

Using the simplified case mix tool (sCMT) to identify cost in special care dental services to support commissioning

B.G. Duane¹, R. Freeman², D. Richards³, S. Crosbie⁴, P. Patel⁴, S. White⁵ and G. Humphris⁶

¹Dublin Dental School and Hospital Dublin, Ireland; ²Dental Health Services Research Unit, University of Dundee; ³Dental Public Health South East Scotland; NHS Forth Valley, Stirling ⁴Sussex Community NHS Trust Special Care Dental Service, UK; ⁵Public Health England, Skipton House, London ⁶University of St Andrews Medical School, St Andrews, Scotland, UK

To commission dental services for vulnerable (special care) patient groups effectively, consistently and fairly an evidence base is needed of the costs involved. The simplified Case Mixed Tool (sCMT) can assess treatment mode complexity for these patient groups. **Objective:** To determine if the sCMT can be used to identify costs of service provision. **Clinical Setting:** Patients (n=495) attending the Sussex Community NHS Trust Special Care Dental Service for care were assessed using the sCMT. **Main Measures:** sCMT score and costs (staffing, laboratory fees, etc.) besides patient age, whether a new patient and use of general anaesthetic/intravenous sedation. **Method:** Statistical analysis (adjusted linear regression modelling) compared sCMT score and costs then sensitivity analyses of the costings to age, being a new patient and sedation use were undertaken. Regression tables were produced to present estimates of service costs. **Results:** Costs increased with sCMT total scale and single item values in a predictable manner in all analyses except for ‘cooperation’. Costs increased with the use of IV sedation; with each rising level of the sCMT, and with complexity in every sCMT category, except cooperation. **Conclusion:** Costs increased with increase in complexity of treatment mode as measured by sCMT scores. Measures such as the sCMT can provide predictions of the resource allocations required when commissioning special care dental services.

Key words: cost, special care, case mix tool, economics, contract services, diagnosis-related groups, relative-value scales, cost analysis, England

Introduction

Throughout the UK’s National Health Service (NHS) the Community Dental Service (CDS) delivers care to vulnerable patients who generally have more complex needs than those traditionally seen by the ‘high street’ NHS primary care dentist. In England, CDS type provision is purchased by the country’s commissioner, NHS England, at a local level. CDSs varies in size (geographically, by population served and numbers of staff employed) and in the type of services provided.

While the availability of NHS dental service is now considered generally good, there have been times over the past 20 years when it has been characterized as poor (NHS England 2014a). To provide access to care for a number of people not then receiving it, the CDS expanded its traditional remit and provided routine dentistry to people without specific special care needs. Today, although access has improved for the general population (Bateman, 2012), some CDSs continue to treat patients without special care needs which has impacted upon the capacity available to meet the needs of patients with special needs. In addition, differences in geography, employee numbers, commissioning targets or the remit of the CDS, complicate comparisons between different CDSs. For instance, a dental service review comparing CDSs in Fife and Lothian found significant differences in the main population groups for which services were provided and this made deriving comparable cost estimates challenging (Duane and Richards, 2013).

Commissioners may not appreciate the behavioural difficulties and clinical complexity of treating special care

groups and so fail to take these into account when making comparisons with more mainstream General Dental Service patients. Where CDSs have been benchmarked against general dental services, in some areas this may have resulted in a reduction of contract value. The CDS would argue that a higher capitation rate is required to reflect the additional resources and time required to provide tailored services for these vulnerable groups. (Bateman, 2012)

NHS England (2014b) recognizes that the NHS, in general, needs transformational change to services to deliver better outcomes for patients and to ensure effective commissioning. Local NHS commissioners face complex decisions over the level of service required for all patients and how resources might be allocated to best provide care. To categorize and measure the case complexity of patients seen within the CDS, Bateman *et al.* (2010) developed the BDA special care case mix model, BDACMT (BDA, 2010). The tool, constructed by an expert group of special care dentists, measured complexity in six categories; ability to communicate, ability to cooperate, medical status, oral risk factors, access to oral care, and legal and ethical barriers to care.

