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Antimicrobial prescribing in European nursing homes

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Objectives: The aim of this study was to investigate antimicrobial prescribing in nursing homes in countries across Europe.

Methods: Point prevalence studies were completed in April and November 2009 in 85 nursing homes in 15 European countries and two UK administrations.

Results: A total of 10 388 and 9430 residents participated in April and November 2009, respectively. The mean prevalence of antimicrobial prescribing in the nursing homes was 6.5% in April and 5.0% in November. The most commonly prescribed antimicrobials were methenamine (17.5%), trimethoprim (11.4%) and co-amoxiclav (11.1%) in April and co-amoxiclav (12.2%), nitrofurantoin (12.2%) and methenamine (11.5%) in November. There was large variation in the overall mean antimicrobial prescribing in the selected nursing homes from each of the contributing countries, ranging from 1.4% in Germany and Latvia to 19.4% in Northern Ireland in April and 1.2% in Latvia to 13.4% in Finland in November. Furthermore, differences in prescribing were apparent within countries with the largest variation evident in nursing homes in Northern Ireland (21.5%) in April and Finland in November (30.1%).

Conclusions: This is the first study to investigate antimicrobial prescribing in nursing homes in a large number of European countries. The findings suggest that there is considerable variation in antimicrobial prescribing in nursing homes across and within European countries. Nursing homes provide a significant service to the European community and must be supported in order to optimize antimicrobial use and limit the development of antimicrobial resistance.

Keywords: antibiotics, long-term care, ESAC

Introduction

It is widely recognized that inappropriate use of antimicrobials plays a key role in the development of multiresistant bacteria.[1] Greater effort is needed to ensure more prudent use of antimicrobials in the future so that patients do not develop untreatable infections, similar to those of the pre-antibiotic era.[2]

Antimicrobial prescribing should be optimized in all populations, including those who are resident in nursing and residential facilities, collectively described as long-term care. The European population is ageing[3] and consequently, demand for long-term care is also increasing.[4] The older population suffers from a higher incidence and severity of infectious diseases, with individuals >80 years of age being at greatest risk of complications and death from infections.[5] This is due to a number of factors including chronic illness and debilitation resulting in declining immunological function.[6] Age-related changes in metabolism often result in an increased risk of adverse effects from medication, and polypharmacy can lead to significant drug interactions particularly with antimicrobials.[7] In long-term care, and most notably in the nursing home sector, vulnerable and often ill individuals reside alongside each other and require frequent care contact with staff. Infection control systems are not optimal in nursing homes,[8] which increases the risk of acquiring and spreading infection. This results in increased consumption of antimicrobials with the potential for development of resistant bacteria.[9]

Several European studies coordinated by the European Surveillance of Antimicrobial Consumption (ESAC) team (University of Antwerp, Belgium) have investigated antimicrobial use in

hospitals[10,11] and primary care.[12] Although some researchers have investigated antimicrobial prescribing in nursing homes in individual European Union countries[13,14] and in long-term care facilities in several American states,[15] no studies have investigated antimicrobial prescribing in nursing homes on a European scale. Therefore, the aim of these ESAC nursing home point prevalence studies (PPSs) was to measure antimicrobial prescribing in a sample of European nursing homes during both April and November 2009.

Methods

Recruitment

Initially, 17 European countries (Belgium, Croatia, the Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, Malta, The Netherlands, Norway, Poland, Slovenia and Sweden) and two administrations from the UK (England and Northern Ireland) agreed to participate in the project during both PPSs in April and November 2009. In addition Hungary and Russia agreed to participate in the second PPS in November 2009.

Ethical approval was sought and obtained depending on individual countries' national requirements. Each country agreed to collect data from a minimum sample size of five nursing homes (with an eligible population of at least 250 nursing home residents), each of which participated on a voluntary basis. For the purpose of this study, nursing homes were defined as institutions where older people live temporarily or permanently and are provided with highly skilled nursing care.[16] Residential homes, sheltered accommodation, day centres, protected living facilities and highly specialized units were excluded. Each national representative or local surveyor obtained consent from nursing home managers to allow data collection to be undertaken. In several countries, ethics committee requirements meant that consent to collect relevant data was obtained from either residents or their next of kin when residents were considered by nursing staff to lack the capacity to consent. Residents were eligible to participate, providing they were present at 8.00 am in the morning on the PPS day and had been living in the nursing home for at least 24 h.

