Health Protection Scotland

NHS National Services Scotland

NHSScotland Risk Based Recommendations for the Decontamination of Semi-Invasive Ultrasound Probes:

Risk of infection following semi-invasive ultrasound procedures in Scotland, 2010 to 2016

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Contents

Summary

Objective: To evaluate the risk of infection, using microbiological reports and community antibiotic prescriptions as proxy measures, associated with semi-invasive ultrasound probe (SIUP) procedures, including transoesophageal echocardiography (TOE), transvaginal (TV) and transrectal (TR) ultrasound, prior to the development of NHSScotland guidance in April 2016 recommending high-level disinfection of SIUPs.

Design: Retrospective cohort study using linked national datasets.

Methods: Patient records from the NHS National Services Scotland (NSS) Electronic Communication of Surveillance in Scotland (ECOSS) and the NSS Prescribing Information System (PIS) were linked with the NSS Scottish Morbidity Record (SMR) for all eligible cases between 1st April 2010 and 31st March 2016. Three cohorts were created to include inpatients/day-cases and outpatients in the following specialties: Cardiology, Gynaecology and Urology. Cox regression was used to quantify the association between SIUP procedures and the risk of positive microbiological reports and community antibiotic prescriptions in the 30-day period following the procedure.

Results: There was a greater hazard ratio (HR) of positive microbiological reports for patients who had undergone TOE (HR: 4.92; 95% CI: 3.17–7.63), TV (HR: 1.41; 95% CI: 1.21–1.64) and TR ultrasound (HR: 3.40; 95% CI: 2.90–3.99), compared with unexposed cohort members after adjustment for age, co-morbidities, area of residence, previous hospital admissions and past care home residence. Similarly, there was a greater HR of community antibiotic prescribing for those who had received TV (HR: 1.26; 95% CI: 1.20–1.32) and TR (HR: 1.75; 95% CI: 1.66–1.84) ultrasound, compared with unexposed patients.

Conclusion: Analysis of linked national datasets demonstrated a greater risk of positive microbiological reports and community antibiotic prescriptions within 30 days for Scottish adults who had undergone SIUP procedures in Scotland. This indicates that, prior to the publication of NHSScotland guidance advocating high-level disinfection, the re-use of SIUPs without high level disinfection posed an increased risk of infection.

Introduction

Reports of outbreaks and incidents in the published literature suggest a possible risk of cross-infection following medical procedures that involve the use of semi-invasive ultrasound probes (SIUPs).[1] This risk concerns endocavitary ultrasound probes: transoesophageal echocardiography (TOE) probes, transvaginal (TV) probes and transrectal (TR) probes; as well as non-endocavitary ultrasound probes when in contact with broken skin. Following one particular incident, the UK Medicines and Healthcare products Regulatory Agency (MHRA) released a Medical Device Alert (MDA) in June 2012 in relation to the decontamination of SIUPs after the death of a patient from hepatitis B virus infection; an event that may have been caused by the failure to appropriately disinfect a TOE probe between patient use.[2] This event underscores the clinical importance of quantifying the infectious risk of inadequately decontaminated SIUPs to inform appropriate methods of decontamination.

In 2011, the British Society of Echocardiography published guidelines for cleaning and disinfecting TOE probes.[3] The authors acknowledged that the evidence for a risk of cross-infection was minimal and that they could identify no well-performed comprehensive studies demonstrating a risk of cross-transmission from poorly cleaned TOE probes. However, there have been four published outbreaks of healthcare-associated infections related to the use of TOE probes since 2003: in the USA,[4] Japan[5;6] and France.[7] These reports included cases of bloodstream infection and pneumonia associated with *Pseudomonas aeruginosa* and *Legionella pneumophila*, respectively, as well as positive cultures of *Enterobacter cloacae* and *Escherichia coli* from blood and sputum specimens. Invariably, the outbreaks were linked to the use of low-level disinfection (LLD) or contaminated rinse water. However, in France, where LLD is current standard practice, Bénet *et al.*[8] concluded from retrospective cohorts of 50 244 patients tested for HIV and 105 955 patients tested for HCV that exposure to a SIUP in the past 12 months was not associated with a greater risk of infection, having made adjustments for a range of confounding factors.

There have been no published outbreaks associated with TV or TR probes, although these procedures are commonly employed within outpatient settings and are therefore unlikely to be identified as such. Leroy *et al.*[9] have estimated a risk of cross-infection for TV and TR probes of 0.7–6.0% for selected microbial pathogens, including blood-borne viruses (e.g. HIV and HCV), human papillomavirus and *Chlamydia trachomatis*, based on mathematical modelling for a hypothetical cohort. Similarly, a meta-analysis of 24 cohort studies has pooled the prevalence of infectious complications following TR ultrasound-guided prostate biopsy, indicating an infection risk of 3.1%.[10]

Under the Spaulding classification system, endocavitary ultrasound probes that come into contact with mucous membranes and non-endocavitary ultrasound probes that touch non-intact skin should both be considered as semi-critical items.[11] Accordingly, high-level disinfection (HLD) is advised by the US Centers for Disease Control and Prevention (CDC). In April 2016, Health Protection Scotland (HPS) and

Health Facilities Scotland (HFS) published joint guidance recommending the use of HLD technologies for the decontamination of reusable SIUPs.[12] As demonstrated in a national survey carried out by HFS in 2012, prior to national guidance being issued there was considerable variation in practice with regard to methods for cleaning SIUPs in Scotland.[13] Of the 42 departments that responded, only four (9.5%) departments were using HLD. Similarly, a Europe-wide survey distributed via the European Society of Radiology in 2015 found that only 14.7% of respondents reported using HLD for endocavitary probes.[14]

This study aimed to use both microbiological and prescribing data as proxy measures to give an estimated risk of infection following SIUP procedures in Scotland from 2010 to 2016, prior to the publication of NHSScotland guidance in April 2016 on decontamination of SIUPs.

Methods

The study created three retrospective cohorts – Cardiology, Gynaecology and Urology – covering the period 2010 to 2016 across Scotland. Administrative records of eligible inpatients/day-cases and outpatients in the Scottish Morbidity Record (SMR) datasets were linked to positive microbiological reports, via the National Services Scotland (NSS) Electronic Communication of Surveillance in Scotland (ECOSS) dataset, and antibiotic use in the community, via the NSS Prescribing Information (PIS) dataset. Study data were generated during routine care and had all patient identifiers removed prior to analysis. Data analysis adhered to the NSS Information Governance Policy and Procedures.

Individuals were assigned to one of three cohorts, based on their recorded exposure to certain procedures or hospital admissions/outpatient attendance in comparator specialties and who were also Scottish residents aged ≥16 as of 1st April 2010 with a valid Community Health Index (CHI) number – a unique patient identifier used in the National Health Service (NHS).[15] Patients were included in the Cardiology cohort if they had undergone a TOE procedure in the period from 1st April 2010 to 31st March 2016 or if they were a Cardiology inpatient or outpatient in the same time period. Patients were included in the Gynaecology cohort if they had a recorded Gynaecology inpatient/day-case episode in the time period or a recorded outpatient attendance under the Gynaecology specialty, and they were included in the Urology cohort if they had a recorded Urology inpatient/day-case episode or an outpatient attendance. Detailed inclusion criteria can be seen in Table 1.