In 2014 Duane *et al.* conducted a detailed psychometric evaluation of the BDACMT, and a simpler modified version was proposed, the simplified Case Mix Tool (sCMT). This differed from the original BDACMT in that it consists of five of the original measures by dropping oral risk factors, and the scoring was also simplified to three responses used consistently across all items. Introduced to improve speed and ease of completion these changes were found to improve psychometric reliability (Duane *et al.*, 2014).

Although there is no nationally compiled information, it is our understanding that a number of UK CDSs use either the BDACMT or the sCMT to assess special need and treatment requirement. However, with no obligation for NHS services to use the tool, implementation is inconsistent. Surprisingly, despite these tools having been used by some CDSs for a number of years, to our knowledge, the data are not used to any great extent to improve understanding of special care service activity or commissioning. Al Kindi *et al.* (2016) used the BDACMT to determine the need for specialist service referral and found that some domains such as ‘oral risk’ were not associated with the need for treatment under conscious sedation and general anaesthesia. Hence, the link between case complexity and referral was inconsistent. To date no evaluation of the relationship between the sCMT score and the resultant financial resource use has been published.

The aim of this study is to report the UK levels of treatment cost across the range of sCMT scores.

Materials and Methods

The study was regarded by both the ethics committees of the University of St Andrews and the SCFT SCDS as audit, and therefore no further ethical approval was required.

The sample necessary to enable comparisons across low and high complexities was calculated with the assumption, based on experience, that within the service there would be total face-to-face and non-patient-facing contact time for an average course of care, for a patient with no special care need (sCMT score zero) of 25 minutes, and for a patient with special care needs, 45 minutes. The estimated standard deviation was 25% of the mean. Based on this information, it was calculated that the ability to test for a two-sided difference between low complexity case and a high complexity case within the CDS would require a sample size of 243 in each group (sCMT) at 85% power. For regression purposes with eight parameters to predict total estimated costs would allow for over 60 individuals per parameter to identify a significant effect ($\alpha=5\%$) at 90% power.

The Sussex Community NHS Foundation Trust Special Care Dental Service (SCFT SCDS) was funded by Public Health England to provide information on 500 patients, including their sCMT scores and resource use. Potentially confounding variables age (<16 , ≥ 16 yrs) and new patient (yes/no) were also recorded. For practical reasons a decision was made not to record the range of dental treatment required for each patient.

The sCMT’s five categories (ability to communicate, ability to cooperate, medical status complexity, access to oral care and legal and ethical barriers to care) were scored by clinicians, following the tool’s guidance: 0, no complexity; 1, maybe complex; and 2, yes complex). The Total sCMT score is the simple unweighted sum which ranges from zero to ten

As the staff had been using the BDACMT tool for a number of years, no additional training was given. In addition, to reflect the ‘real-life’ use of this tool, no calibration of the staff’s use of the tool was undertaken.

Within SCFT SCDS, from April 1st 2015, the first

500 consecutive patients whose treatment was completed were, as is usual practice, allocated a sCMT score. The SCFT SCDS then consisted of nine clinics and all were included in this study.

Each administrator and clinician entered data onto a spreadsheet held on a secure NHS communal hard drive. Time given to each patient (either administrative or clinical) was recorded rounded up or down to the nearest five minutes. The time included non-patient-facing time, e.g. time to attend multi-disciplinary patient best interest meetings. When patients received care requiring laboratory costs, intravenous sedation or general anaesthesia this was also recorded. The time recorded to deliver care under general anaesthetic or intravenous sedation was recorded similarly. The number of contacts, or times the patient was seen was also recorded.

CDS staff working within the NHS are employed either under Agenda for Change (AfC) Bandings or medical and dental terms and conditions. For the purpose of this study AfC staff (AfC bands 3-6) were allocated to ‘admin’ codes or clinical codes (AfC bands 3-7) as appropriate. Staff employed under the medical and dental terms and conditions (dental officers, senior dental officers, assistant clinical directors and consultants) were recorded under each of their staff categories. To ensure the study’s patients and staff remained anonymous, no personal identifiable information was collected.

