

DR CATRIONA M DOUGLAS (Orcid ID : 0000-0002-5564-1513)

Article type : Original Manuscript

A 20 year observational cohort of a 5 million patient population – tonsillectomy rates in the context of two national policy changes.

C M Douglas, U, Altmyer, L, Cottom, D Young, P Redding, LJ Clark

C M Douglas, ENT Registrar, L. J. Clark , ENT Consultant, Department of Otolaryngology – Head and Neck Surgery, Queen Elizabeth University Hospital, 1345 Govan Rd, Glasgow G51 4TF.

U, Altmyer, L, Cottom Microbiology Registrar, P, Redding, Microbiology Consultant, Department of Microbiology - Queen Elizabeth University Hospital, 1345 Govan Rd, Glasgow G51 4TF.

D Young. Department of Statistics, Strathclyde University. 16 Richmond Street , Glasgow, G1 1XQ.

Address for correspondence

Miss C.M.Douglas, ENT Registrar.

Department of Otolaryngology – Head and Neck Surgery, Queen Elizabeth University Hospital, 1345 Govan Rd, Glasgow G51 4TF

Catriona.douglas2@nhs.net

Key Words

Tonsillitis, tonsillectomy, peri-tonsillar abscess, deep neck space infection.

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/coa.13233

This article is protected by copyright. All rights reserved.

Aim

1. To report national trends for tonsillectomy, tonsillitis, peri-tonsillar abscess and deep neck space infection in secondary care.
2. To report national trends in sore throat consultations in primary care.
3. To report national trends in antibiotic prescribing in both primary and secondary care between 2011 and 2015.

Design

Retrospective nationwide cohort study. Data requested from Information Statistics Department (ISD) Scotland for tonsillectomy, tonsillitis admissions, peri-tonsillar abscess admissions and deep neck space infection (DNSI) admissions in Scotland, between 1993/94 and 2015/16. Data for antibiotic prescriptions in general practice and hospital admissions between 2011 – 2015.

Setting

Scottish ENT departments and GP practices.

Participants

Scottish patients who underwent tonsillectomy, or were admitted to hospital with tonsillitis, peritonsillar abscess or deep neck space infection. Scottish patients that attended their GP with tonsillitis.

Results.

Tonsillectomy rates between 1993/94 and 2015/16 decreased by 48% ($p < 0.001$). Over the same time period there has been a corresponding 136% increase in tonsillitis admission ($p < 0.001$) and a 167% increase in peri-tonsillar abscess admissions, ($p < 0.001$). Between 1996/97 and 2015/16 there was a 500% increase in deep neck space abscesses ($p < 0.001$).

Conclusion

There has been a significant decrease in tonsillectomy rates over the past two decades. Over the same time period there has been a significant increase in admissions to secondary care with tonsillitis, peri-tonsillar abscess and deep neck space infection. These changes have happened in the context of two separate national policies being introduced - SIGN guidelines for management of sore throat and the Scottish Reduction in Antibiotic Prescribing.

Background

Tonsillitis is a common condition with an incidence in general practice of up to 100 per 1000 population a year, in the UK¹. The majority of cases of tonsillitis occur in the context of viral upper respiratory tract infections, however bacterial infection with Group A beta-haemolytic Streptococcus (GAS) is thought to be the cause in 5-15% of adults presenting with tonsillitis. In children and adolescents, GAS tonsillitis is more common, causing 15-30% of tonsillitis cases. GAS infections have been increasing, along with resistance to macrolide antibiotics but not to penicillin. A rise in GAS has been reported in Scotland in 2015 and Finland between 1990- 2010^{2,3}.

SIGN guidelines state tonsillectomy should be performed if patients are suffering from severe recurrent tonsillitis – see Box 1. Tonsillectomy is one of the most commonly performed surgical procedures in the UK, accounting for 20% of all operations performed by otolaryngologists⁴. The SIGN guidelines for the management of sore throat and indications for tonsillectomy were introduced in 1999, with a subsequent revision in 2010⁵.

We hypothesised that the decrease in tonsillectomy rate may be associated with an increased rate of admissions for tonsillitis and peri-tonsillar abscess. The objectives of this paper were;

- 1.To report national trends for tonsillectomy, tonsillitis, peri-tonsillar abscess and deep neck space infection in secondary care.
- 2.To report national trends in sore throat consultations in primary care.

3.To report national trends in all antibiotic prescribing in both primary and secondary care between 2011 and 2015.

Box 1. Sign Guidelines for indications for consideration of tonsillectomy.

