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Infectious Diseases in Finland 2016

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Introduction

Development of the prevention and control of communicable diseases

The Finnish Parliament has given its approval to the amended Communicable Diseases Act (www.finlex.fi 1227/2016) and Decree. The Act entered into force on 1 March 2017. Compared to its predecessor, the amended Act, which underwent eventful communication and consultation rounds, brings numerous improvements, including more specific details on the monitoring, prevention and control of infections related to treatment as well as antimicrobial resistance. Statutes concerning vaccinations to health care personnel, infection monitoring systems as well as opportunities for obtaining information in connection with outbreak investigations have been expanded in the new Act. Other amendments concerning public authority include sections on health examinations and decision-making on absences, the new sickness allowance on account of an infectious disease as well as licences for microbiological laboratories and the import of microorganisms.

The legislative reform could not yet take into account the new structures introduced by the health and social services reform. However, as the responsibility on the prevention and control of communicable diseases and infections is likely to be transferred from municipalities to counties, there will soon be a need to update the Act. In fact, the Ministry of Social Affairs and Health has appointed a group operating under the Advisory Board on Communicable Disease for this purpose.

The group's task is to prepare necessary amendment proposals. In this context, it is important to ensure not only that all necessary activities are transferred, but also that sufficient resources and responsibilities are allocated to them in the health and social service organisations of the counties. It is also important to maintain a relationship with environmental health care to ensure that there are no gaps in the prevention and control of food and water related epidemics.

A significant reform took place at the departmental level in the National Institute for Health and Welfare as the operations of infectious disease monitoring and control, microbiological specialist laboratories, vaccinations and environmental health were united into one department. The Department of Health Security began its operations on 1 January 2017 and aims to develop its operations into an entity providing good service to its customers as part of the National Institute for Health and Welfare.

International situation

After a few years (Ebola 2014–15, Mers 2015, Zika 2015), the international situation for cross-border infection threats had become slightly calmer. Meanwhile, there was a lot of development work related to the capability to prevent outbreaks and ensure that they do not evolve into extensive regional problems or even a global pandemic. Under the guidance of the Ministry of Social Affairs and Health, Finland was actively involved in promoting cross-administrative cooperation for the implementation of the obligations set in the International Health Regulations (IHR 2005) in support of the World Health Organisation (WHO). Under the guidance of WHO, an external evaluation of the functions required by the IHR was carried out in over 30 countries in 2016. Specialists from the National Institute for Health and Welfare, the Radiation and Nuclear Safety Authority, the food safety sector and the defence sector also participated in this work.

On the status of infectious diseases in Finland

In the influenza season of spring 2016, the epidemic dominant viruses were first A(H1N1)pdm09 subtype viruses and, later in the spring, influenza B viruses. The epidemic season 2016–2017 started earlier than expected and was extremely severe, and this time influenza A(H3N2) subtype viruses emerged as the epidemic dominant viruses. This influenza season was the earliest since the 2009 pandemic. The number of cases in the RSV epidemic of season 2016 was exceptionally high.

There were outbreaks of intestinal infection caused by both *Salmonella* Enteritidis as well as EHEC and EPEC bacteria, most likely caused by the consumption of sprouts (Salmonella) and food containing rocket salad. A new type of norovirus was detected, and this was connected to five separate outbreaks around Finland as well as one extensive epidemic on a cruise ship from May to June 2016. An increase in campylobacter infections and listeriosis cases in recent years caused some concern. No reason is known for this, but the incidence of campylobacter infections has also increased in Sweden in recent years.

There is also a slight increase in sexually transmitted diseases, and a record number of chlamydia and syphilis cases were reported in 2016. The majority of the cases of people of Finnish origin had been contracted in Finland.

In 2016, a national working group prepared a cross-administrative strategy on the prevention of antimicrobial resistance, which was competed in 2017 and published in May. The measures recommended by the strategy aim to reverse the upward trend in the resistance. This is a necessary step as the number of MRSA infections was significantly higher than in the previous year and the number of blood cultures also grew. By contrast, the situation of cases caused by Carbapenemase-Producing Enterobacteriaceae (CPE) continues to be moderately good although their number has nonetheless increased. In recent years, three clusters of infections caused by KPC-3 positive *K. pneumoniae* (ST512) in care institutions have been found in Finland. The number of tuberculosis drug-resistant *Mycobacterium tuberculosis* strains has also increased slightly in recent years. By contrast, the number of tuberculosis cases has not risen, as there were fewer cases than in 2015.

A similar number of severe pneumococcal infections was diagnosed as in the year before. The incidence of pneumococcal infection increased slightly in children under 5 due to the more frequent occurrence of serotypes not included in the vaccine. However, it is worth noticing that since the vaccination programme was introduced, severe pneumococcal infections caused by PCV10 vaccine serotypes have been almost totally eliminated in young children, and they continued to decline in 2016.

Almost 16,000 bacterial findings were detected in cultured blood samples from adults. It is worrying that these findings have constantly increased, particularly in patients aged 65 or over. *Escherichia coli* was the most common finding in both the working age population and in patients aged 65 and over. Other common findings included *Staphylococcus aureus*, a significant percentage of which is known to be treatment-related infections. As the population is ageing, there would be good reason to pay increasing attention to the systematic prevention and control of these infections both at the local and regional level.

An increase was observed in zoonotic diseases that follow significant year-to-year variation. More cases of Puumala virus were reported than in 2015. The vole populations carrying the virus increased especially in Southern and Eastern Finland, which was reflected as a higher number of cases. More cases of Pogosta disease were reported than in the year before. A significant increase in tuleramia cases was recorded compared to recent years; the number of these cases exceeded the total number reported in the last six years.