Data collection

For the majority of nursing homes in all countries, data were collected for the first PPS during one single day between 1 April 2009 and 30 April 2009 and for the second PPS during one day between 1 November 2009 and 30 November 2009. In larger homes, data collection took place over two or more consecutive days; however, all eligible residents within a distinct unit (i.e. ward or section) of the nursing home were surveyed during one single day in each PPS. In some countries data were collected by an employee from each relevant nursing home, e.g. nurse in charge, infection control practitioner, designated physician, etc. In other countries, one or several trained external surveyor(s) who had been recruited by the ESAC national representative collected the data from all of the participating nursing homes in their country. Three data collection documents were completed: the ward list, to obtain denominator data for all eligible residents in a distinct unit in the nursing homes; the resident questionnaire for any residents taking antimicrobials on the day of the survey; and the institutional questionnaire to consider nursing home-specific factors relating to antimicrobials and infection control. A brief description of these data collection instruments is shown in Figure 1 and the resident and institutional questionnaires are available as Supplementary data at *JAC* Online. However, for the purpose of this paper, only data collected in the resident questionnaire will be considered. This was completed for residents who were receiving antibacterials or antimycotics for systemic use, drugs used for the treatment of tuberculosis or nasal mupirocin for methicillin-resistant *Staphylococcus aureus* (MRSA) decolonization. All oral, rectal, intramuscular, intravenous or inhaled antimicrobials were included. Antivirals, antimicrobials for topical use (except nasal mupirocin) and antiseptics were excluded. Topical antimicrobials except nasal mupirocin were not recorded as there are difficulties in determining the dose used of topical products.

Data were obtained through examining nursing notes and medication administration records in the nursing homes. The Anatomical Therapeutic Chemical (ATC) classification system[17] was used to classify the antimicrobials prescribed into the major therapeutic groups. To ensure confidentiality, unique nursing home study and resident numbers were recorded on the questionnaires.

Data entry and analysis

Data were collected in the participating nursing homes either via paper-based forms with optical character reading, which were then sent to the ESAC coordinating centre for optical data reading, or via web-based PPS software developed by ESAC for direct data entry.

All data were then exported into SPSS version 18. The study protocol had stated that each participating country had to collect data from a minimum of five nursing homes. Therefore, if a country collected data in only five nursing homes, all data were included for the current analysis. However, for those countries that collected data from more than the minimum number, five nursing homes were randomly selected without replacement for analysis. As several countries provided data for different nursing homes in PPS2 compared with PPS1 random selection was used on both occasions. All drug data were converted into defined daily doses (DDDs). The term DDD is defined as the assumed average maintenance dose per day for a drug used for its main indication in adults.[17] All DDDs were subsequently standardized to DDDs/1000 residents/day.

Analysis was undertaken to provide descriptive statistics relating to antimicrobial prescribing in the nursing homes in participating countries and administrations.

Results

Thirty thousand and fifty-eight eligible residents from 301 nursing homes in 17 countries and two UK administrations were recruited to the study in April and 28569 residents from 265 nursing homes in 19 countries and two UK administrations were recruited to the study in November 2009. The number of participating nursing homes in each country varied greatly (range 1–116 in April and 3–105 in November). Data have not been included for Lithuania, The Netherlands, Hungary or Russia as the minimum required sample size of five nursing homes was not met. In both April and November seven countries (including England) collected data in only five nursing homes, while the remaining participating countries exceeded this minimum number during both PPSs. From the latter, five nursing homes were randomly selected as previously described. Therefore, we will describe data from 85 nursing homes in 15 countries and two UK administrations for both PPSs. For the selected sample ($n=10590$), 98.1% ($n=10388$) of nursing home residents were eligible to participate in the study in April. In November 95.1% ($n=9430$) of residents participated from the available sample ($n=9911$). Those who were excluded had been admitted within 24 h of data collection, were not present in the nursing home on the PPS day or did not provide consent (if this was a national requirement). The mean number of eligible residents per nursing home was 122 (range 16–602) in April and 110 (range 17–599) in November. In April 645 residents (6.2%)