Statistical analysis included univariate inspection of frequency counts and distributions for categorical variables, with means and standard errors for continuous variables. SPSS v.22 (SPSS, Chicago IL) was used for editing, recoding of variables and univariate analyses. STATA13 (StataCorp 2013) was used to conduct linear OLS multiple regression models using the ‘regress’ procedure and ‘adjust’ function. A nominal fee of £100 has been added to the data to allow for additional unaccounted costs (e.g. building costs, material costs) which also removes two incidental negative values associated with the statistical analysis.

Results

Costs varied with levels of sCMT Total Scale and single category values. Tables of mean costs (with 95% confidence intervals) were generated from regression equations to present costs across levels of the sCMT Total Scale and its individual item values. In addition, these costs were broken down by new/existing patient and whether IV sedation or GA was provided. Adjustment of these means for other factors independently associated with costs was included to derive as accurate an estimate as possible. The adjustment factors included; age level (<16 or ≥ 16 yrs) and number of contacts.

Table 1 presents the regression analysis, showing a strong relationship between the sCMT score and total cost for all patients. For every unit level increase in sCMT the costs will rise on average with all other variables held constant, by £42. The new patient/existing patient and use of IV/GA were strong factors associated with costs and were investigated in greater detail. There is a much weaker relationship between cost and the variables “number of patient contacts” and “patient age”.

Table 1. Simplified Case Mix Tool (sCMT): Regression analysis

Variable	Coefficient	SE	t	P
sCMT Total Score	41.51	9.92	4.19	0.001
New Patient ¹	340.61	54.32	6.27	0.001
IV Sedation ²	470.97	139.93	3.37	0.001
Nº of Contacts	24.04	9.56	2.51	0.012
Age: ≥16 years ³	-46.21	49.91	-0.93	0.355
Constant	-102.94	75.30	-1.37	0.172

¹ Reference group: previously seen Patient;

² Reference group: No IV Sedation;

³ Reference group: Age<16 years; N=495;

F(5, 489)=26.68, P<0.0001; Adj R sq=0.21

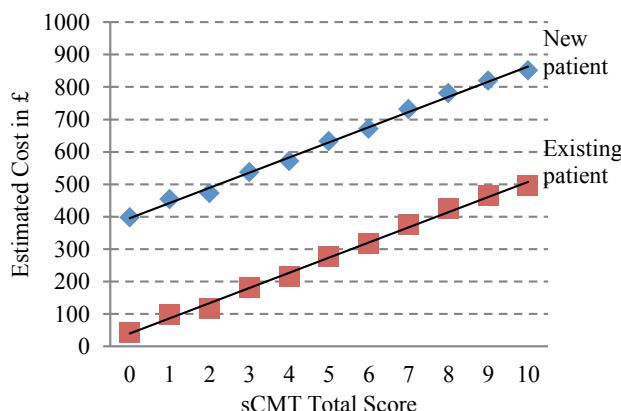
To understand the cost differences for caring for patients with special needs further analysis was undertaken on patients who had not received or IV sedation or GA (n=379). These cost differences are detailed and will be explored in an additional paper.

In Table 2 and Figure 1 it can be seen that course of care costs rise progressively in relation to an increased sCMT score, from £42 for an existing patient with a score of 0, to £496 for one with a of 10. The costs are higher for new patients ranging from £398 if the sCMT score is 0, to £852 for a sCMT score of 10.

Table 2. Mean treatment costs and 95% confidence intervals for each Simplified Case Mix Tool (sCMT) total score split by new and existing patients

sCMT	Existing patients		New patients	
	Mean	95%CI	Mean	95%CI
0	42	-80, 165	398	238, 558
1	99	-8, 206	454	313, 596
2	117	27, 208	473	343, 603
3	183	103, 263	538	427, 650
4	216	151, 282	572	469, 675
5	278	218, 338	633	541, 726
6	316	258, 374	672	583, 760
7	376	309, 443	732	653, 811
8	425	349, 501	781	699, 862
9	465	376, 554	820	733, 908
10	496	395, 598	852	751, 953

Note: In Tables 2 and 3 a nominal fee of £100 has been added to the data to allow for additional unaccounted costs (e.g. building costs, material costs) which also removes negative values associated with the statistical analysis

**Figure 1.** Cost and sCMT scores

The costs for each sCMT category rise with increase in complexity except in the case of cooperation which decreased (Table 3).