The following are recommended as indications for consideration of tonsillectomy for recurrent acute sore throat in both children and adults:

- sore throats are due to acute tonsillitis
- the episodes of sore throat are disabling and prevent normal functioning
- seven or more well documented, clinically significant, adequately treated sore throats in the preceding year or
- five or more such episodes in each of the preceding two years or
- three or more such episodes in each of the preceding three years.

Materials and Methods:

An observational cross-sectional study was performed. No ethical clearance was required as this project was using anonymous population data from Information Statistics Department (ISD) Scotland. Safeguards in the ISD extract service do not allow disclosure of potentially patient identifiable information (very small samples).

Admission Data

A bespoke report was commissioned from ISD Scotland. The database was interrogated for the following information:

1. Tonsillectomy finished consultant episodes (FCEs) using Office of Population Censuses and Surveys (OPCS-4) code F34;
2. Peritonsillar abscess aspiration FCEs using OPCS-4 code F36.3; Peritonsillar abscess FAEs using ICD-10 code J36 or ICD-9 code 475;
3. Pharyngitis and tonsillitis finished admission episodes (FAEs) using International Statistical Classification of Diseases (ICD-10) codes J02 and J03 or ICD-9 codes 034, 462 and 463;

4. Retro and parapharyngeal abscess FAEs using ICD-10 code J39 or ICD-9 code 478.

The admission data for the previous 22 years from 1993/94 to 2015/16 was provided by health board of the patient's residence. Data was recorded and analysed using excel and Minitab version 17. Bed data was also requested for the same time period. National primary care information was only available between 2003/04 and 2012/2013 for patients consulting their GP or practice nurse with tonsillitis or pharyngitis. Antibiotic prescribing information for all conditions was obtained from Health Protection Scotland (HPS) Scottish Antibiotic Prescribing Group (SAPG) for primary and secondary care between 2012 – 2015. 2012 was chosen as this was when the Scottish Reduction in Antibiotic Prescribing Policy (ScRAP) was introduced⁶.

Exclusion criteria

The number of retropharyngeal and parapharyngeal abscesses reported for 1993-1995 was unrealistically high. ICD coding changed from 9 to 10 during this period. ISD Scotland suggested that coding was not correct for this period, therefore it was excluded.

Statistical analysis was carried out using IBM statistics SPSS 24. Linear trend tests were performed to look for a significant trend.

Ethical considerations

Research ethics committee advice was sought using the online tool from the NHS health research authority and Medical Research council website and was not required (<http://www.hra-decisiontools.org.uk/research>).

Results

Secondary Care Admissions

Figure 1 shows the overall trends in Scotland for the tonsillectomy rate, tonsillitis admission rate, peri-tonsillar abscess rate and deep neck space abscess rate. The majority of the fall

in tonsillectomy rates occurred between 1993/94 and 2001/02. There is a small dip in the rate of tonsillectomy between 2000 and 2002, which is when the Department of Health recommended single use tonsillectomy instruments in response to concerns about the transmission of the prion disease Creutzfeldt Jakob Disease (CJD). There was a 624% increase in day case tonsillectomy over the study period.

There was a significant decrease in tonsillectomy rates over time ($p < 0.001$), see table 1. There was a significant increase in patients admitted to hospital with tonsillitis ($p < 0.001$), peri-tonsillar abscess ($p < 0.001$) and deep neck space infection ($p < 0.001$) between 1993/94 and 2015/16, see table 1. Although overall the tonsillectomy rates showed a significant decrease, from 2002 the trend flattened out and rates were constant (chi-squared trend $p = 0.153$).

Secondary Care bed days

Table 2 shows the total number of bed days for tonsillectomy, tonsillitis, peri-tonsillar abscess and deep neck space infection. Table 3 shows the length of stay for tonsillectomy, tonsillitis, peri-tonsillar abscess and deep neck space infection. There was an 85% decrease in the total number of bed days for all tonsillectomies between 1993/94 and 2015/16, with a corresponding 66% decrease in length of stay for tonsillectomy patients (1993/94 - 2.6 days versus 2015/16 - 0.7 days). All length of stays have decreased between 1993/94 and 2015/16, see table 3. The largest decrease in length of stay was seen in tonsillectomy (66% decrease), followed by tonsillitis length of stay (58% decrease).

Primary Care

Figure 2 shows the rate of patients in Scotland consulting with a GP or practice nurse at least once in the year with tonsillitis/pharyngitis between 2003/04 and 2012/13, there is a significant 27% decrease in consultation rate per 1000 registered patients ($p < 0.001$).

Antibiotic prescribing.

Figure 3 and 4 demonstrate the trends in primary care and secondary care antibiotic prescribing for all conditions. There was a significant decreasing trend in primary care antibiotic prescribing, $p < 0.001$. In secondary care there was a significant increasing trend, $p < 0.001$.

