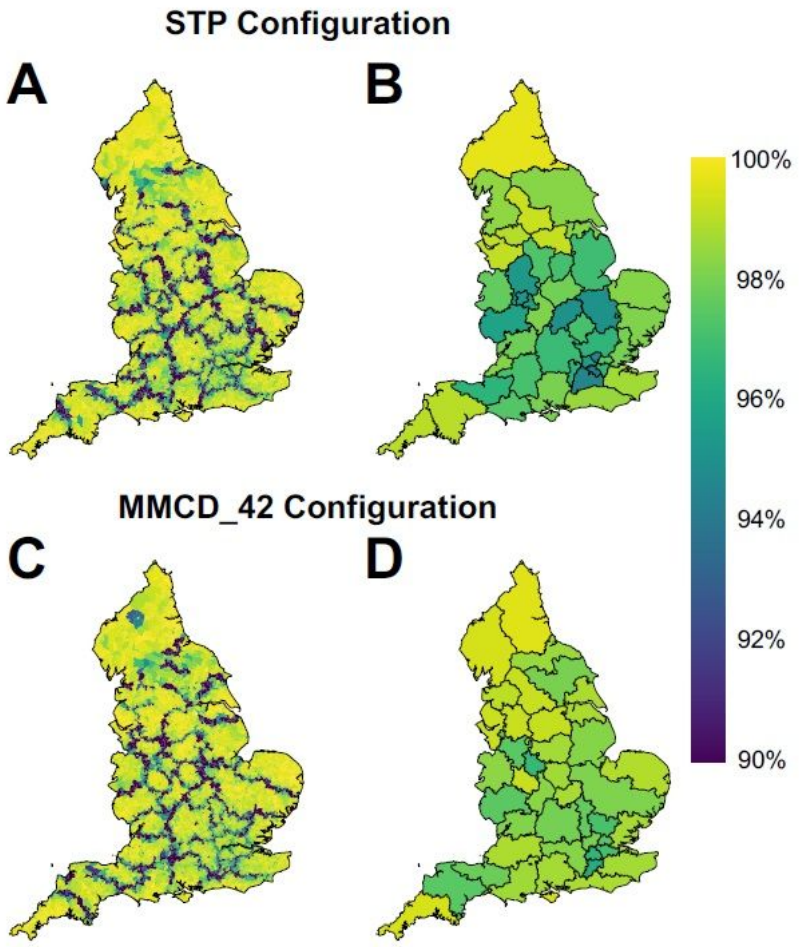

Figure 3

Percentage of patients registered to a GP practice in the same community as their LSOA of residence. Panel A shows the percentage of patients in each LSOA that are registered to a GP practice in the same STP as their LSOA. Panel B shows the percentage of patients in each STP that are registered to a GP practice in the same STP as their LSOA. Panel C shows the percentage of patients in each LSOA that are registered to a GP practice in the same MMCD_42 community as their LSOA. Panel D shows the overall percentage of patients in each MMCD_42 community that are registered to a GP practice in the same MMCD_42 community as their LSOA.