Data collection instrument	Data collected
Ward list	- Number of beds. - Number of hospitalized residents. - Number of occupied beds. - Number of eligible residents. For eligible residents: - Number taking antimicrobials, with urinary catheters, with vascular catheters, those who are incontinent, with wounds, who are disorientated in time and/or space and are wheelchair bound/bedridden.
Resident questionnaire (for all eligible residents taking antimicrobials)	- Gender and year of birth. - Admission to nursing home ≤1 year or >1 year. - Admission to hospital in last 3 months. - Presence of urinary catheter, vascular catheter, incontinence, wounds, disorientation and whether or not wheelchair bound/bedridden. - Antimicrobial name, total prescribed daily dose, administration route, indication, where it was first prescribed, who prescribed it, whether or not a culture sample was taken before commencing the antimicrobial and the ATC classification. Recording causative microorganisms was optional.
Institutional questionnaire	General nursing home information - Ownership status, i.e. private or public. - Total number of new admissions during 2008. - Whether or not qualified nurses are present 24 h per day. Provision of medical care - Medical care provided by General Practitioner (GP) and/or medical doctor employed by nursing home. - If relevant the number of different GPs providing care in the nursing home. - If relevant the number of full time equivalent medical doctors employed. - Presence of a coordinating physician (CP). - If relevant the speciality of the CP, i.e. gerontology, general practice; number of hours CP works in nursing home per month; tasks performed by CP, e.g. training, development of infection and antibiotic policies, etc. Provision of infection control - Presence of infection control practitioner (ICP). - If relevant the number of full time equivalent ICPs employed; profession of ICP, e.g. nurse, doctor; tasks performed by ICP, e.g. training, investigation of outbreaks, feedback to GPs, etc. - Presence of infection control committee. - Official connection with hospital infection control team. - Protocol for management of MRSA carriers/hand hygiene. Antimicrobial policy - Those who are eligible to prescribe antimicrobials. - Availability of restrictive antimicrobial lists and if relevant classes of antimicrobials restricted. - Presence of antibiotic committee, whether data are available on annual antibiotic consumption, whether microbiological samples are taken to assist antibiotic choice. - Availability of therapeutic guidelines and if relevant how often the guidelines are applied.

Figure 1. Data collection instruments used during the PPS in April 2009.

were taking antimicrobials on the day of data collection and 29 residents were taking two antimicrobials simultaneously (combination therapy or treatment of two different infections) resulting in 674 antimicrobials in total being prescribed. The median and mean prevalence of antimicrobial prescribing in the 85 nursing homes was 6.3% and 6.5%, respectively, in April. In November, 450 (4.8%) residents were taking antimicrobials on the day of data collection and 19 residents were taking two antimicrobials

simultaneously resulting in 469 antimicrobials in total being prescribed. In November, both the median and mean prevalence of antimicrobial prescribing in the 85 nursing homes was 5.0%.

The average age of residents taking antimicrobials was 83 years (range 38–103) in April and 82 years in November (range 31–106) and most of the residents were female (April, 71.3%; November, 67.1%).

Antimicrobials for systemic use (ATC Class J01) accounted for 97.0% and 98.9% of the total antimicrobials prescribed in April and November, respectively, with antimycotics for systemic use (J02), antimycobacterials (J04), antimicrobials for local use (D06), i.e. mupirocin, antiprotozoals (P01) and intestinal antiinfective agents (A07) accounting for the remainder.