Discussion

Synopsis of key findings.

This study demonstrated a 48% decrease in the tonsillectomy rate between 1993/94 and 2015/16. Over the same time period there is a 136% increase in hospital admissions for tonsillitis, and a 167% increase for peri-tonsillar abscess. Between 1996/97 and 2015/16 there was a 500% increase in admissions for deep neck space infections. All these trends were significant. Despite the tonsillectomy rate now seeming stable since 2002, there is still an unexplained continuing rise in infection rates.

Comparison to other studies

This series from Scotland highlights a trend that is replicated across the UK⁷. Millington and Philips reported an overall downward trend in tonsillectomy procedures, with a two to threefold increase in admissions with tonsillitis⁸. Swift et al, using Hospital Episode Statistics (HES) data, demonstrated a fall of 44% in the tonsillectomy rate in England between 1991 and 2011 comparable to this paper, with a comparable increase in the tonsillitis admission rate of 310%. This series noted a significant increase in the incidence of deep neck space infection, also noted by Swift et al⁹. This finding is concerning as deep neck space infections have serious potential morbidity and mortality. Furthermore these life threatening infections are also costly to society due to patients' length of time away from work and the need for increased resources in managing them¹⁰.

Bed Data

Over the period of this study there has been a large change in bed utilization. There has been a significant reduction in bed utilization for tonsillectomy, a decrease of 85% over the study period. The reduction in bed utilization for tonsillectomy patients is due to the increase

in day case tonsillectomies. Day case tonsillectomy has been demonstrated to be a safe procedure and this is now standard practice.

There has been a large increase in bed utilization for patients admitted with tonsillitis, peritonsillar abscess and deep neck space infection. The largest change, an increase of 196% in bed utilization, was seen in patients admitted with deep neck space infection. These patients are often very unwell and require high dependency and intensive care during their management. Unfortunately we do not have information on the specific type of bed utilization, but it would be very useful to know if the utilization of high dependency and intensive care beds is increasing in these patients.

National trends in context of new national policies

The UK now has one of the lowest rates of tonsillectomy in Europe. Concerns have been raised about potentially exposing some patients to avoidable morbidity as highlighted by the ENT UK position paper in 2009¹¹. Elsewhere in Europe tonsillectomy rates have remained stable¹². Interestingly in the USA, tonsillectomy rates are increasing¹³. In this series there are 2 distinct interventions that have occurred at a national level; the introduction of the SIGN guidelines in 1999 and the introduction of the ScRAP policy in 2012. The SIGN guidelines were based on the paediatric study by Paradise et al, however the results have been generalized and applied to all ages, which may not be appropriate. Since SIGN was introduced, we see an initial decline in tonsillectomy rates. However, tonsillectomy rates have remained stable since 2002, but we are seeing a continuing upward trend in admissions to secondary care with tonsillitis, peri-tonsillar abscess and deep neck space infection.

Primary Vs Secondary care trends for sore throat.

This paper highlights that the primary care consultations for sore throat have significantly decreased in Scotland (for the time period we have data) in comparison to admission rates for tonsillitis, which have significantly increased. Interestingly this pattern is not replicated elsewhere in Europe, with Scandinavian rates of tonsillitis in children appearing stable over the same time period¹⁴. Over the time period of the study there has not been a marked change in secondary care clinical admission policy; those with a sore throat that are unable to swallow oral medication are admitted to hospital. One of the difficulties with admissions to hospital with a diagnosis of tonsillitis is that there is no differentiation between bacterial and

viral causes in the clinical coding, therefore it is not possible to identify the rates of glandular fever admissions within this cohort. However, Visser et al demonstrated that there is a decreasing incidence of infection mononucleosis in Scotland between 1997 - 2012¹⁵.

Patient education may explain the decreasing trend of patients attending primary care with sore throats, as there has been a large drive to educate the public that sore throats “are viral” and “don’t respond to antibiotics”¹⁶. Furthermore, a recent survey has suggested that patients are deterred from seeing their GP due to prolonged waiting times for appointments¹⁷. These factors may account for the decreasing attendance trend seen in primary care.