Due to the lack of recording as to which devices have been used, a number of procedures were assumed to have involved the use of a TV or TR probe, based upon the authors' knowledge of current best practice for medical procedures. For TV ultrasound, this included transvaginal oocyte recovery and ultrasound of the pelvis when combined with placement/removal of an intrauterine device (IUD) or an unspecified examination of the female genital tract. For TR ultrasound, this included rectal needle biopsy of the prostate and radioactive seed implantation into the prostate.

Table 1: Inclusion criteria for Cardiology, Gynaecology and Urology cohorts.

Cardiology cohort

Inclusion criteria:

- Cardiology inpatient/day-case episode; General Medicine inpatient/day-case episode with Cardiology diagnosis code (ICD10 I20-I25, I26-I28, I30-I52); Cardiology outpatient attendance; or procedure code U20.2 Transoesophageal echocardiography

Exposure classed as procedure code:

- U20.2 Transoesophageal echocardiography

Gynaecology cohort

Inclusion criteria:

- Gynaecology inpatient/day-case episode or outpatient attendance

Exposure classed as procedure code:

- Q55.5 Transvaginal ultrasound examination of female genital tract
- Q51.5 Transvaginal ultrasound guided aspiration of ovarian cyst
- Q21 Placement/removal of IUD AND U09.2 Ultrasound of pelvis
- Q48.4 Transvaginal oocyte recovery
- Q55.9 Unspecified examination of female genital tract AND U09.2 Ultrasound of pelvis

Urology cohort

Inclusion criteria:

- Urology inpatient/day-case episode or outpatient attendance

Exposure classed as procedure code:

- M70.3 Rectal needle biopsy of prostate
- M70.6 Radioactive seed implantation into prostate

Data sources and extraction

Patient-level data for eligible cases on inpatient/day-case hospital episodes and outpatient attendance, including date of SIUP procedure, were obtained from the NSS General/Acute Inpatient and Day Case dataset (SMR01) and the NSS Outpatient Attendance dataset (SMR00), respectively. From SMR01 hospital activity data, a Charlson co-morbidity score was calculated, based on the weightings outlined by Charlson *et al.*[16] and using the algorithm defined for the International Classification of Diseases-10 (ICD-10) codes by Quan *et al.*[17] Diagnostic codes from hospital admissions in the five years prior to 1st April 2010 were used to calculate the Charlson score. SMR01 data were used to determine the number of hospital stays the patient had in the 12 months prior to 1st April 2010.

Data on patient-level microbiological reports were obtained from the NSS ECOSS dataset, which contains details of micro-organisms and infections identified and reported by microbiology laboratories in the NHS in Scotland. The data included: blood, upper respiratory and lower respiratory specimens for Cardiology specialty attendance/episodes; urine and genital specimens for Gynaecology specialty attendance/episodes; as well as blood, urine, genital and faecal specimens for Urology specialty attendance/episodes. However, data on sensitive infections, such as human immunodeficiency virus and hepatitis C virus, were not extracted in order to minimise the risk of violating patient confidentiality. *Mycobacterium tuberculosis* was excluded from the analysis for having an incubation period greater than 30 days.

Data on patient-level prescribing were obtained from the NSS PIS dataset, which contains details of all NHS medication prescribed and dispensed in the community in Scotland.[18] The number of drug classes, defined as the total number of medicines prescribed from different paragraphs of the legacy British National Formulary (BNF) in the 12 months prior to 1st April 2010, was used as an additional measure of co-morbidity.[19] As the outcome variable, prescriptions from the legacy Chapter 5.1, Antibacterial Drugs, were selected, excluding anti-tuberculosis drugs and anti-leprotic drugs (paragraphs 9 and 10, respectively). For Gynaecology specialty attendance/episodes, prescriptions were further classified into those agents most commonly used in the treatment of urinary tract infections in Scotland: trimethoprim, nitrofurantoin, ciprofloxacin, cefalexin and co-amoxiclav. Antibiotics prescribed within 30 days of a previous prescription were assumed to be related to the same period of infection and were excluded.

The SMR01 and PIS datasets were also used to identify if a patient was admitted to hospital from a care home location (i.e. a long-term care facility in the community providing a supported care environment) in the 12 months prior to 1st April 2010, or if the patient was registered on the PIS dataset as being in a care home at the time of a prescription in the 12 months prior to the beginning of the study. This should not be interpreted as the patient being resident in a care home at the time of any possible infection.

Data linkage and analysis

Corresponding microbiological and prescribing data were linked to SIUP procedures using the unique patient CHI number within the NHSScotland Infection Intelligence Platform (IIP).[20] For both microbiological reports and antibiotic prescriptions, a positive outcome linked to a SIUP procedure was defined as a report or prescription in the period from one day following the procedure date to 30 days following the procedure. The 30-day period was chosen on the basis of standard incubation periods for micro-organisms that are likely to pose a risk of cross-infection via SIUPs, as a 'worst-case' scenario.[21]

Individuals in each cohort contributed person-time follow-up from the date they entered the cohort (1st April 2010) to the unexposed grouping whilst not exposed to a SIUP. Individuals exposed to a SIUP procedure contributed person-time follow-up to the exposed group from one day to 30 days post-procedure. All individuals were followed-up until the end of the study (31st March 2016) or date of death, if applicable. Cox proportional hazards was used to compare the rate of occurrence of the appropriate outcome (i.e. microbiological report or antibiotic prescription) in the cohort for the exposed period for each type of SIUP procedure (TOE/TV/TR) against the non-exposed period, to determine the hazard ratio and 95% confidence interval. This process was performed independently for both microbiological and prescribing outcomes.

Unadjusted and fully adjusted analyses were conducted for the following factors: age, gender, NHS board of residence, Charlson co-morbidity index score, number of hospital admissions in past 12 months, number of BNF drug classes prescribed in past 12 months and care home residence in past 12 months. A *p*-value of ≤0.05 was chosen as the threshold for statistical significance. Data manipulation was carried out in SPSS version 21 and all statistical analysis was conducted in R version 3.2.0 using the survival package.[22]

Results

The numbers of patients included were 495 786, 330 500 and 156 625 for the Cardiology, Gynaecology and Urology cohorts, respectively (Table 2). 3 364 (0.7%) patients in the Cardiology cohort had undergone TOE, whereas 60 698 (18.4%) of the Gynaecology cohort and 15 934 (10.2%) of the Urology cohort had received a TV or TR ultrasound procedure. For ECOSS reports, the total number of person-years follow-up was 72 805 743, 53 723 456 and 24 850 921 for Cardiology, Gynaecology and Urology cohorts, respectively. For PIS antibiotic prescriptions, the total number of person-years follow-up was 72 811 440, 53 723 480 and 24 850 921 for the same cohorts. The difference in person-time follow-up for ECOSS and PIS outcomes was due to variation in the number of individuals with a date of death prior to the positive outcome (i.e. microbiological reports could be submitted after date of death).