In April, 28.4% of all prescribed antimicrobials were in the J01C class, i.e. β-lactam antibacterials and penicillins, with co-amoxiclav (J01CR02; 40.3%) prescribed most frequently followed, in rank order, by pivmecillinam (J01CA08; 22.0%), amoxicillin (J01CA04; 19.4%), phenoxymethylpenicillin (J01CE02; 5.9%) and flucloxacillin (J01CF05; 5.4%). Antimicrobials in the J01X class (i.e. other antibacterials) were prescribed for 28.3% of all residents, with methenamine (J01XX05; 63.8%) and nitrofurantoin (J01XE01; 32.4%) accounting for the majority of prescribing.

In November, 30.3% of all prescribed antimicrobials were in the J01C class, with co-amoxiclav (J01CR02 40.1%) prescribed most often followed in rank order by amoxicillin (J01CA04; 23.2%), pivmecillinam (J01CA08; 12.0%), phenoxymethylpenicillin (J01CE02; 9.9%) and flucloxacillin (J01CF05; 9.2%). Antimicrobials in the J01X class were prescribed for 26.7% of all residents with nitrofurantoin (J01XE01; 45.6%) and methenamine (J01XX05; 43.2%) accounting for most of the prescribing.

In April, when all antimicrobials from all classes were considered, the most commonly prescribed in descending order were methenamine (17.5%), trimethoprim (11.4%), co-amoxiclav (11.1%), nitrofurantoin (8.9%), ciprofloxacin (6.8%) and pivmecillinam (6.1%). In November the most commonly prescribed antimicrobials in descending order were co-amoxiclav (12.2%), nitrofurantoin (12.2%), methenamine (11.5%), trimethoprim (7.3%), amoxicillin (7.1%) and ciprofloxacin (5.8%). Antibiotic formularies were available in 15 (17.6%) nursing homes.

Across the participating countries, the most frequently prescribed antimicrobial group in DDDs/1000 residents/day was the β-lactam antibacterials and penicillins group (J01C), which accounted for 45.0% and 42.9% of all DDDs prescribed in the nursing homes in April and November, respectively. J01C DDDs/1000 residents/day ranged from 15.9% in Finland to 48.1% in Northern Ireland in April (Figure 2) and 17.2% in Finland to 93.9% in France in November (Figure 3). The other antibacterials group, e.g. nitrofurantoin, methenamine, etc. (J01X) accounted for 16.3% of total DDDs/1000 residents/day in the nursing homes in April and 21.4% in November. Several countries, e.g. Germany, Latvia, etc. did not have any antimicrobials prescribed from the J01X group in April and November while the majority of the antimicrobials prescribed in Finland were from the J01X group in both April (60.9%) and November (60.0%).

There was large variation in overall antimicrobial prescribing in the selected nursing homes from each of the contributing countries, ranging from a mean of 1.4% in Germany and Latvia to 19.4% in Northern Ireland in April (Figure 4) and 1.2% in Latvia to 13.4% in Finland in November (Figure 5). Furthermore, large variations in prescribing were apparent within countries. This difference was most marked for Northern Ireland (range

