Geographic information system mapping of oral surgery referrals to the Birmingham Dental Hospital

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Key points

- This is the first study to map oral surgery referrals to the dental hospital in Birmingham, UK.
- Suggests geographic information system mapping of referrals can aid in locating MCN tier 2 services.
- Examines how overlaying deprivation data on referral data can give a spatial view of any relationship which may exist.

Abstract

Aims To use geographic information system mapping software to locate where patients referred for oral surgery services at the Birmingham Dental Hospital and referring clinicians to this centre are located in the Birmingham area.

Methods 3,512 consecutive referrals from 1 April to 30 June 2013 were analysed according to postcode and mapped using the specialised software Maptitude.

Results Patients were largely coming from certain pockets of the city. These included the north and east of the city, which correlated with deprivation scores. Referring clinicians were more uniformly spread across the city.

Conclusion The mapping of patient postcodes can provide healthcare commissioners with valuable information on where to target dental services according to where the patients reside. This information can be of use in managed clinical networks (MCNs) as a tool in healthcare planning and resource allocation.

Introduction

John Snow's map of the cholera epidemic in London in 1854 represents perhaps the first kind of a geographic information system (GIS). Such a system makes use of mapping of disease prevalence for healthcare improvement.[1] The British physician's use of a geographic grid to track down the pattern of deaths from cholera in the area of Soho, London, led him to localise the source of the spread to be a contaminated water pump handle. On the removal of this pump handle by town officials, the outbreak of cholera reduced dramatically. Such spatial analysis has great potential to increase the importance and understanding of geography and location with regard to epidemiology.[2] Geographic mapping provides an effective means for demonstrating the location of residence of people, using a particular facility such as a general practice, a specialised clinic or a hospital.[3] The use of spatial methodology and GIS for health has been used in medicine.[4,5,6,7] However, according to the literature, this has only scarcely been used in the context of dental medicine, and more specifically never before for oral surgery referrals.

The Birmingham Dental Hospital is a regional centre in the West Midlands as both an undergraduate and postgraduate teaching facility. Forty-five percent of the activity of the hospital is oral surgery-related, representing the biggest department in terms of activity for this hospital. As a referral centre for the region, to date referral information has not been mapped regarding patients' home postcode, nor have referring practitioners' practice locations been mapped.

According to Skipper: 'managed clinical networks (MCNs) are self-supporting groups of professionals working together to ensure cross-speciality sharing of patients and expertise. They are a strong mechanism for ensuring that patients receive the care they need in a timely fashion from the most suitable professional in the network area'.[8] As MCNs are being developed and implemented in various parts of the United Kingdom, the relevance of specific referral information could improve access for patients.[8] MCN councils could therefore use this information for their region to help locate the most ideal locations for tier 2 services; ie services which could be carried out by dentists with a special interest or specialists within a primary care setting, avoiding the need for patients to be referred to secondary care hospitals. Evidence exists that patients are happy to be treated in a primary care setting for appropriate oral surgery procedures.[9]

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The aim of this study was to first map where oral surgery referrals in the Birmingham region came from with regards to the referrer type and location using dedicated GIS software. Second, to assess the home postal code of the patients being referred according to location in and around Birmingham. A third aim of the study was to assess if there is a spatial relationship between areas with a high referral pattern and social deprivation scores.

Material and methods

Postcodes are a five- to seven-digit alpha numeric system used in the United Kingdom to represent a particular area, sector, district and unit. A combination of letters and numbers, for example B5 7EG, form part of the address. The first two letters correspond to a particular locality within the United Kingdom and the second part relates to a street within that locality. Each street will have a different postcode.

From 1 April to 30 June 2013, 3,512 consecutive referrals to the Birmingham Dental Hospital, department of oral surgery were analysed. Both the postcode of the referring clinician and of the patient's home address were extracted from the referral letter. Data protection and patient confidentiality was maintained as only documenting postcodes; the whole address or patient-specific details were not evaluated. The project was approved from the Birmingham Dental Hospital clinical governance board as a service evaluation.

The data mentioned were extracted and transferred to a respective Excel spreadsheet. For subsequent analysis, a dedicated mapping software was used (Maptitude). By processing the data in this way and using the commercially available mapping software, the following information was gathered:

1. Where the referrals were coming from, which clinicians and their locations; for example, general dental practitioner, general medical practitioner, hospital consultant, internal referral from a department outside oral surgery, eg restorative department
2. The location of each patient taken from his home postcode.

The mapped information was then superimposed with deprivation scores according to the 2011 census.[10] This would be used to create a spatial map view between deprivation and referral patterns.