Acute sore throat is one of the commonest presentations in general practice. One of the difficulties GPs face when seeing a patient with a sore throat is the diagnostic difficulty in differentiating bacterial from viral tonsillitis, with the subsequent decision on whether to prescribe antibiotics. GPs are under pressure not to prescribe antibiotics when they do see a patient with a “sore throat”. The over use of antibiotics in primary care increases the risk of antibiotic resistance and also exposes the patients to potential side effects. A recent Cochrane review “Antibiotics for people with sore throats” concluded that the absolute benefits of antibiotics are modest and they only shortened the duration of symptoms by 16 hours. However, the authors did highlight that there were very few recent trials (only three since 2000) included in the review, so it is unclear if changes in bacterial resistance over this time period could have affected the effectiveness of antibiotics. The Department of Health Medical Advisory Committee publication “the path of least resistance”¹⁸ suggests tactics for reducing “unnecessary” antibiotic prescribing in cases such as sinusitis, sore throat, otitis media and colds. As a result many primary care trusts introduced prescribing indicators into their Prescribing Incentive Schemes with the sole aim of reducing antibiotic prescribing¹⁹. In 2012 NHS Education for Scotland launched an educational toolkit aimed at reducing antimicrobial prescribing in Primary care, the Scottish Reduction in Antibiotic Prescribing (ScRAP). We have evidence of national changes in antibiotic prescribing between 2011 and 2015, with a significant decrease in all primary care antibiotic prescribing ($p < 0.001$), with a corresponding increase in all secondary care prescribing ($p < 0.001$). While these overall trends present an interesting picture, they are not specific to antibiotic prescribing for tonsillitis, making it impossible to draw any firm conclusions²⁰. While GPs are under enormous pressure to reduce antibiotic prescribing, the significant decrease

in primary care prescribing, while at the same time demonstrating a significant increase in secondary care antibiotic prescribing suggests that this burden may have been transferred directly from primary to secondary care, with the associated increased costs.

SIGN guidelines suggest that the Centor clinical prediction score can be used to assist the decision on whether antibiotics should be prescribed or not, but also advise that this cannot be relied upon for a precise diagnosis⁵. To date, no clinical prediction score has proven to be highly sensitive and specific for the diagnosis of bacterial tonsillitis. Other tools which a GP may use to help guide the decision on whether antibiotics should be prescribed include routine microbiology throat swabs and rapid antigen detection tests (RADTs). The SIGN guidelines recommend that throat swabs should not be carried out routinely⁵. Rapid antigen detection tests have been widely adopted in some countries including France and Finland. One argument for using RADTs is that it avoids the empirical use of antibiotics or waiting for routine throat swab results. Within the general population approximately 10% of people are carriers of group A strep, with the rates as high as 20% in children. Consequently, a positive RADTs test has poor sensitivity and specificity⁵. The randomized control trial of PRISM (primary care streptococcal management), which compared the use of a clinical score (FeverPAIN) to RADTs for managing sore throats, showed no clear advantage of antigen testing over clinical score alone²¹. Furthermore, there is increasing incidence of *Fusobacterium necrophorum*-positive acute tonsillitis²². This is associated with Lemierre's syndrome, a rare but potentially fatal complication of tonsillitis requiring prompt recognition and emergency treatment. A RADTs and routine throat swab would not routinely pick up *Fusobacterium necrophorum*.

Novel biomarkers may help with the differentiation of bacterial and viral tonsillitis in the future. It is often very difficult clinically to differentiate between a bacterial and viral sore throat. Venge et al looked at a new and novel biomarker, Human Neutrophil Lipocalin (HNL). They assessed patients with a number of different infections including streptococcal tonsillitis. When HNL was measured in whole blood, it showed high positive and negative predictive values in the distinction between acute viral and bacterial infections, superior to current biomarkers that are used (CRP, Neutrophils)²³. Novel biomarkers such as this may be important for future research in the diagnosis and management of tonsillitis.

The rising admission rates could be related to both the rates and virulence of GAS. Lindsay et al highlighted that Scotland is seeing higher than expected rates of GAS, occurring against a background of increased rates of Scarlet fever in the rest of the UK²⁴. They also highlighted an increase in the circulating *emm* types, the most predominant being type 1. Type 1 was most significantly associated with invasive disease. There has been a significant increase in scarlet fever in the UK, with rates at their highest level since 1967, however it has yet to be established why the rates have increased so much. Clinically, ENT surgeons report that they are seeing more patients being admitted with complications of tonsillitis and mastoiditis. It may be related to the incidence of infection in the community. In 2015 it was noted that levels of invasive group A strep were still raised compared to 2011 and higher than expected over the Winter period²⁵. Furthermore recent evidence has suggested that Group A beta-haemolytic streptococcus (GAS) is becoming more virulent^{26,27}. This may help partially explain why more patients are being admitted to hospital with tonsillitis and peri-tonsillar abscess.