Of the Cardiology cohort, 51.6% were male, 27.9% had previously been hospitalised and 1.1% had been resident in a care home. For the Gynaecology cohort, 16.2% had previously been hospitalised and 0.1% had been resident in a care home; as for the Urology cohort, 23.8% had previously been hospitalised and 0.6% had been resident in a care home. 12.3% of the Cardiology cohort, 19.2% of the Gynaecology cohort and 22.4% of the Urology cohort had not been prescribed any drugs within the past 12 months. When individuals with unknown Charlson scores were excluded from the analysis, 44.3% of the Cardiology cohort had a Charlson score of 1 or higher, as did 15.9% of the Gynaecology cohort and 35.1% of the Urology cohort. An unknown Charlson score suggests that the patient had no hospital admissions in the five years prior to the start of the study; therefore, a Charlson score could not be calculated. Both the Cardiology and Urology cohorts had a higher prevalence of co-morbidities than the Gynaecology cohort, in addition to which the Gynaecology cohort was largely younger in age. 64.9% of the Gynaecology cohort was below the age of 45, whereas 71.1% of the Cardiology cohort and 58.1% of the Urology cohort were aged 55 years or older.

Table 2: Characteristics of Cardiology, Gynaecology and Urology cohorts by age group, gender, Charlson score, British National Formulary (BNF) drug classes prescribed, previous hospital admissions and past care home residence.

	Cardiology Cohort		Gynaecology Cohort		Urology Cohort	
	n	%	n	%	n	%
Age group						
16-24	12 271	2.5	70 698	21.4	9 142	5.8
25-34	17 747	3.6	75 033	22.7	13 999	8.9
35-44	38 756	7.8	68 607	20.8	19 272	12.3
45-54	74 527	15.0	55 645	16.8	23 151	14.8
55-64	101 783	20.5	28 385	8.6	33 054	21.1
65-74	116 368	23.5	19 674	6.0	33 470	21.4
75-84	100 322	20.2	10 497	3.2	20 401	13.0
≥85	34 012	6.9	1 961	0.6	4 136	2.6
Gender						
Male	256 031	51.6	0	0.0	156 625	100.0
Female	239 750	48.4	330 500	100.0	0	0.0
Charlson score						
0	168 085	33.9	121 025	36.6	53 653	34.3
1-2	99 945	20.2	19 765	6.0	22 004	14.1
3-4	24 206	4.9	1 866	0.6	4 980	3.2
≥5	9 560	1.9	1 303	0.4	1 993	1.3
Unknown	193 990	39.1	186 541	56.4	73 995	47.2
BNF drug classes prescribed						
0	60 778	12.3	63 476	19.2	35 092	22.4
1-4	134 104	27.1	159 761	48.3	56 371	36.0
5-9	162 250	32.7	74 959	22.7	40 933	26.1
10-14	94 938	19.2	23 444	7.1	17 682	11.3
15-19	33 538	6.8	6 816	2.1	5 135	3.3
≥20	10 178	2.1	2 044	0.6	1 412	0.9
Previous hospital admissions						
0	357 476	72.1	276 927	83.8	119 320	76.2
1	83 053	16.8	39 005	11.8	22 167	14.2
2	30 531	6.2	9 133	2.8	7 993	5.1
3	12 312	2.5	2 734	0.8	3 409	2.2
≥4	12 414	2.5	2 701	0.8	3 736	2.4
Past care home residence						
No	490 478	98.9	330 093	99.9	155 718	99.4
Yes	5 308	1.1	407	0.1	907	0.6

There was a significant increase (p<0.001) in the risk of infection for all three types of SIUP procedure, as determined by micro-organisms reported via ECOSS and community antibiotic prescriptions recorded by PIS (Table 3). The increased risk continued to be statistically significant when the analysis was adjusted for confounding factors. A greater adjusted hazard ratio (HR) of microbiological reports was observed for patients who had undergone TOE (HR: 4.92; 95% CI: 3.17–7.63), TV (HR: 1.41; 95% CI: 1.21–1.64) and TR ultrasound (HR: 3.40; 95% CI: 2.90–3.99). Similarly, there was a greater adjusted HR of community antibiotic prescribing for those who received TV (HR: 1.26; 95% CI: 1.20–1.32) and TR (HR: 1.75; 95% CI: 1.66–1.84) ultrasound. The adjusted HR for community antibiotic prescriptions following TOE procedures was also raised (HR: 1.05; 95% CI: 0.92–1.20), although the difference was non-significant (p=0.49).

Table 3: Unadjusted and adjusted hazard ratios (HR), with 95% confidence intervals (CI) and *p*-values, for Electronic Communication of Surveillance in Scotland (ECOSS) microbiological reports and Prescribing Information System (PIS) community antibiotic prescriptions by transoesophageal echocardiography (TOE), transvaginal (TV) and transrectal (TR) ultrasound procedures.

		Number of events	Total person-years	Unadjusted		Adjusted	
				HR (95% CI)	*p*-value	HR (95% CI)	*p*-value
ECOSS reports							
Cardiology	*No procedure*	46 343	72 799 310	1.00 Reference		1.00 Reference	
	TOE procedure	20	6 433	4.64 (95% CI: 3.00 – 7.20)	<0.001	4.92 (95% CI: 3.17 – 7.63)	<0.001
Gynaecology	*No procedure*	46 167	53 602 489	1.00 Reference		1.00 Reference	
	TV procedure	168	120 967	1.40 (95% CI: 1.20 – 1.63)	<0.001	1.41 (95% CI: 1.21 – 1.64)	<0.001
Urology	*No procedure*	33 289	24 819 966	1.00 Reference		1.00 Reference	
	TR procedure	153	30 955	3.36 (95% CI: 2.87 – 3.94)	<0.001	3.40 (95% CI: 2.90 – 3.99)	<0.001
PIS prescriptions							
Cardiology	*No procedure*	2 366 475	72 805 006	1.00 Reference		1.00 Reference	
	TOE procedure	225	6 434	0.99 (95% CI: 0.86 – 1.12)	0.827	1.05 (95% CI: 0.92 – 1.20)	0.490
Gynaecology	*No procedure*	1 554 212	53 602 513	1.00 Reference		1.00 Reference	
	TV procedure	4 887	120 967	1.40 (95% CI: 1.34 – 1.47)	<0.001	1.26 (95% CI: 1.20 – 1.32)	<0.001
Urology	*No procedure*	671 366	24 819 966	1.00 Reference		1.00 Reference	
	TR procedure	1 535	30 955	1.67 (95% CI: 1.59 – 1.76)	<0.001	1.75 (95% CI: 1.66 – 1.84)	<0.001

Figure 1: Adjusted hazard ratios and 95% confidence intervals for ECOSS microbiological reports by SIUP procedure.