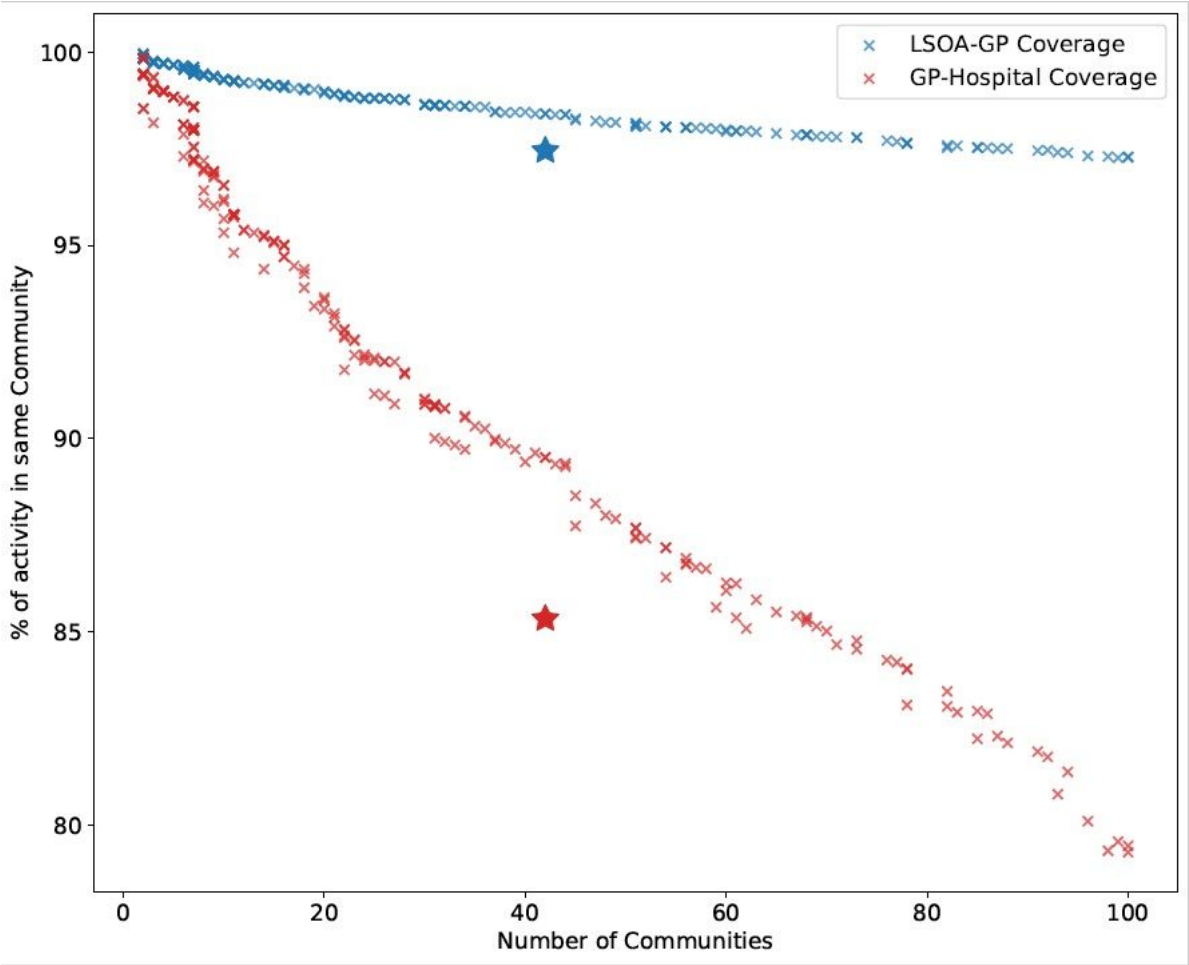

Figure 4

Percentage of Activity Contained Within the same Community. This scatter plot shows the percentage of patients who were registered to a GP practice in the same community as their LSOA of residence (blue) and the percentage of hospital appointments occurring at a hospital in the same community as the referring GP practice (red) plotted for each community produced by Markov Multiscale Community Detection in the range of 2-100 communities. The blue and red stars indicate the respective coverage of the current STP configuration.