Tonsillectomy

The efficacy of tonsillectomy has long been debated, with the most recent Cochrane review concluding that “Insufficient information is available on the effectiveness of adeno-/tonsillectomy versus non-surgical treatment in adults to draw a firm conclusion”²⁸. This has been debated since 1923²⁹. The introduction of tonsillectomy with safe general anaesthesia in the 1920s resulted in a decrease in Scarlet fever although no reduction in Rheumatic fever³⁰.

In 2009, McKinsey reported that £700m is unnecessarily spent on operations with limited clinical benefit, which include tonsillectomy, varicose vein surgery and inguinal hernia surgery³¹. The reported lack of evidence for tonsillectomy has led to a drive to curtail the operation. However, there is ample evidence to demonstrate that tonsillectomy for recurrent tonsillitis gives patients a significant improvement in their quality of life³².

McKinsey does not account for the decline in tonsillectomy as the beginning of the decline pre-dates this and the rates have been very stable since 2009. The Scottish Intercollegiate Guideline Network (SIGN) guideline 34 on “Management of sore throat and indication for tonsillectomy” was first published in 1999, accounting for a steep decline in tonsillectomy rates seen in Figure 1. However, as the rates have now been stable since 2002, this alone can not account for the steady increase in emergency admissions. As mentioned earlier, the increase in rates and virulence of GAS may be contributing to this increasing rate of

Accepted Article
emergency admissions. Furthermore, tonsillectomy is also not without risk. The national tonsil audit reporting a post tonsillectomy haemorrhage rate of 3.5%³³. There is also the risk of significant blood loss requiring transfusion, the potential requirement for HDU/ITU care if the bleed is significant and the risk of death from significant haemorrhage. It goes without saying that the number of these significant complications should decrease if there are far less tonsillectomies being performed.

Potential weakness of study

Data from ISD Scotland may have missing or miscoded information; however, this is unlikely in the event of tonsillectomy and tonsillitis as these are very common and well defined codes. Many of the OPCS-codes were first introduced in 1992, and they have not changed significantly since introduction. We do not have comparable time scale data from primary care to allow a true comparison between primary care and secondary care rates of tonsillitis/sore throat. We don't have long term data on antibiotic prescribing, and the data we do have it for all antibiotic prescribing, not specific to penicillin.

Conclusion

Tonsillectomy rates decreased significantly with the introduction of the SIGN guidelines, however, the rates have remained stable for over a decade. Over the past 20 years there has been a steady increase in emergency admissions with "sore throat". As this is a population based study and we do not have patient level data, we are unable to draw any firm conclusions as to the cause of more emergency admissions. The paper highlights the difficulty in diagnosing viral and bacterial tonsillitis, with the impact of whether antibiotics should be prescribed. This research highlights the complex nature of this field and shows that further research is warranted.

References

1. Shvartzman P. Are antibiotics appropriate for sore throats? Careful prescribing is beneficial. *BMJ*. 1994;309(6960):1011-1012.
2. Tapiainen T, Launonen S, Renko M, et al. Invasive Group A Streptococcal Infections in Children: A Nationwide Survey in Finland. *Pediatr Infect Dis J*. 2016;35(2):123-128.
3. <http://www.hps.scot.nhs.uk/documents/ewr/pdf2015/1511.pdf>. Increased Group A streptococcal activity in Scotland. *Health Protection Scotland* 2015;49(11):109.
4. van Staaij BK, van den Akker EH, Rovers MM, Hordijk GJ, Hoes AW, Schilder AG. Effectiveness of adenotonsillectomy in children with mild symptoms of throat infections or adenotonsillar hypertrophy: open, randomised controlled trial. *BMJ*. 2004;329(7467):651.
5. SIGN. Management of sore throat and indication of tonsillectomy. SIGN 117. . 2010; <http://www.sign.ac.uk/guidelines/fulltext/117/>. .
6. Division. HPSaIS. Scottish Antimicrobial Use and Resistance in Humans in 2015. *Health Protection Scotland and Information Services Division*. 2016.
7. Al-Hussaini A, Owens D, Tomkinson A. Health costs and consequences: have UK national guidelines had any effect on tonsillectomy rates and hospital admissions for tonsillitis? *Eur Arch Otorhinolaryngol*. 2013;270(6):1959-1965.
8. Millington AJ, Phillips JS. Current trends in tonsillitis and tonsillectomy. *Ann R Coll Surg Engl*. 2014;96(8):586-589.
9. Lau AS, Upile NS, Wilkie MD, Leong SC, Swift AC. The rising rate of admissions for tonsillitis and neck space abscesses in England, 1991-2011. *Ann R Coll Surg Engl*. 2014;96(4):307-310.
10. Hurley RH, Douglas CM, Montgomery J, Clark LJ. The hidden cost of deep neck space infections. *Ann R Coll Surg Engl*. 2017:1-6.
11. UK E. Indications for tonsillectomy position paper. *ENT UK London*. 2009.
12. Materia E, Di Domenicantonio R, Baglio G, et al. [Epidemiology of tonsillectomy and/or adenoidectomy in Italy]. *Pediatr Med Chir*. 2004;26(3):179-186.
13. Erickson BK, Larson DR, St Sauver JL, Meverden RA, Orvidas LJ. Changes in incidence and indications of tonsillectomy and adenotonsillectomy, 1970-2005. *Otolaryngol Head Neck Surg*. 2009;140(6):894-901.
14. Uijen JH, Bindels PJ, Schellevis FG, van der Wouden JC. ENT problems in Dutch children: trends in incidence rates, antibiotic prescribing and referrals 2002-2008. *Scand J Prim Health Care*. 2011;29(2):75-79.
15. Visser E, Milne D, Collacott I, McLernon D, Counsell C, Vickers M. The epidemiology of infectious mononucleosis in Northern Scotland: a decreasing incidence and winter peak. *BMC Infect Dis*. 2014;14:151.