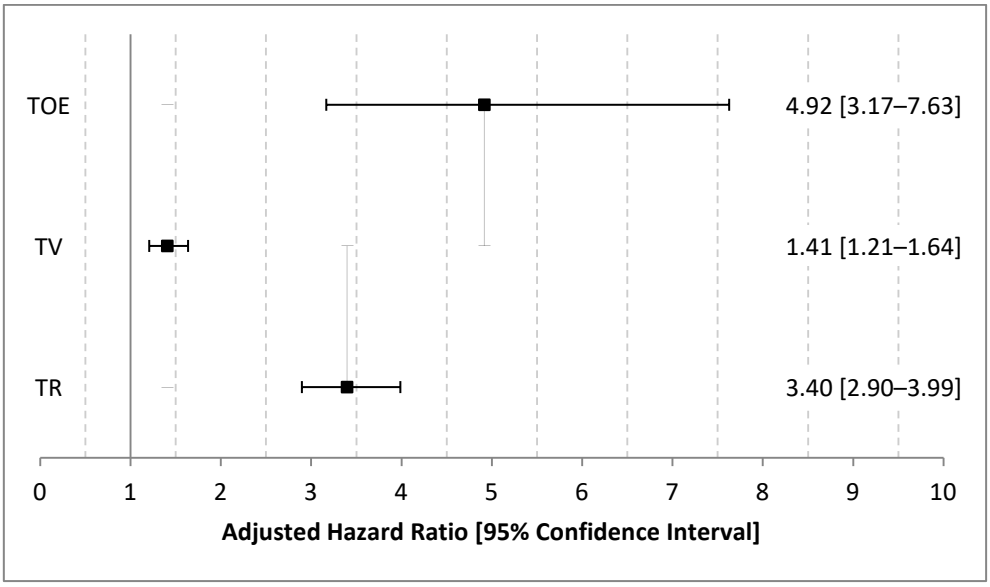
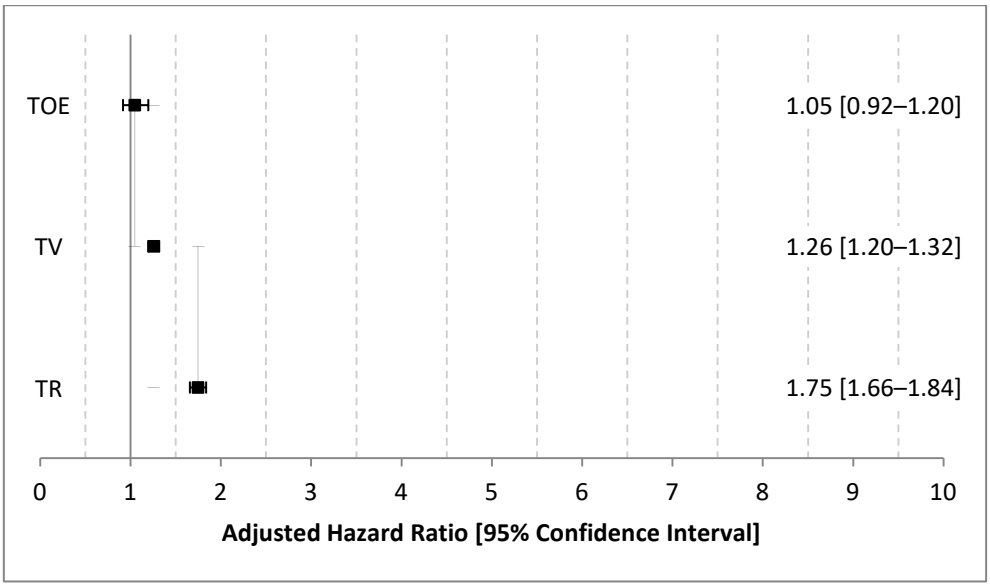


Figure 2: Adjusted hazard ratios and 95% confidence intervals for PIS community antibiotic prescriptions by SIUP procedure.



Discussion

Through linking national datasets of routinely collected data, we found that exposure to a medical procedure involving a SIUP was associated with an increased risk of infection, as demonstrated by raised hazard ratios for both positive microbiological reports and community antibiotic prescriptions. To the authors' knowledge, this is the first study using linkage of national datasets to determine the risk of infection associated with SIUP procedures. However, the use of surveillance data entails the limitation that microbiological reports and antibiotic prescriptions are only proxy measures for clinical infection and may respectively represent asymptomatic colonisation – as opposed to overt infection – or a provisional diagnosis of infection without prior confirmation by microbiological culture.

Adjusted hazard ratios were greatest for those undergoing TOE procedures, followed by TR ultrasound procedures. The substantially greater hazard ratio for TOE procedures reflects the number of infection outbreaks associated with TOE probes in the published literature.[4-7] These patients commonly receive ultrasound examination during an episode of care as an inpatient and are likely to be medically compromised with multiple co-morbidities, increasing their risk of infection. We therefore made statistical adjustments to minimise the impact of medical co-morbidities as a confounding factor. TOE probes are frequently used as an operative aid during cardiac surgery, in which case surveillance data would not be able to distinguish between cross-infection as a consequence of probe contamination and a surgical site infection from the introduction of a patient's endogenous flora into a normally sterile body site. Furthermore, TOE procedures, in common with other semi-invasive ultrasound procedures, are not mandatory to record in the SMR01 dataset unless the patient has been specifically admitted for that procedure. Therefore it is likely that TOE procedures carried out in the inpatient setting will not have been included in the study cohort. The non-significant difference in antibiotic prescriptions for those receiving TOE procedures in the Cardiology cohort is once again likely to be due to these patients undergoing the procedure during an inpatient stay, with the consequence that any antibiotic prescriptions will not be recorded in the PIS community prescribing dataset. Importantly, there were significant differences in the hazard ratios of different NHS regional boards, which may indicate variation in procedure-recording practices.

A number of procedures recorded in the SMR were assumed to have involved use of a TR probe, based upon the authors' knowledge of current best practice for medical procedures, e.g. rectal needle biopsy of the prostate. The higher risk of infection for TR ultrasound than use of a TV probe may be due to the nature of procedures conducted using this technique: in the vast majority of cases, a TR probe was assumed to have been used as a surgical guide during needle biopsy of the prostate, as recommended by the European Association for Urology, leading to a greater risk of surgical site infection with the patient's own endogenous flora.[23] The published literature on the risk of infectious complications following prostate biopsy provides an estimate of approximately 5%.[24] The majority of

these infectious complications are likely to have arisen as urinary tract infections, which are often treated empirically without microbiological culture for confirmation. Likewise, pre-surgical antibiotic prophylaxis for needle biopsy of the prostate is currently recommended by the European Association for Urology, and differential uptake in this practice could have influenced the results.[23] Reporting of urine, genital and faecal specimens in ECOSS is not mandatory, so there is likely to be a degree of under-reporting for TR ultrasound procedures. Similarly, there is significant variation amongst different NHS regional boards with regard to reporting of specimens.

Approximately 98% of TV ultrasound procedures were recorded under the diagnostic code 'transvaginal ultrasound examination of female genital tract'. When surgical procedures and medical examinations assumed to have involved a TV probe were excluded, the adjusted hazard ratios were still significant for both microbiological reports (HR: 1.41; 95% CI: 1.21–1.65) and antibiotics commonly prescribed for urinary tract infections in an outpatient setting (HR: 1.27; 95% CI: 1.21–1.32). This observation indicates that the infection risk is more likely due to pathogen cross-transmission during examination, rather than being a consequence of surgical intervention.

The findings imply that low-level disinfection may be inadequate for re-use of SIUPs and pose a risk of cross-infection, albeit a very low risk. Under the precautionary principle, in the event that the risk is low and the consequences are high, full scientific certainty should not be used as justification for postponing cost-effective measures to prevent future infections. Hence, failure to comply with guidance recommending high-level disinfection of SIUPs will continue to result in an unacceptable risk of harm to patients.

Recommendations

The following recommendations for NHSScotland are based on the findings of the data linkage study:

- Health Boards should follow the NHSScotland guidance for decontamination of semi-invasive ultrasound probes (SIUP) for the decontamination of all SIUP probes between uses.
- Health Protection Scotland will undertake an evaluation of the uptake of the NHSScotland guidance for decontamination of semi-invasive ultrasound probes prior to any future data linkage studies.
- Health Boards should consider recording all semi-invasive probe procedures within the SMR00 or SMR01 patient management systems. This will ensure datasets are more complete and data more robust for any future data linkage exercises or national surveillance.
- Following the implementation of HPS guidance on SIUP decontamination, HPS should consider a prospective cohort study using a similar methodology to ascertain if national guidance has reduced the risk of infection from SIUP procedures.