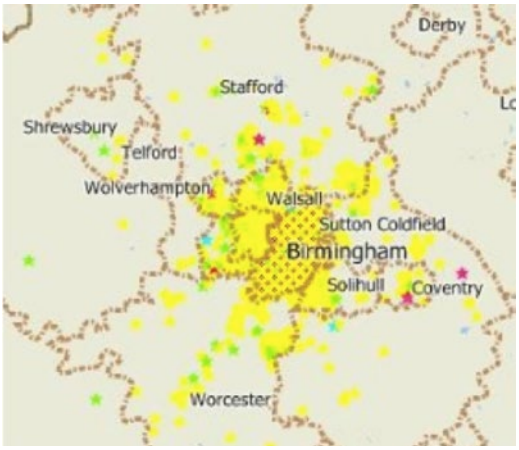

Fig. 1 The range of referrals from the West Midlands region to the oral surgery department to show the catchment area across the counties. Yellow represents a GDP referral, green represents a GMP referral and red represents a hospital referral

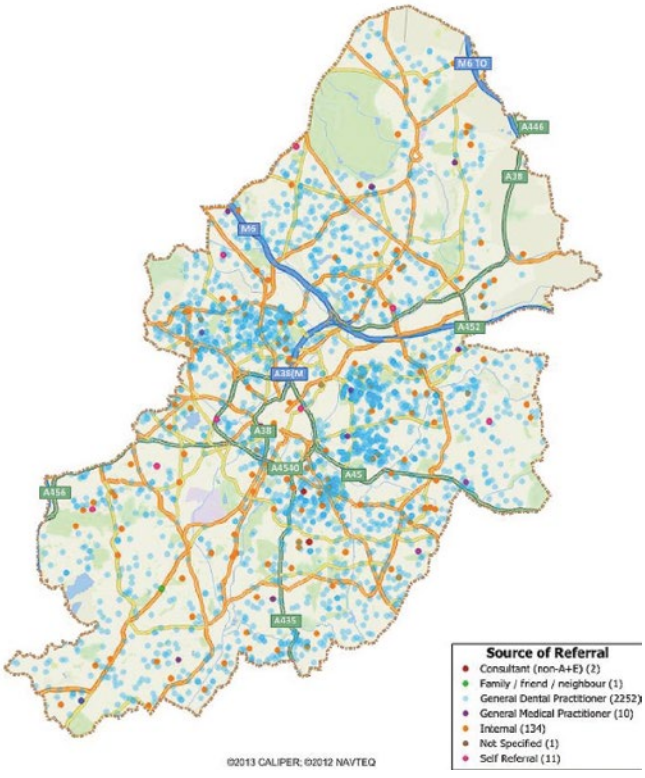

Fig. 2 Within the Birmingham area, referral mapped according to source of referral. Red represents a referral from a hospital consultant; light blue a GDP referral, orange a referral from another department within the dental hospital

Results

The maps generated are presented in Figures 1, 2, 3, 4, 5. The initial focus was on the actual range where patients come from across the region to access care at the department of oral surgery, which is shown in Figure 1. It can be seen by the spread that a significant catchment came from outside the city of Birmingham and some from outside the West Midlands.

The referrer type, such as general dental practitioner (GDP), general medical practitioner (GMP), internal referral from another department to the oral surgery department (for example, an orthodontist referring to oral surgery to expose an impacted canine) is displayed in Figure 2, according to the patient's home postcode. Figure 3 shows the postcode location of the referring clinician, most of these referring clinicians are general dental practitioners. Of interest is

how the general dental clinics are spread out consistently throughout the region.

The focus on the home postcode of patients who have been referred to the oral surgery department at the Birmingham Dental Hospital can be seen in Figure 4. Here, four 'hot spot' localities in the north, east, and south of the city can be seen. These areas were Saltley, Sparkbrook, Small Heath and Birchfield. The darker shades of red on this map indicate a higher number of patients coming from these areas.

Deprivation scores taken from the 2011 census data are overlaid in Figure 5. The deeper the colour green, the higher the deprivation score for the respective locality. There is a spatial relationship between the areas with a high level of patient residence and deprivation scores.