16. Choices N. <http://www.nhs.uk/conditions/Sore-throat/Pages/Introduction.aspx>.
17. GP. WTWSaTFSa. YouGov. <http://yougov.co.uk/news/2013/08/29/waiting-times-would-third-stop-them-seeing-gp/>.
18. Health Do. <http://antibiotic-action.com/wp-content/uploads/2011/07/Standing-Medical-Advisory-Committee-The-path-of-least-resistance-1998.pdf>. 1998.
19. Ashworth M, Golding S, Majeed A. Prescribing indicators and their use by primary care groups to influence prescribing. *J Clin Pharm Ther.* 2002;27(3):197-204.
20. Division. HPSaIS. *Scottish Antimicrobial Use and Resistance in Humans in 2015.* . 2016.
21. Little P, Moore M, Hobbs FD, et al. PRImary care Streptococcal Management (PRISM) study: identifying clinical variables associated with Lancefield group A beta-haemolytic streptococci and Lancefield non-Group A streptococcal throat infections from two cohorts of patients presenting with an acute sore throat. *BMJ Open.* 2013;3(10):e003943.
22. Hagelskjaer LH, Prag J, Malczynski J, Kristensen JH. Incidence and clinical epidemiology of necrobacillosis, including Lemierre's syndrome, in Denmark 1990-1995. *Eur J Clin Microbiol Infect Dis.* 1998;17(8):561-565.
23. Venge P, Douhan-Hakansson L, Garwicz D, Peterson C, Xu S, Pauksen K. Human Neutrophil Lipocalin as a Superior Diagnostic Means To Distinguish between Acute Bacterial and Viral Infections. *Clin Vaccine Immunol.* 2015;22(9):1025-1032.
24. Lindsay DS, Brown AW, Scott KJ, et al. Circulating emm types of Streptococcus pyogenes in Scotland: 2011-2015. *J Med Microbiol.* 2016;65(10):1229-1231.
25. Scotland HP. Increased Group A Streptococcal activity in Scotland, Volume 49 No.2015/11. 17 March 2014.
26. HPA. Infection reports. Pyogenic and non pyogenic streptococcal bacteraemia, England, Wales and Northern Ireland. 2009 http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1287144931510. 2009.
27. Lamagni TL, Efstratiou A, Dennis J, et al. Increase in invasive group A streptococcal infections in England, Wales and Northern Ireland, 2008-9. *Euro Surveill.* 2009;14(5).
28. Burton MJ, Glasziou PP, Chong LY, Venekamp RP. Tonsillectomy or adenotonsillectomy versus non-surgical treatment for chronic/recurrent acute tonsillitis. *Cochrane Database Syst Rev.* 2014;11:CD001802.
29. Glover JA. The incidence of tonsillectomy in school children. 1938. *Int J Epidemiol.* 2008;37(1):9-19.
30. Ash R. *Am J Dis Child* 1938;55(1):63-78.

31. <http://www.hsj.co.uk/comment/leader/mckinsey-report-unthinkable-solutions-set-scene-for-nhs-cuts/5015368.fullarticle>.
32. Douglas CM, Lang K, Whitmer WM, Wilson JA, Mackenzie K. The effect of tonsillectomy on the morbidity from recurrent tonsillitis. *Clin Otolaryngol*. 2017.
33. Lowe D, van der Meulen J, Cromwell D, et al. Key messages from the National Prospective Tonsillectomy Audit. *Laryngoscope*. 2007;117(4):717-724.

Table 1. Summary of trends in rates of admission per 100,000 population admission rates with chi-squared trend.