Appendix

Table 4: Cardiology cohort hazard ratios for ECOSS microbiological reports and PIS antibiotic prescriptions by all variables.

Variable	ECOSS reports			PIS prescriptions		
	Unadjusted	Adjusted		Unadjusted	Adjusted	
	HR (95% CI)	HR (95% CI)	*p*-value	HR (95% CI)	HR (95% CI)	*p*-value
Procedure						
No	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
Yes	4.64 (95% CI: 3.00 – 7.20)	4.92 (95% CI: 3.17 – 7.63)	<0.001	0.99 (95% CI: 0.86 – 1.12)	1.05 (95% CI: 0.92 – 1.20)	0.490
Age group						
16-24	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
25-34	1.60 (95% CI: 1.40 – 1.83)	1.42 (95% CI: 1.24 – 1.62)	<0.001	1.03 (95% CI: 1.02 – 1.05)	0.95 (95% CI: 0.94 – 0.96)	<0.001
35-44	1.80 (95% CI: 1.60 – 2.03)	1.33 (95% CI: 1.17 – 1.50)	<0.001	1.12 (95% CI: 1.11 – 1.13)	0.92 (95% CI: 0.91 – 0.93)	<0.001
45-54	2.49 (95% CI: 2.22 – 2.80)	1.50 (95% CI: 1.33 – 1.68)	<0.001	1.22 (95% CI: 1.21 – 1.24)	0.88 (95% CI: 0.87 – 0.89)	<0.001
55-64	4.03 (95% CI: 3.60 – 4.52)	2.00 (95% CI: 1.78 – 2.24)	<0.001	1.41 (95% CI: 1.40 – 1.42)	0.89 (95% CI: 0.88 – 0.90)	<0.001
65-74	5.39 (95% CI: 4.81 – 6.03)	2.25 (95% CI: 2.01 – 2.52)	<0.001	1.63 (95% CI: 1.61 – 1.64)	0.88 (95% CI: 0.87 – 0.89)	<0.001
75-84	5.36 (95% CI: 4.79 – 6.00)	2.11 (95% CI: 1.88 – 2.37)	<0.001	1.72 (95% CI: 1.70 – 1.74)	0.86 (95% CI: 0.85 – 0.87)	<0.001
≥85	5.33 (95% CI: 4.75 – 5.99)	2.20 (95% CI: 1.96 – 2.48)	<0.001	1.84 (95% CI: 1.82 – 1.86)	0.90 (95% CI: 0.89 – 0.91)	<0.001
Gender						
Male	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
Female	0.90 (95% CI: 0.89 – 0.92)	0.77 (95% CI: 0.76 – 0.79)	<0.001	1.53 (95% CI: 1.53 – 1.53)	1.32 (95% CI: 1.32 – 1.32)	<0.001
Charlson score						
0	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
1-2	2.45 (95% CI: 2.39 – 2.51)	1.61 (95% CI: 1.57 – 1.65)	<0.001	1.35 (95% CI: 1.35 – 1.35)	1.04 (95% CI: 1.04 – 1.04)	<0.001
3-4	3.58 (95% CI: 3.46 – 3.70)	1.74 (95% CI: 1.68 – 1.80)	<0.001	1.59 (95% CI: 1.58 – 1.60)	1.05 (95% CI: 1.04 – 1.06)	<0.001
≥5	4.63 (95% CI: 4.43 – 4.85)	2.00 (95% CI: 1.91 – 2.10)	<0.001	1.66 (95% CI: 1.65 – 1.68)	1.06 (95% CI: 1.05 – 1.07)	<0.001
Unknown	0.76 (95% CI: 0.74 – 0.78)	1.04 (95% CI: 1.01 – 1.07)	0.005	0.68 (95% CI: 0.68 – 0.69)	0.90 (95% CI: 0.90 – 0.90)	<0.001
BNF drug classes prescribed						
0	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
1-4	1.39 (95% CI: 1.32 – 1.46)	1.28 (95% CI: 1.21 – 1.34)	<0.001	1.82 (95% CI: 1.81 – 1.84)	1.72 (95% CI: 1.71 – 1.73)	<0.001

5-9	2.79	(95% CI: 2.66 – 2.93)	2.07	(95% CI: 1.97 – 2.18)	<0.001	2.80	(95% CI: 2.78 – 2.82)	2.56	(95% CI: 2.54 – 2.57)	<0.001
10-14	5.16	(95% CI: 4.92 – 5.42)	3.31	(95% CI: 3.15 – 3.49)	<0.001	4.28	(95% CI: 4.25 – 4.31)	3.74	(95% CI: 3.71 – 3.76)	<0.001
15-19	8.75	(95% CI: 8.33 – 9.20)	5.02	(95% CI: 4.75 – 5.30)	<0.001	6.07	(95% CI: 6.03 – 6.11)	5.08	(95% CI: 5.05 – 5.12)	<0.001
≥20	14.16	(95% CI: 13.4 – 15.0)	7.32	(95% CI: 6.89 – 7.79)	<0.001	8.14	(95% CI: 8.07 – 8.21)	6.58	(95% CI: 6.52 – 6.64)	<0.001
Previous hospital admissions										
0	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
1	1.69	(95% CI: 1.66 – 1.73)	1.06	(95% CI: 1.03 – 1.09)	<0.001	1.41	(95% CI: 1.41 – 1.41)	1.01	(95% CI: 1.01 – 1.02)	<0.001
2	2.25	(95% CI: 2.18 – 2.33)	1.12	(95% CI: 1.08 – 1.16)	<0.001	1.62	(95% CI: 1.61 – 1.63)	1.02	(95% CI: 1.02 – 1.03)	<0.001
3	2.93	(95% CI: 2.80 – 3.05)	1.22	(95% CI: 1.17 – 1.28)	<0.001	1.81	(95% CI: 1.79 – 1.82)	1.03	(95% CI: 1.03 – 1.04)	<0.001
≥4	4.66	(95% CI: 4.50 – 4.83)	1.69	(95% CI: 1.62 – 1.76)	<0.001	2.02	(95% CI: 2.01 – 2.04)	1.08	(95% CI: 1.07 – 1.09)	<0.001
Past care home residence										
No	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
Yes	1.99	(95% CI: 1.83 – 2.16)	1.02	(95% CI: 0.94 – 1.11)	0.615	1.81	(95% CI: 1.78 – 1.83)	1.20	(95% CI: 1.19 – 1.22)	<0.001
NHS board of residence										
GG&C	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
A&A	1.24	(95% CI: 1.19 – 1.28)	1.13	(95% CI: 1.10 – 1.17)	<0.001	0.99	(95% CI: 0.99 – 1.00)	0.99	(95% CI: 0.99 – 1.00)	0.003
Borders	0.81	(95% CI: 0.76 – 0.87)	0.87	(95% CI: 0.82 – 0.93)	<0.001	0.85	(95% CI: 0.84 – 0.86)	0.95	(95% CI: 0.94 – 0.96)	<0.001
D&G	1.14	(95% CI: 1.08 – 1.20)	1.11	(95% CI: 1.05 – 1.16)	0.001	0.89	(95% CI: 0.88 – 0.89)	0.94	(95% CI: 0.93 – 0.95)	<0.001
Fife	0.94	(95% CI: 0.90 – 0.98)	0.93	(95% CI: 0.89 – 0.97)	<0.001	0.91	(95% CI: 0.90 – 0.91)	0.95	(95% CI: 0.95 – 0.96)	<0.001
Forth Valley	1.18	(95% CI: 1.13 – 1.24)	1.21	(95% CI: 1.15 – 1.26)	<0.001	0.93	(95% CI: 0.92 – 0.94)	0.97	(95% CI: 0.96 – 0.98)	<0.001
Grampian	0.87	(95% CI: 0.84 – 0.91)	0.89	(95% CI: 0.85 – 0.92)	<0.001	0.92	(95% CI: 0.91 – 0.92)	1.00	(95% CI: 1.00 – 1.01)	0.021
Highland	0.84	(95% CI: 0.80 – 0.88)	0.86	(95% CI: 0.82 – 0.90)	<0.001	0.84	(95% CI: 0.84 – 0.85)	0.92	(95% CI: 0.91 – 0.92)	<0.001
Lanarkshire	0.95	(95% CI: 0.92 – 0.98)	0.96	(95% CI: 0.93 – 0.99)	0.005	1.04	(95% CI: 1.03 – 1.04)	1.04	(95% CI: 1.04 – 1.05)	<0.001
Lothian	1.17	(95% CI: 1.13 – 1.20)	1.26	(95% CI: 1.22 – 1.30)	<0.001	0.93	(95% CI: 0.93 – 0.94)	1.03	(95% CI: 1.02 – 1.03)	<0.001
Orkney	0.37	(95% CI: 0.30 – 0.47)	0.42	(95% CI: 0.34 – 0.53)	<0.001	0.70	(95% CI: 0.68 – 0.71)	0.84	(95% CI: 0.82 – 0.86)	<0.001
Shetland	0.90	(95% CI: 0.75 – 1.08)	0.89	(95% CI: 0.74 – 1.07)	0.208	0.87	(95% CI: 0.85 – 0.89)	0.95	(95% CI: 0.92 – 0.97)	<0.001
Tayside	1.12	(95% CI: 1.08 – 1.17)	1.19	(95% CI: 1.14 – 1.23)	<0.001	0.91	(95% CI: 0.91 – 0.92)	0.99	(95% CI: 0.98 – 0.99)	<0.001
WI	1.02	(95% CI: 0.88 – 1.17)	0.95	(95% CI: 0.82 – 1.09)	0.440	0.98	(95% CI: 0.97 – 1.00)	0.99	(95% CI: 0.97 – 1.01)	0.451