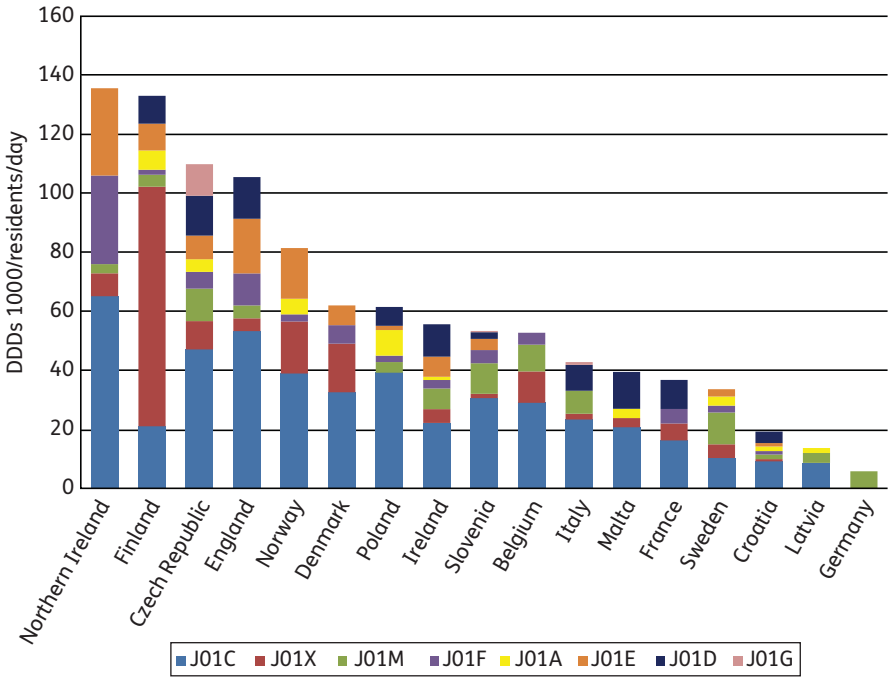

Figure 2. Patterns of prescribing of antimicrobials for systemic use (J01 class) in the selected sample of European nursing homes according to country in DDDs/1000 residents/day in April 2009.

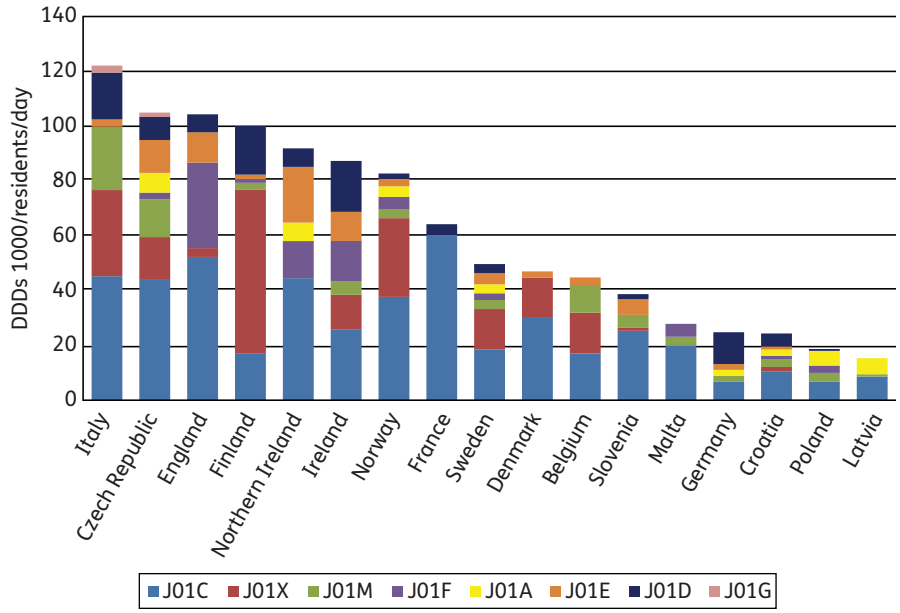

Figure 3. Patterns of prescribing of antimicrobials for systemic use (J01 class) in the selected sample of European nursing homes according to country in DDDs/1000 residents/day in November 2009.

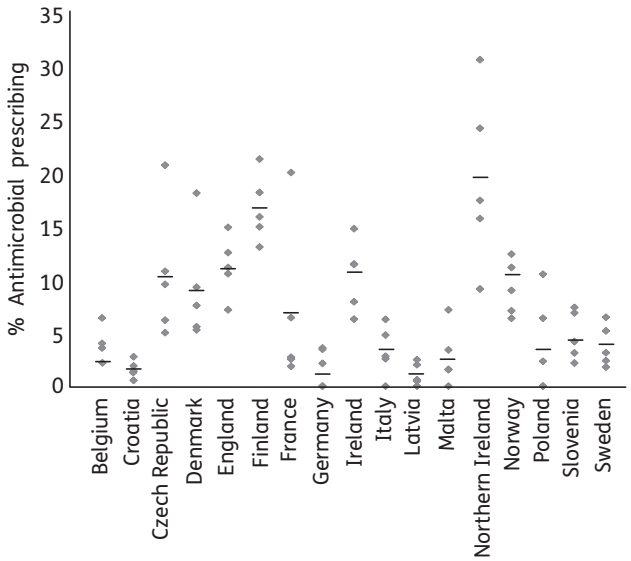

Figure 4. Variation in prescribing of antimicrobials in nursing homes between and within European countries in April 2009 (short horizontal lines correspond to mean values).