	1993/94	2015/2016	Change (%)	p-value
All Tonsillectomy	165.4	86.7	-48%	p <0.001
Tonsillitis	114.6	270.1	+136%	p <0.001
Peri-tonsillar abscess	2.4	6.4	+167%	p <0.001
	1996/97 rate	2015/16 rate		
All tonsillectomy	149	86.7	-42%	
Deep neck space abscess	0.3	1.8	+500%	p <0.001

Table 2. Total Bed Days for tonsillectomy and sore throat.

	1993/94 rate	2015/16 rate	Change
All Tonsillectomy	22,033	3302	-85%
Tonsillitis	8710	9328	+7%
Peri-tonsillar abscess	451	785	+74%
Sore throat (tonsillitis and peri-tonsillar abscess)	9161	10,113	+10%
All tonsillectomy + sore throat	31,194	13,415	-57%
	1996/97 rate	2015/16 rate	Change
Deep neck space infection	187	553	+196%

Table 3. Length of stay for tonsillectomy, tonsillitis, peri-tonsillar abscess and deep neck space infection.

	1993/94	2015/16	% change
Tonsillectomy	2.4 days	0.7 days	-66%
Tonsillitis	2.6 days	1.1 day	-58%
Peri-tonsillar abscess	2.6 days	1.5 days	-42%
	1996/97	2014/15	% change
Deep neck space abscess	11.7 days	6.4 days	-45%

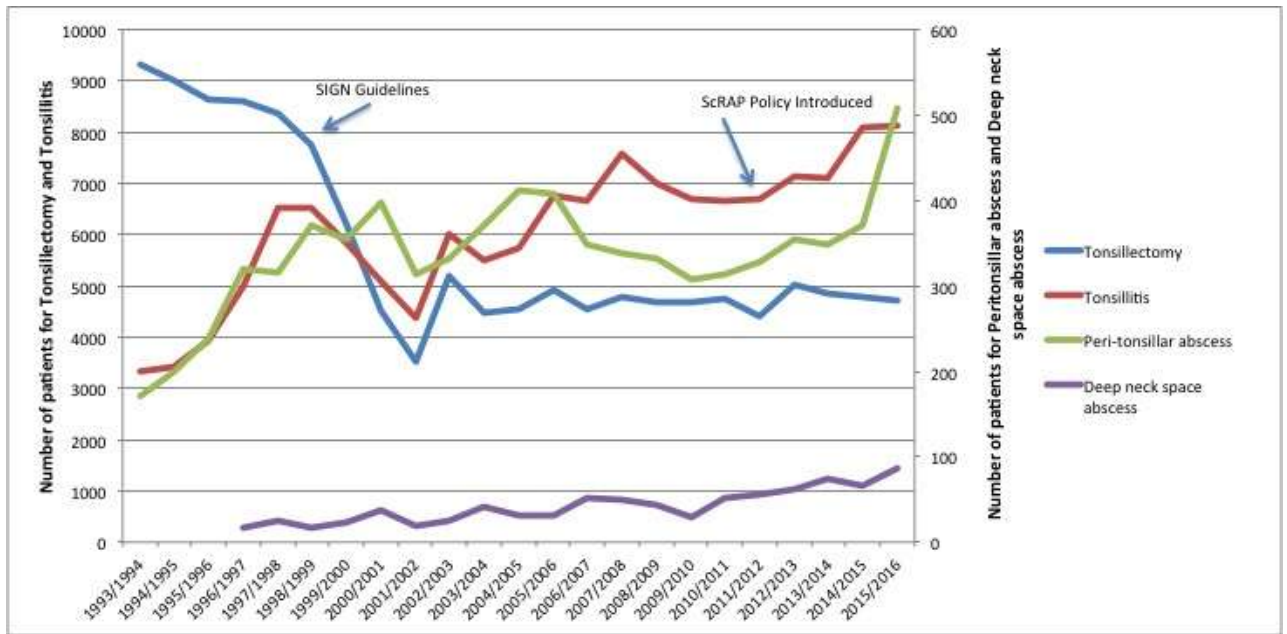


Figure 1 Overall trends in Scotland for tonsillectomy and tonsillitis admissions (left vertical axis) and peri-tonsillar abscess and deep neck space abscess (right vertical axis).