GG&C = Greater Glasgow & Clyde; A&A = Ayrshire & Arran; D&G = Dumfries & Galloway; WI = Western Isles.

Table 5: Gynaecology cohort hazard ratios for ECOSS microbiological reports and PIS antibiotic prescriptions by all variables.

Variable	ECOSS reports			PIS prescriptions		
	Unadjusted	Adjusted		Unadjusted	Adjusted	
	HR (95% CI)	HR (95% CI)	*p*-value	HR (95% CI)	HR (95% CI)	*p*-value
Procedure						
No	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
Yes	1.40 (95% CI: 1.20– 1.63)	1.41 (95% CI: 1.21 – 1.64)	<0.001	1.40 (95% CI: 1.34 – 1.47)	1.26 (95% CI: 1.20 – 1.32)	<0.001
Age group						
16-24	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
25-34	0.85 (95% CI: 0.82 – 0.88)	0.79 (95% CI: 0.77 – 0.82)	<0.001	0.91 (95% CI: 0.90 – 0.91)	0.84 (95% CI: 0.83 – 0.84)	<0.001
35-44	1.01 (95% CI: 0.97 – 1.04)	0.85 (95% CI: 0.82 – 0.88)	<0.001	1.00 (95% CI: 0.98 – 1.00)	0.83 (95% CI: 0.83 – 0.84)	<0.001
45-54	1.30 (95% CI: 1.26 – 1.35)	1.02 (95% CI: 0.98 – 1.05)	0.290	1.10 (95% CI: 1.09 – 1.11)	0.86 (95% CI: 0.85 – 0.87)	<0.001
55-64	2.63 (95% CI: 2.54 – 2.72)	1.68 (95% CI: 1.62 – 1.74)	<0.001	1.56 (95% CI: 1.54 – 1.58)	1.05 (95% CI: 1.04 – 1.06)	<0.001
65-74	4.63 (95% CI: 4.48 – 4.78)	2.53 (95% CI: 2.44 – 2.62)	<0.001	2.31 (95% CI: 2.29 – 2.34)	1.30 (95% CI: 1.29 – 1.31)	<0.001
75-84	6.63 (95% CI: 6.40 – 6.87)	3.32 (95% CI: 3.20 – 3.46)	<0.001	2.72 (95% CI: 2.69 – 2.75)	1.35 (95% CI: 1.33 – 1.37)	<0.001
≥85	10.22 (95% CI: 9.61 – 10.9)	5.00 (95% CI: 4.69 – 5.33)	<0.001	3.32 (95% CI: 3.24 – 3.40)	1.56 (95% CI: 1.53 – 1.60)	<0.001
Charlson score						
0	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
1-2	2.26 (95% CI: 2.20 – 2.33)	1.07 (95% CI: 1.04 – 1.10)	<0.001	1.53 (95% CI: 1.52 – 1.54)	0.92 (95% CI: 0.92 – 0.93)	<0.001
3-4	4.58 (95% CI: 4.32 – 4.87)	1.29 (95% CI: 1.21 – 1.37)	<0.001	2.17 (95% CI: 2.13 – 2.22)	0.89 (95% CI: 0.87 – 0.91)	<0.001
≥5	3.23 (95% CI: 2.96 – 3.53)	1.36 (95% CI: 1.24 – 1.49)	<0.001	1.53 (95% CI: 1.48 – 1.59)	0.87 (95% CI: 0.84 – 0.90)	<0.001
Unknown	0.59 (95% CI: 0.58 – 0.60)	0.83 (95% CI: 0.82 – 0.85)	<0.001	0.58 (95% CI: 0.58 – 0.59)	0.80 (95% CI: 0.79 – 0.80)	<0.001
BNF drug classes prescribed						
0	1.00 Reference	1.00 Reference		1.00 Reference	1.00 Reference	
1-4	1.55 (95% CI: 1.50 – 1.61)	1.36 (95% CI: 1.32 – 1.41)	<0.001	1.78 (95% CI: 1.76 – 1.80)	1.69 (95% CI: 1.67 – 1.71)	<0.001
5-9	3.21 (95% CI: 3.10 – 3.33)	2.09 (95% CI: 2.01 – 2.17)	<0.001	3.34 (95% CI: 3.31 – 3.37)	2.88 (95% CI: 2.85 – 2.91)	<0.001
10-14	5.69 (95% CI: 5.48 – 5.92)	2.88 (95% CI: 2.76 – 3.00)	<0.001	5.72 (95% CI: 5.66 – 5.79)	4.48 (95% CI: 4.43 – 4.54)	<0.001
15-19	9.28 (95% CI: 8.87 – 9.71)	4.03 (95% CI: 3.84 – 4.24)	<0.001	8.20 (95% CI: 8.09 – 8.31)	6.16 (95% CI: 6.07 – 6.25)	<0.001
≥20	11.28 (95% CI: 10.6 – 12.0)	4.95 (95% CI: 4.62 – 5.30)	<0.001	11.35 (95% CI: 11.2 – 11.6)	8.46 (95% CI: 8.29 – 8.63)	<0.001
Previous hospital admissions						