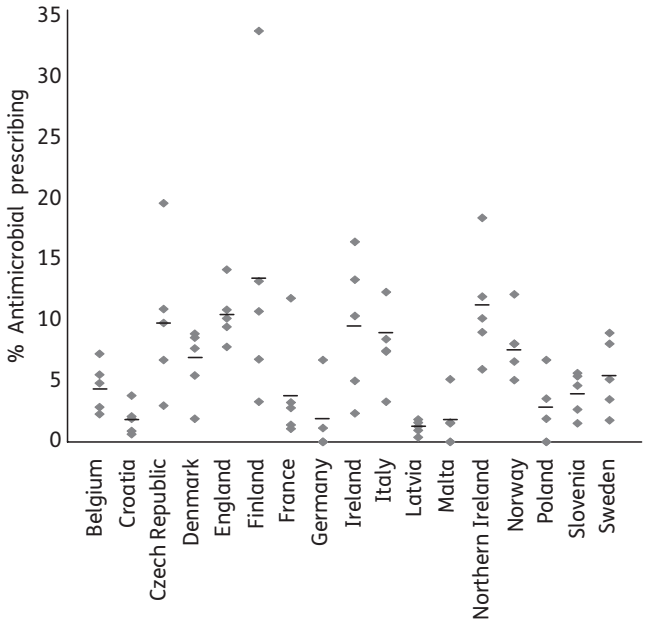

Figure 5. Variation in prescribing of antimicrobials in nursing homes between and within European countries in November 2009 (short horizontal lines correspond to mean values).

9.1%–30.6%) in April and in Finland (range 3.2%–33.3%) in November. The smallest difference between the five nursing homes in the same country was in Croatia (range 0.5%–2.8%) in April and in Latvia in November (range 0.4%–1.8%).

Discussion

To the best of our knowledge, this is first study that has reported on antimicrobial prescribing in nursing homes across Europe. The study examined prescribing in 85 nursing homes in 15 countries and two UK administrations. The key findings indicate that there is great variation across countries but also within countries. Such variations have been previously highlighted in other studies. For example, in Canada, differences have been reported in the state of Ontario where prescribing ranged from 2.9 to 13.9 antibiotic courses per 1000 patient days in 22 long-term care facilities.[18] The differences in our findings were maintained when the data were converted to DDDs/1000 residents/day ranging from

5.9 in Germany to 135.7 in Northern Ireland in April and from 15.3 in Latvia to 121.9 in Italy in November. The reasons for these dramatic differences in DDDs are not known. It is possible that in some of the participating nursing homes, unnecessary antimicrobials may have been prescribed[19] whilst in other homes, there may have been infections that were not treated.[20] Variation in antimicrobial prescribing has also been shown in a Norwegian study, which was conducted in 133 nursing homes and reported that antibacterial use ranged from 4 to 44 DDDs/100 bed days.[21] Previous work by ESAC undertaken in the community also noted variation in antimicrobial prescribing with DDDs/1000 inhabitants/day ranging from 9.8 to 31.4 in 25 countries in 2003.[22] However, direct comparison between the ESAC community study[22] and the present nursing home research cannot be made as the methodology of sampling and data collection were different. Ranking of countries in terms of antimicrobial prescribing in the nursing home study does not correlate with the rankings observed in the community study.[22] Furthermore, not all countries participated in both studies.