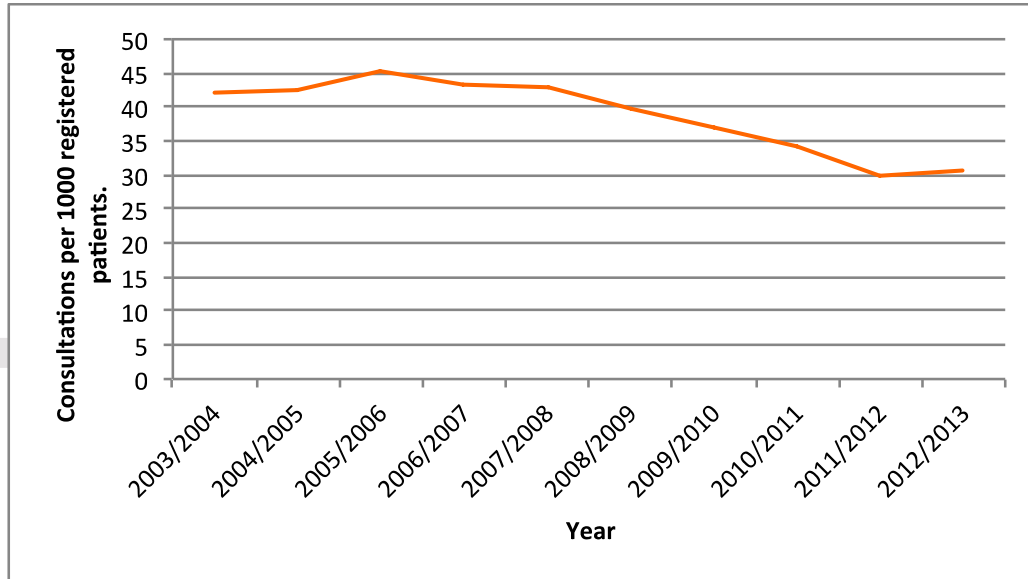


Figure 2. Patients in Scotland consulting GP or practice nurse at least once in the year with tonsillitis/pharyngitis per 1000 registered patients between 2003/04 and 2012/13.

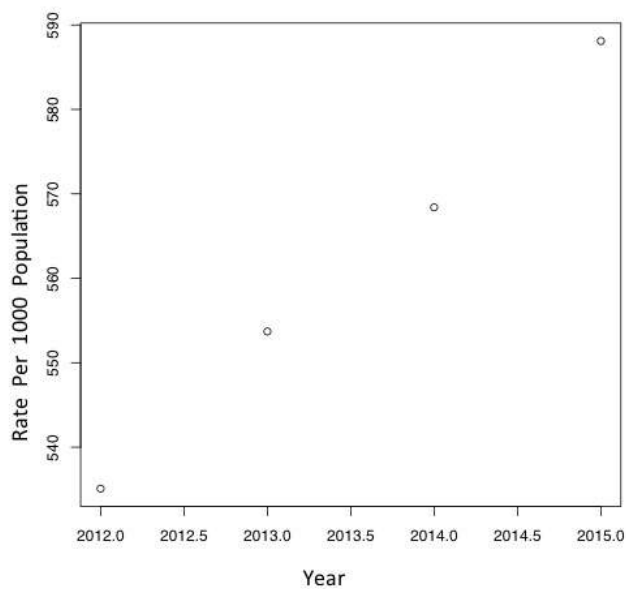


Figure 3. Trend in secondary care antibiotic use.

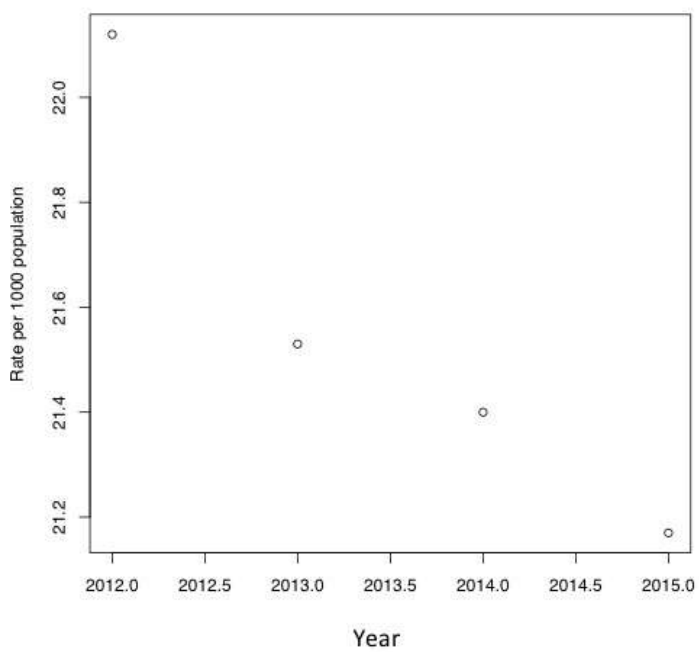


Figure 4. Trend in primary care antibiotic use.