0	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
1	1.69	(95% CI: 1.66 – 1.73)	1.04	(95% CI: 1.01 – 1.06)	0.013	1.61	(95% CI: 1.60 – 1.62)	1.02	(95% CI: 1.02 – 1.03)	<0.001
2	2.25	(95% CI: 2.18 – 2.33)	1.14	(95% CI: 1.09 – 1.19)	<0.001	2.09	(95% CI: 2.06 – 2.11)	1.07	(95% CI: 1.06 – 1.09)	<0.001
3	2.93	(95% CI: 2.80 – 3.05)	1.21	(95% CI: 1.14 – 1.29)	<0.001	2.52	(95% CI: 2.47 – 2.57)	1.10	(95% CI: 1.08 – 1.13)	<0.001
≥4	4.66	(95% CI: 4.50 – 4.83)	1.44	(95% CI: 1.35 – 1.53)	<0.001	2.71	(95% CI: 2.66 – 2.77)	1.16	(95% CI: 1.14 – 1.19)	<0.001
Past care home residence										
No	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
Yes	7.52	(95% CI: 6.63 – 8.53)	1.66	(95% CI: 1.46 – 1.89)	<0.001	3.49	(95% CI: 3.33 – 3.66)	1.36	(95% CI: 1.29 – 1.42)	<0.001
NHS board of residence										
GG&C	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
A&A	5.63	(95% CI: 5.44 – 5.83)	5.14	(95% CI: 4.96 – 5.32)	<0.001	1.00	(95% CI: 0.99 – 1.02)	0.98	(95% CI: 0.97 – 0.99)	<0.001
Borders	3.47	(95% CI: 3.27 – 3.68)	4.02	(95% CI: 3.80 – 4.27)	<0.001	0.77	(95% CI: 0.76 – 0.79)	0.87	(95% CI: 0.86 – 0.89)	<0.001
D&G	5.14	(95% CI: 4.90 – 5.39)	5.00	(95% CI: 4.76 – 5.24)	<0.001	0.88	(95% CI: 0.87 – 0.90)	0.91	(95% CI: 0.89 – 0.92)	<0.001
Fife	2.89	(95% CI: 2.77 – 3.01)	2.97	(95% CI: 2.85 – 3.10)	<0.001	0.94	(95% CI: 0.92 – 0.95)	0.97	(95% CI: 0.96 – 0.98)	<0.001
Forth Valley	0.53	(95% CI: 0.48 – 0.58)	0.61	(95% CI: 0.55 – 0.67)	<0.001	0.91	(95% CI: 0.90 – 0.93)	0.99	(95% CI: 0.98 – 1.01)	0.423
Grampian	5.34	(95% CI: 5.16 – 5.52)	5.64	(95% CI: 5.45 – 5.83)	<0.001	0.87	(95% CI: 0.87 – 0.88)	0.96	(95% CI: 0.95 – 0.97)	<0.001
Highland	3.36	(95% CI: 3.23 – 3.50)	3.30	(95% CI: 3.17 – 3.44)	<0.001	0.88	(95% CI: 0.87 – 0.89)	0.92	(95% CI: 0.91 – 0.93)	<0.001
Lanarkshire	3.59	(95% CI: 3.46 – 3.72)	3.61	(95% CI: 3.49 – 3.75)	<0.001	1.05	(95% CI: 1.04 – 1.06)	1.02	(95% CI: 1.01 – 1.03)	<0.001
Lothian	0.29	(95% CI: 0.27 – 0.31)	0.34	(95% CI: 0.32 – 0.37)	<0.001	0.92	(95% CI: 0.91 – 0.93)	1.06	(95% CI: 1.05 – 1.07)	<0.001
Orkney	5.87	(95% CI: 5.23 – 6.60)	5.10	(95% CI: 4.54 – 5.73)	<0.001	0.89	(95% CI: 0.84 – 0.94)	0.90	(95% CI: 0.85 – 0.95)	<0.001
Shetland	5.09	(95% CI: 4.47 – 5.81)	5.06	(95% CI: 4.44 – 5.77)	<0.001	0.88	(95% CI: 0.84 – 0.93)	0.90	(95% CI: 0.85 – 0.95)	<0.001
Tayside	1.27	(95% CI: 1.20 – 1.34)	1.21	(95% CI: 1.15 – 1.28)	<0.001	0.93	(95% CI: 0.92 – 0.94)	0.95	(95% CI: 0.94 – 0.96)	<0.001
WI	7.13	(95% CI: 6.60 – 7.71)	6.32	(95% CI: 5.85 – 6.83)	<0.001	1.04	(95% CI: 1.00 – 1.08)	0.99	(95% CI: 0.95 – 1.02)	0.445

GG&C = Greater Glasgow & Clyde; A&A = Ayrshire & Arran; D&G = Dumfries & Galloway; WI = Western Isles.

Table 6: Urology cohort hazard ratios for ECOSS microbiological reports and PIS antibiotic prescriptions by all variables.