The most commonly prescribed antimicrobials in the participating nursing homes were β-lactams and penicillins (J01C), which reflects trends that were previously reported in the community.[22,23] Within this category, co-amoxiclav was the most widely used drug, followed by amoxicillin and pivmecillinam. For most countries a large proportion of the prescribed antimicrobials were from the J01C category. However, Finland is one of the few exceptions with the antimicrobial methenamine (from the J01X category) accounting for 48.2% of all antimicrobials prescribed in April and 48.8% of antimicrobials prescribed in November. This finding is similar to that reported from a Norwegian nursing homes study in 2003[21] where methenamine accounted for 45.5% of all antibacterial DDDs prescribed and may reflect regional prescribing preferences. This is a surprising finding as a Cochrane review concluded that there was little evidence to support the use of this agent to prevent urinary tract infections.[24] Furthermore, this drug was not prescribed at all in any of the other countries, with the exception of Denmark in April (3.2%) and Norway in April (17.3%) and November (28.9%).

There have been many calls for a reduction in inappropriate antibiotic prescribing in both primary and secondary care.[25,26] The nursing home environment is no exception and these data have revealed some interesting trends. Although this study did not assess the appropriateness of antibiotic prescribing in nursing homes, it has been documented that inappropriate antimicrobial prescribing is prevalent in the long-term care environment.[27] Therefore, there is the potential for the development of antibiotic resistance and *Clostridium difficile*. The number of *C. difficile* cases is increasing across Europe[28] and it is the primary cause of nosocomial infectious diarrhoea in nursing homes.[29] Furthermore, some recent publications have highlighted the prevalence of MRSA in the nursing home setting,[30,31] reinforcing the perception that this environment may be a reservoir for infection and resistance.[32]

Infection is more difficult to diagnose in the older population due to non-typical symptoms[7] and treatment can be challenging due to the increased diversity of causative pathogens with age.[5] Further issues with prescribing exist in the nursing home setting in many countries where general practitioners often prescribe over the telephone without examination.[33]

Within some countries, formularies and guidelines have been developed to improve antimicrobial prescribing in both primary and secondary care.[34,35] In this study almost 18% of participating nursing homes had antibiotic formularies available. However, such guidelines may not always be adhered to and this was highlighted in two Cochrane reviews that synthesized evidence as to what types of interventions were most successful in improving antibiotic prescribing. It was shown that restrictive methods, i.e. obtaining approval from specialists prior to initiating antimicrobial therapy and delaying antimicrobial prescriptions to several days after consultation were more successful than persuasive methods such as printed material, lectures, feedback and guidelines.[36,37] These approaches may go some way to enhancing antibiotic stewardship in the nursing home setting.

There are a number of limitations to this research. Firstly, the results cannot be assumed to be representative of all antimicrobial prescribing throughout European nursing homes. This paper has presented findings from only five homes from each participating country for each PPS. It is also difficult to compare prescribing between countries as the organization and delivery of nursing home care differ from country to country, with different resident populations and case mix. No adjustments were made for case mix, which may also account for some antimicrobial prescribing; however, it is evident that nursing homes are caring for an older sicker population, who in the past were more likely to have been managed in hospital geriatric wards.[8] We have no data on the duration of treatment as these was not collected as part of the study. Furthermore, the results do not allow assessment of the absolute appropriateness of prescribing. However, the study has provided the first overview of antimicrobial prescribing in this unique setting in a large number of European countries. This study has identified that considerable variation in antimicrobial prescribing exists between and within countries. The reasons for this variation are currently unknown and should be the focus of further research.

Demographic patterns are changing, with an ageing population and increased demand for long-term institutional care. Nursing homes provide a significant service to the European community and must be supported to optimize antimicrobial use and limit the development of antimicrobial resistance and *C. difficile*.

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Transparency declarations

None to declare.

Disclaimer

The information contained in this publication does not necessarily reflect the opinion or the position of the European Commission.

Supplementary data

The resident and institutional questionnaires are available as Supplementary data at *JAC* Online (http://jac.oxfordjournals.org/).

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