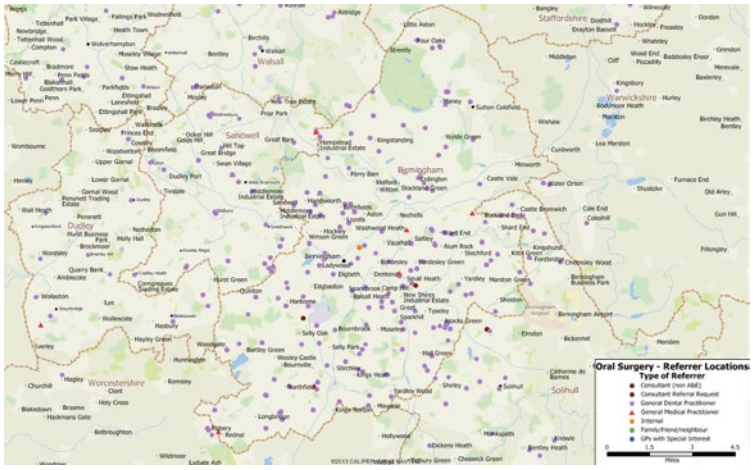

Fig. 3 Referrer location mapped according to type of referrer. Each purple dot represents a general dental practice as dentists are the majority of referrers

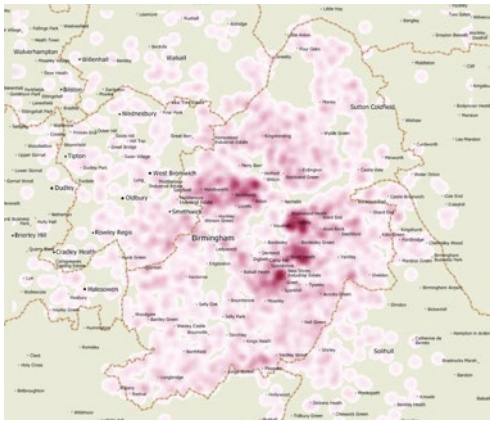

Fig. 4 A heat map showing hot spots demonstrating patients' home postcodes. The greater the intensity, the more referrals were coming from that locality. Four spots are seen in the north, east, and south of the city

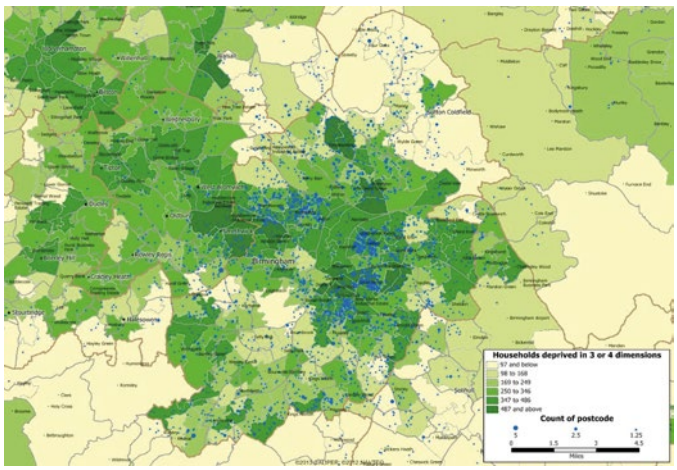

Fig. 5 Patients' home postcodes, referrals (blue dots) mapped against household deprivation scores represented by intensity of green. The deeper green represents more deprived areas using the 2011 census data[10]

Discussion

Nationalised health systems such as the United Kingdom's National Health Service (NHS) provide its citizens free health care at the point of delivery. This was developed by Aneurin Bevan and presented to parliament in 1946, with the official creation of the NHS on 5 July 1948.[11] The NHS has seen significant changes especially with regard to dental services, which is divided into general dental practice, hospital practice and the community dental services. Most treatment can be carried out in primary care settings by general dental practitioners. Those cases needing further expertise are referred to the appropriate community or secondary care sector. Most patients treated in general dental practice are expected to pay a subsidised fee for treatment with exception of patients under exemption such as pregnant mothers, children under the age of 18 or those receiving certain state benefits. It is important to note, however, that when patients are referred for treatment in the secondary care or hospital setting (such as the Birmingham Dental Hospital), all patients irrespective of their individual status are provided free dental care.

The mapping of oral surgery referrals does provide valuable information from a health care planning perspective. It highlights the areas where a large proportion of patients are coming from with regard to care provided, in this case oral surgical interventions. Furthermore, the relationship between such a cohort of patients and their socioeconomic deprivation can be assessed. The link between

socioeconomic status, deprivation and dental disease is well established.[12] This mapping information could be potentially utilised for the following purposes:

1. The development of MCN providing tier 2 services, where oral surgery is carried out in primary care by dentists with a special interest or extended skills. Areas where more patients seek or require treatment provide health care planners with a guide as to where oral surgery services can be placed. This can be in the primary care setting via clinics specially designed for oral surgery. Oral surgery clinics could be located in the areas with the highest demand/need in order to reduce the demand on secondary care settings, such as dental hospitals, and by the same token also reduce waiting time. Providing services closer to the patient's home or along transport links saves patients travel time. This has been studied in Sydney, Australia, where the bus network in relation to private dental clinics was ascertained using GIS looking at the distribution of the bus stops from an urban planning perspective[13]. The use of GIS in another study has been used to locate dental clinics according to need[14]
2. Much of the diagnosed dental diseases are preventable, and teeth are generally lost due to periodontal breakdown or gross caries. If one considers a referral letter as requesting an oral surgery intervention, the argument can also be made that more preventive care is needed to reduce the onset of periodontal disease and dental decay in these high need areas ('hot spot'). In a socialised, nationalised health system, identifying areas of high need and establishing targeted education will enable healthcare providers to ensure that patients who are in the most deprived areas have improved access to dental care as well as receiving relevant oral health education. This is contrary to a privatised and market-driven New Zealand healthcare model, where GIS showed the location of private dental clinics to be directly related to patients' socioeconomic status, not according to patient need.[15] However, the data presented needs to be interpreted with some caution as many oral surgery referrals can be for non-bacterial conditions such as impacted third molars, which are not (directly) related to oral hygiene and diet. Such needs for referral include temporomandibular joint (TMJ) dysfunction or impacted canines for orthodontic reasons or orthodontic extractions. Perhaps linking dmft/DMFT scores from regional epidemiology studies can provide a more accurate picture on where to focus preventative services according to a high risk approach providing greater value for the health service.[16] In a Brazilian study, GIS was used to assess dental health in terms of DMFT among 12-year-old children.[17] This study from Sao Paulo demonstrated, with the use of maps, that those children in outlying deprived areas had worse oral health compared to those in the central, more affluent districts.

There are also further factors, which need to be taken into consideration when considering the patterns of referrals seen in the present study. These can be divided into three categories: patient factors, dentist factors and secondary care hospital factors.

Patient factors

Areas with a higher population density, such as the inner city compared to rural areas, are likely to generate more patient referrals. This would therefore lead to a higher referral rate from those areas.

This study does not differentiate the kind of referral which has been sent in, for example we are equating a patient referred in for a TMJ dysfunction syndrome to a horizontally-impacted wisdom tooth needing sedation, or an adult who needs local anaesthesia to remove a failing root-treated upper first molar. In the present study, each case represents one referral but does not differentiate between complexities of each case.

Furthermore, patients who are fee-paying and would need to pay for services carried out in the dental clinic would not need to pay in the hospital setting. It could be possible that some patients ask the dentist to refer them to the hospital for routine oral surgery treatment for financial reasons. The department of oral surgery triages all cases, even routine ones, as this provides teaching cases for undergraduate students where more straightforward extractions are needed for learning purposes.

Dentist factors

Certain dentist factors could also be responsible for a higher rate of referrals. These include dentists who may lack the appropriate training or skills to carry out complex surgical extractions, or lack the surgical equipment required for oral surgery and thus are more likely to refer patients. Dentists who are unable to provide sedation services are also more likely to refer anxious patients. Finally, patients who need significant treatment such as a full mouth clearance under local anaesthesia are compensated at the same rate as a single tooth extraction. Thus there is no incentive for dentists to take on cases, which could be perceived as loss making for the practice, these again are often referred to secondary care.

Hospital/secondary care factors

The Birmingham Dental Hospital is not the only secondary care oral surgery provider in the region, other hospitals in the region also provide oral surgery services within the realms of oral and maxillofacial surgery. This study only maps oral surgery referrals to the Birmingham Dental Hospital. To gain a wider perspective of referral patterns in the West Midlands, we would need to map patient postcodes for each hospital. Amalgamating all patient referrals for the region from all hospitals would provide a more accurate picture of where oral surgery patients reside. This was beyond the scope of this study. However, the maps generated do provide valuable information for our centre.

Conclusions

The mapping of referrals by postcode and region can provide important information on the nature of where patients reside and where referring dentists are based. MCNs could apply GIS mapping and use this data as an adjunctive tool for strategically planning and locating tier 2 services, that is, services, which can be provided in primary care. When data for social deprivation was analysed descriptively, there was a spatial association between high deprivation scores and high levels of patients referred. However, this finding for the deprivation scores needs to be assessed and correlated further using more robust statistical analyses including DMFT/dmft values. Identifying areas of high need and establishing targeted education could enable patients who are in the most deprived areas to have improved access to dental care as well as receiving relevant preventative education. Also, it could be possible to work with practices of high referral rates to establish areas of training for dental practitioners. This information, together with other epidemiological and dental public health research, can provide mangers, commissioners, policymakers and healthcare planners with information on how to structure dental service provision for the benefit of patients.

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