Variable	ECOSS reports				PIS prescriptions			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	HR (95% CI)		HR (95% CI)	*p*-value	HR (95% CI)		HR (95% CI)	*p*-value
Procedure								
No	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Yes	3.36	(95% CI: 2.87– 3.94)	3.40	(95% CI: 2.90 – 3.99)	<0.001	1.67	(95% CI: 1.59 – 1.76)	1.75	(95% CI: 1.66 – 1.84)	<0.001
Age group								
16-24	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
25-34	1.35	(95% CI: 1.20 – 1.53)	1.30	(95% CI: 1.15 – 1.46)	<0.001	1.00	(95% CI: 0.98 – 1.01)	0.95	(95% CI: 0.94 – 0.97)	<0.001
35-44	2.23	(95% CI: 2.00 – 2.48)	1.95	(95% CI: 1.75 – 2.17)	<0.001	1.18	(95% CI: 1.16 – 1.19)	1.00	(95% CI: 0.98 – 1.01)	0.873
45-54	3.76	(95% CI: 3.39 – 4.17)	2.91	(95% CI: 2.62 – 3.23)	<0.001	1.48	(95% CI: 1.46 – 1.50)	1.06	(95% CI: 1.05 – 1.08)	<0.001
55-64	4.93	(95% CI: 4.46 – 5.46)	3.31	(95% CI: 2.99 – 3.67)	<0.001	1.69	(95% CI: 1.67 – 1.72)	1.05	(95% CI: 1.04 – 1.07)	<0.001
65-74	7.20	(95% CI: 6.51 – 7.97)	4.20	(95% CI: 3.79 – 4.65)	<0.001	1.98	(95% CI: 1.95 – 2.01)	1.06	(95% CI: 1.05 – 1.08)	<0.001
75-84	11.48	(95% CI: 10.4 – 12.7)	6.07	(95% CI: 5.48 – 6.73)	<0.001	2.33	(95% CI: 2.30 – 2.36)	1.13	(95% CI: 1.12 – 1.15)	<0.001
≥85	18.14	(95% CI: 16.3 – 20.2)	9.49	(95% CI: 8.49 – 10.6)	<0.001	2.68	(95% CI: 2.63 – 2.73)	1.29	(95% CI: 1.26 – 1.31)	<0.001
Charlson score								
0	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
1-2	1.82	(95% CI: 1.76 – 1.87)	1.13	(95% CI: 1.10 – 1.17)	<0.001	1.42	(95% CI: 1.41 – 1.43)	1.04	(95% CI: 1.03 – 1.05)	<0.001
3-4	3.25	(95% CI: 3.11 – 3.39)	1.45	(95% CI: 1.39 – 1.52)	<0.001	1.80	(95% CI: 1.78 – 1.82)	1.08	(95% CI: 1.06 – 1.09)	<0.001
≥5	4.12	(95% CI: 3.87 – 4.38)	1.77	(95% CI: 1.66 – 1.90)	<0.001	1.93	(95% CI: 1.90 – 1.97)	1.13	(95% CI: 1.11 – 1.15)	<0.001
Unknown	0.65	(95% CI: 0.63 – 0.67)	0.92	(95% CI: 0.89 – 0.94)	<0.001	0.67	(95% CI: 0.66 – 0.67)	0.87	(95% CI: 0.87 – 0.88)	<0.001
BNF drug classes prescribed								
0	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
1-4	1.66	(95% CI: 1.59 – 1.73)	1.21	(95% CI: 1.16 – 1.26)	<0.001	1.79	(95% CI: 1.78 – 1.81)	1.69	(95% CI: 1.68 – 1.71)	<0.001
5-9	3.26	(95% CI: 3.13 – 3.39)	1.67	(95% CI: 1.60 – 1.75)	<0.001	2.84	(95% CI: 2.82 – 2.87)	2.49	(95% CI: 2.47 – 2.52)	<0.001
10-14	5.03	(95% CI: 4.82 – 5.24)	2.19	(95% CI: 2.08 – 2.29)	<0.001	4.19	(95% CI: 4.15 – 4.23)	3.50	(95% CI: 3.46 – 3.53)	<0.001
15-19	7.07	(95% CI: 6.72 – 7.44)	2.79	(95% CI: 2.63 – 2.95)	<0.001	5.73	(95% CI: 5.67 – 5.80)	4.63	(95% CI: 4.57 – 4.69)	<0.001
≥20	8.99	(95% CI: 8.35 – 9.68)	3.42	(95% CI: 3.16 – 3.71)	<0.001	7.16	(95% CI: 7.04 – 7.29)	5.67	(95% CI: 5.57 – 5.78)	<0.001
Previous hospital admissions								

0	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
1	1.66	(95% CI: 1.62 – 1.71)	1.04	(95% CI: 1.00 – 1.07)	0.026	1.46	(95% CI: 1.45 – 1.47)	1.00	(95% CI: 0.99 – 1.01)	0.970
2	2.15	(95% CI: 2.07 – 2.24)	1.07	(95% CI: 1.02 – 1.12)	0.002	1.72	(95% CI: 1.70 – 1.73)	1.01	(95% CI: 1.00 – 1.02)	0.007
3	2.72	(95% CI: 2.57 – 2.87)	1.18	(95% CI: 1.11 – 1.25)	<0.001	1.97	(95% CI: 1.95 – 2.00)	1.07	(95% CI: 1.06 – 1.09)	<0.001
≥4	3.90	(95% CI: 3.72 – 4.08)	1.54	(95% CI: 1.46 – 1.62)	<0.001	2.17	(95% CI: 2.14 – 2.20)	1.08	(95% CI: 1.07 – 1.10)	<0.001
Past care home residence										
No	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
Yes	7.07	(95% CI: 6.57 – 7.60)	3.24	(95% CI: 3.01 – 3.49)	<0.001	2.43	(95% CI: 2.37 – 2.49)	1.40	(95% CI: 1.36 – 1.44)	<0.001
NHS board of residence										
GG&C	1.00	Reference	1.00	Reference		1.00	Reference	1.00	Reference	
A&A	0.80	(95% CI: 0.74 – 0.86)	3.07	(95% CI: 2.95 – 3.19)	<0.001	0.95	(95% CI: 0.94 – 0.96)	0.99	(95% CI: 0.98 – 1.00)	0.015
Borders	0.85	(95% CI: 0.81 – 0.90)	2.30	(95% CI: 2.14 – 2.48)	<0.001	0.97	(95% CI: 0.95 – 0.98)	1.01	(95% CI: 0.99 – 1.03)	0.363
D&G	0.58	(95% CI: 0.56 – 0.61)	2.37	(95% CI: 2.24 – 2.51)	<0.001	1.01	(95% CI: 0.99 – 1.02)	1.01	(95% CI: 0.99 – 1.02)	0.327
Fife	0.29	(95% CI: 0.27 – 0.31)	2.01	(95% CI: 1.93 – 2.10)	<0.001	0.87	(95% CI: 0.86 – 0.87)	0.97	(95% CI: 0.96 – 0.98)	<0.001
Forth Valley	0.94	(95% CI: 0.91 – 0.98)	0.98	(95% CI: 0.91 – 1.05)	0.595	0.91	(95% CI: 0.90 – 0.92)	0.98	(95% CI: 0.97 – 0.99)	0.002
Grampian	0.33	(95% CI: 0.32 – 0.34)	2.96	(95% CI: 2.85 – 3.08)	<0.001	0.93	(95% CI: 0.92 – 0.94)	1.01	(95% CI: 1.00 – 1.02)	0.011
Highland	0.61	(95% CI: 0.58 – 0.64)	1.81	(95% CI: 1.72 – 1.91)	<0.001	0.88	(95% CI: 0.87 – 0.89)	0.92	(95% CI: 0.91 – 0.93)	<0.001
Lanarkshire	0.79	(95% CI: 0.77 – 0.83)	2.41	(95% CI: 2.32 – 2.51)	<0.001	1.11	(95% CI: 1.10 – 1.12)	1.09	(95% CI: 1.09 – 1.10)	<0.001
Lothian	0.22	(95% CI: 0.21 – 0.23)	0.69	(95% CI: 0.65 – 0.73)	<0.001	1.00	(95% CI: 0.99 – 1.01)	1.06	(95% CI: 1.05 – 1.07)	<0.001
Orkney	1.14	(95% CI: 0.94 – 1.39)	3.28	(95% CI: 2.70 – 3.99)	<0.001	0.97	(95% CI: 0.91 – 1.03)	1.02	(95% CI: 0.96 – 1.09)	0.472
Shetland	0.89	(95% CI: 0.67 – 1.17)	2.88	(95% CI: 2.19 – 3.79)	<0.001	0.94	(95% CI: 0.87 – 1.01)	0.96	(95% CI: 0.89 – 1.04)	0.297
Tayside	0.32	(95% CI: 0.30 – 0.34)	1.09	(95% CI: 1.03 – 1.16)	0.004	0.88	(95% CI: 0.87 – 0.89)	1.00	(95% CI: 0.99 – 1.01)	0.606
WI	1.14	(95% CI: 1.01 – 1.28)	2.89	(95% CI: 2.56 – 3.26)	<0.001	1.03	(95% CI: 0.99 – 1.07)	0.96	(95% CI: 0.92 – 0.99)	0.023

GG&C = Greater Glasgow & Clyde; A&A = Ayrshire & Arran; D&G = Dumfries & Galloway; WI = Western Isles.

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