Table 3. Total treatment costs to provide care (without sedation) by Simplified Case Mix Tool (sCMT) category and score: means and 95% confidence intervals

sCMT category	sCMT Score	Mean £	95%CI £
Communication	0	178	0, 264
	1	349	300, 399
	2	591	531, 650
Cooperation	0	524	454, 595
	1	432	383, 480
	2	259	164, 354
Medication	0	195	109, 281
	1	358	309, 407
	2	606	544, 668
Access	0	179	100, 271
	1	341	289, 392
	2	583	524, 643
Legal	0	310	217, 403
	1	337	280, 393
	2	511	454, 568

Discussion

In the literature we could find only limited studies within dentistry where the use of case mix was combined with an economic evaluation. Chantravekin *et al.* (2014) looked at the costs of capital, labour and materials for patients receiving dental treatment in Thailand and found no relationship demonstrated between the cost of dental care for a specific procedure and its difficulty. Wisaijohn *et al.* (2010) demonstrated that a Thai-developed case mix classification could be used to predict and control the production costs. Within special care dentistry, Iida *et al.* (2010) used bivariate and multivariable regression analyses to evaluate the effect of special health care needs on dental care expenditures, but found no difference between children with special care needs and those without. Conversely in 2000, Newacheck and Kim (2005) analysed information from the Medical Expenditure Panel Survey (MEPS) and demonstrated that children with special needs had three times the health care costs (2,099\$ vs 628\$, P<0.01). Their findings are in line with Wisaijohn *et al.* (2010) who demonstrated a clear increase in costs with increasing sCMT score.

As expected given the time and preparation involved, patients undergoing IV sedation are more costly for the CDS than caring for those patients who receive care without sedation. In future years the costs to provide sedation for dental care could also increase further, given the recent Intercollegiate Advisory Committee's guidance (RCS/RCA, 2015). However, it is important to remember that for some people with special needs, IV sedation is imperative for high quality care.

It is unclear why the costs of care for patients who were not cooperative actually decreased. Perhaps cooperative patients with complex physical needs may require greater time spent to provide more complicated care and treatment in the dental setting. Alternatively, considering our finding that new patients require more resources than existing patients, it may be that cooperative patients are more likely not to have a backlog of care required. Conceivably, the quantity of dental care offered to patients with cooperation difficulties is simply lower as patient behavior management becomes more complex.

It is a potential limitation that the sCMT assesses the complexity of the mode care for each patient for that particular episode of treatment but does not take into account the length of treatment. In this study we investigated the clinical resource needed for a group of patients that could have considerable differences in the length (and cost) of dental care required. Some patients for example may require a simple examination and scale; others, comprehensive care. This clinical heterogeneity would still exist regardless of the sCMT score. It is possible that the breadth of presentation by special care patients prevents simplistic attempts to determine costs. However, our approach has been to present the parameters we suspect are vital to understanding the implicit variance of costs for this special patient group and identify additional factors that could affect our analysis. The confidence intervals for some of the 'costs' reported in the tables overlap indicating small, if any, meaningful differences between each of the categories. The steady gradient across the range of sCMT total scores is evident in Figure 1. The importance of the results presented was considered in the light of the limited evidence that commissioners have to predict budgets for specialist care when delivered in community services. Larger sample sizes could, of course, increase precision and differentiation between groups.

Additionally, there are likely to be numerous other factors influencing costs, including the experience of the clinician and the location of the practice.

It is possible that there could be differences in how operators measure complexity. Different operators may 'categorise' the course of treatment for patients into different sCMT scores. However, the purpose of this audit was to collect 'real-life' sCMT scores, so no exercises were conducted (e.g. calibration, additional training) to improve validity.