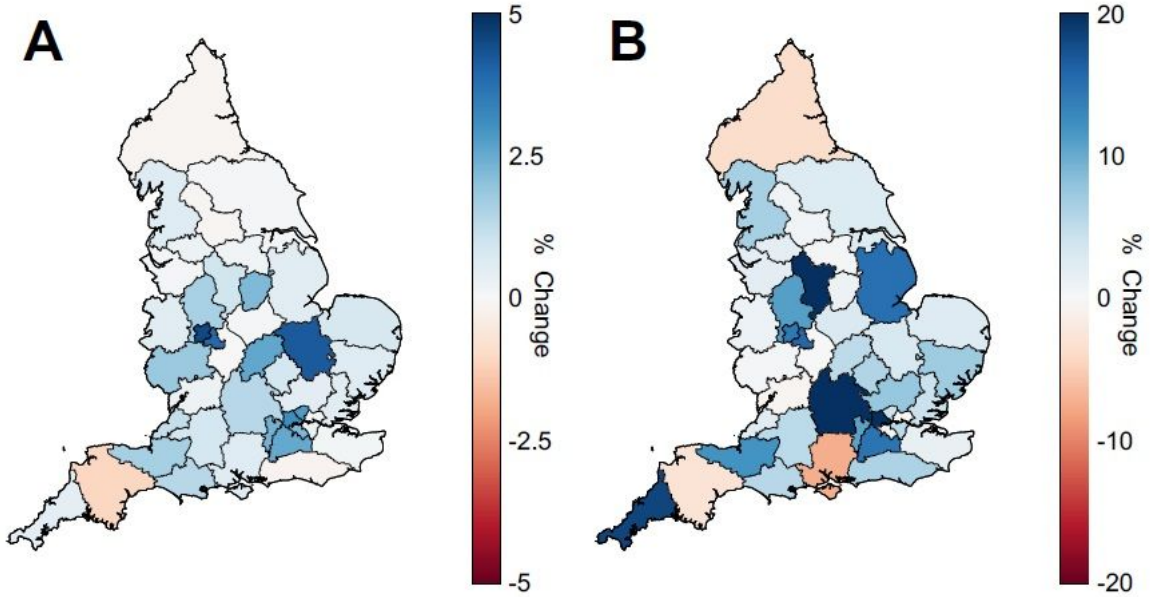

Figure 5

Change in Coverage under the MMCD_42 configuration compared to the current STP configuration. Panel A shows for each current STP the percentage change in the number of patients registered to a GP practice in the same community as their LSOA of residence under the MMCD_42 configuration. Panel B shows for each current STP the percentage change in the number of hospital appointments to hospitals in the same community as the referring GP under the MMCD_42 configuration.

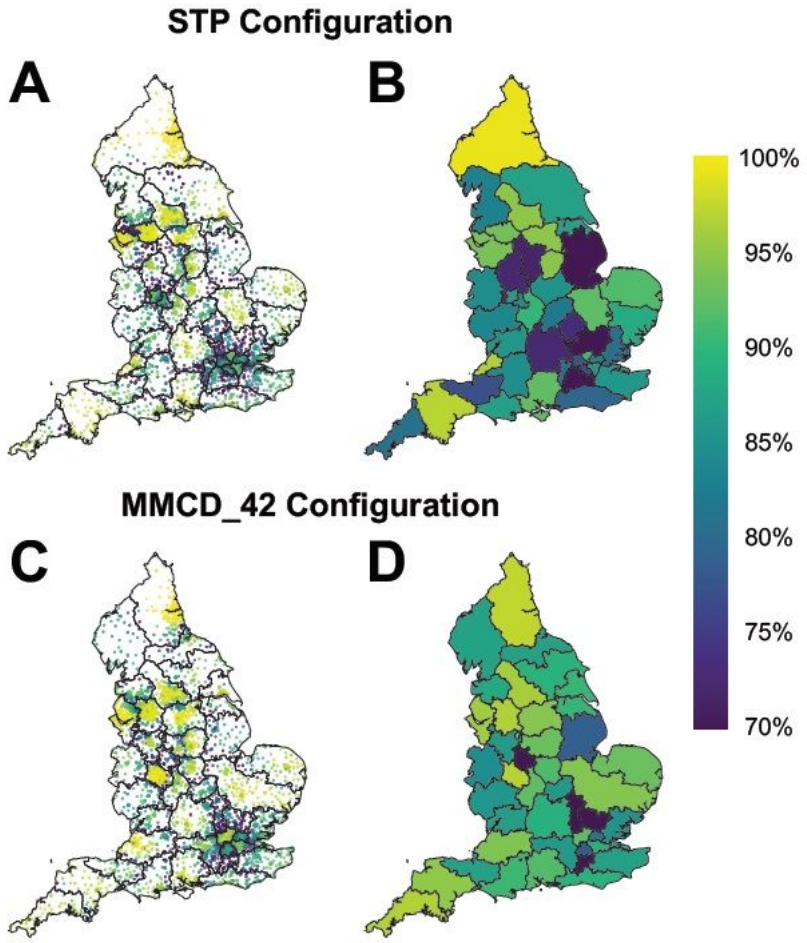

Figure 6

Percentage of hospital appointments to hospitals in the same community as the referring GP practice. Panel A shows the percentage of appointments from each GP practice to hospitals in the same current STP as their GP practice. Panel B shows the overall percentage of appointments from GP practices in each current STP to hospitals that are in the same STP as the referring GP practice. Panel C shows the percentage of appointments from each GP practice to hospitals in the same MMCD_42 community as their GP practice. Panel D shows the overall percentage of appointments from GP practices in each MMCD_42 community to hospitals that are in the same MMCD_42 community as the referring GP practice.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- ADDITIONALFILE1.docx
- ADDITIONALFILE2.xls