To calculate costs in this study we included wage costs (including pension costs, annual leave, training) and infrastructure costs but not other associated resource demands such as dental material costs. The National Society of Dental Accountants regularly publishes data outlining the additional costs associated with running a dental practice and from these the commissioning costs could be calculated. However, this is beyond the scope of this paper.

Recommendation

The authors suggest that NHS England (and other UK commissioning bodies) consider using these costings to commence pilot testing of an alternative model of financing special care dentistry. The cost calculations may then allow future cost comparisons between services with different complexities of patient.

Conclusion

The subsequent cost of care for a dental patient clearly increases with complexity of mode of care as assessed by the simplified case mix tool score. There is evidence to consider testing the use of this score for more effective commissioning.

References

- Al Kindi, N. and Nunn, J. (2016): The use of the BDA Case Mix Model to assess the need for referral of patients to specialist dental services. *British Dental Journal* **220**, 401-406.
- Bateman, P. (2012): Editorial - The impact of national policies on Special Care Dentistry. *Journal of Disability and Oral Health* **13**, 43-44
- Bateman, P., Arnold, C., Brown, R., Foster, L., Greening, S., Monaghan, N. and Zoiopoulos, L. (2010): BDA special care case mix model. *British Dental Journal* **208**, 291-296.
- British Dental Association, BDA (2010): *Case Mix Tool*. www.bda.org/dentists/representation/salaried-primary-care-dentists/ccphd/casemix
- Chantavekin, Y., Boonsong, S., Muangsised, S. and Monarak, R. (2014): Dental casemix computer program for basic dental procedure reimbursement. Conference: IADR General Session and Exhibition.
- Duane, B. and Richards, D. (2013): *NHS Lothian Special Care Dentistry Needs Assessment and Service Review*. Available from the authors.
- Duane, B., Humphris, G., Richards, D., O'Keefe, E.J., Gordon, K. and Freeman, R. (2014): Weighing up the weighted case mix tool (WCMT): a psychometric investigation using confirmatory factor analysis. *Community Dental Health* **31**, 200-206.
- Iida, H., Lewis, C., Zhou, C., Novak, L. and Grembowski, D. (2010): Dental care needs, use and expenditures among U.S. children with and without special health care needs. *Journal of the American Dental Association* **141**, 79-88.
- National Accountants for Specialised Dental and Legal Practices. www.nasdal.org.uk/assets/articles/24-25%20NASDAL%20accounts.pdf
- Newacheck, P.W. and Kim S.E. (2005): A national profile of health care utilization and expenditures for children with special health care needs. *Archives of Pediatric Adolescent Medicine* **159**, 10-17.
- NHS England (2014a): *Improving dental care and oral health - A call to action*. Leeds: NHS England. www.england.nhs.uk/wp-content/uploads/2014/04/imprv-oral-health-info.pdf
- NHS England (2014b): *Commissioning for Effective Service Transformation: What we have learnt?* London: NHS England. www.england.nhs.uk/wp-content/uploads/2014/03/serv-trans-guide.pdf
- Poswill Report, The (1990): General anaesthesia, sedation and resuscitation in dentistry, Report of an expert working party prepared for the Standing Dental Advisory Committee.
- Royal Colleges of Surgeons and the Royal College of Anaesthetists, The dental faculties of the, RCS/RCA (2015): *Standards for Conscious Sedation in the Provision of Dental Care: Report of the Intercollegiate Advisory Committee for Sedation in Dentistry*. London: RCS. www.rcseng.ac.uk/fds/publications-clinical-guidelines/docs/standards-for-conscious-sedation-in-the-provision-of-dental-care-2015
- Wisaijohn, T., Pimkhaokham, A., Lapying, P., Itthichaisri, C., Pannarunothai, S., Igarashi, I. and Kawabuchi, K. (2010): New casemix classification as an alternative method for budget allocation in Thai oral healthcare service: a pilot study. *International Journal of Dentistry* **2010**, 231398.