A significant number of cases of exposure to rabies can be observed in the infections related to tourism (60 people, mostly in Thailand and Indonesia, exposure through a dog or monkey bite). Nearly all cases of malaria originated in Africa, over half of them were connected to visiting relatives in regions with high malaria incidence. Six infections caused by the zika virus were diagnosed in Finnish tourists.

Helsinki, 7th August, 2017

Mika Salminen
Director
Department of Health Security

Respiratory infections

- In the influenza season 2015–2016, the dominant viruses were first A(H1N1)pdm09 subtype viruses and, later in the spring, influenza B viruses.
- The epidemic season 2016–2017 started earlier than expected and was extremely severe, and this time influenza A(H3N2) subtype viruses emerged as the epidemic dominant viruses. This influenza season was the earliest since the 2009 pandemic.
- The number of rhinovirus infections peaked in August–December, and almost one half of them were found in children aged under 4.
- As expected, the minor winter epidemic of 2015 was followed by a more significant RSV epidemic with an exceptional number of cases compared to earlier epidemics of a similar nature.
- More enterovirus infections were diagnosed in the autumn than in previous years, including type D68. Enterovirus epidemics also occurred in other European countries.
- The number of whooping cough cases was considerably higher than in the year before. While the highest number was found in young infants, the incidence was particularly high in young people aged 10 to 15.
- Of legionellosis patients, it was confirmed that four had contracted the infection at home or in its surroundings, and for one patient, the source of infection was the water supply system of a hospital.

ADENOVIRUS

In 2016, 915 confirmed adenovirus infections were recorded (2015: 1,134). The largest number of cases was reported in the under 5 age group (more than 500), but a moderate number was also diagnosed in the 5 to 9 and 15 to 19 age groups. In January–April and November–December 2016, slightly more adenovirus infections were reported than in the other months (83–124 cases per month). At other times of the year, the monthly numbers of adenovirus infections varied between 36 and 66 cases per month.

More than 60 types of adenoviruses are known. Some cause respiratory infections, while others cause gastrointestinal, eye or other infections. Adenoviruses are common pathogens in infants and young children, but they also infect adults.

Laboratories have various test methods for detecting adenoviruses in clinical samples. Antigen detection, virus cultures and PCR are highly sensitive and reliable methods used in specialised virus laboratories.

INFLUENZA

The peak weeks of two different influenza epidemics were recorded in 2016 that belonged to epidemic seasons 2015–2016 and 2016–2017. Two separate epidemic waves were observed in the first six months of 2016, or during influenza season 2015–2016. The dominant viruses were A(H1N1)pdm09 subtype viruses in the first wave and influenza B viruses later in the spring. In late 2016, the epidemic season 2016–2017 started earlier than expected and was extremely severe, and this time influenza A(H3N2) subtype viruses emerged as the dominant viruses.

Influenza A

In 2016, 20,889 findings of influenza A were reported to the National Infectious Diseases Register, which is almost three times the previous year's figure (2015: 7,723). In the first six months of 2016, 10,281 influenza A infections were reported to the National Infectious Diseases Register, while this figure for October–December was 10,562. In May–September, only sporadic cases of influenza A infections were diagnosed.

Season 2015–2016

The first influenza A infections of the 2015–2016 season were reported to the National Infectious Diseases Register as early as in October–November 2015. The number of cases increased after mid-November 2015. Almost 5,000 diagnoses of influenza A were reported in both January and February. Unlike in previous seasons, more than 1,000–2,000 cases of influenza A infections were reported each week. National surveillance of influenza virus infections by the National Institute for Health and Welfare led to the detection of 152 influenza A infections in the 2015–2016 season, of which 92% were diagnosed as having been caused by the influenza A(H1N1)pdm09 virus. All A(H1N1) pdm09 viruses subjected to a closer analysis were 6B.1 viruses of a new genetic type that were antigenically almost identical to the A/California/07/2009 vaccine virus of the season. During the epidemic season, only sporadic cases of influenza A(H3N2) infections were diagnosed. Genetically analysed A(H3N2) viruses belonged to two different groups (3C.2a and 3C.3a), which had a good antigenic correspondence to the A/Switzerland/9715293/2013 virus included in the vaccine.

The National Infectious Diseases Register and the national influenza surveillance of the National Institute for Health and Welfare indicate that the peak period of influenza A in 2015–2016 was seen in weeks 2 to 7. The numbers of reported influenza A cases remained at a moderately high level for several weeks. The case numbers only started showing a decline towards the end of April and beginning of May, after which only individual influenza A infections were diagnosed. In October, the numbers of influenza A cases again started to increase, indicating that the season 2016–2017 started exceptionally early.

Season 2016-2017

2016–2017 was the earliest influenza season since the 2009 pandemic. After mid-November 2016, there was a strong increase in the numbers of influenza A infections. In December 2016 and January 2017, 9,418 and 5,309 influenza A infections respectively were reported to the National Infectious Diseases Register. In weeks 49/2016–2/2017, the number of reported cases exceeded 1,000–3,000 a week. The epidemic virus was of the subtype A(H3N2). Between November 2016 and February 2017, no influenza A(H1N1)pdm09 viruses were found.

In February 2016, WHO recommended that the influenza A(H3N2) virus component be changed to A/Hong Kong/4801/2014 for the epidemic season 2016–2017, as it would be antigenically a better match with the A(H3N2) viruses circulating as epidemics.

At the beginning of the season, the virus contained in the vaccine had a relatively good correspondence to the epidemic A(H3N2) viruses, but as the season progressed, the range of viruses broadened. The viruses that circulated as epidemics represented two different genetic groups (3C.2a and 3C.2a1). Mutations occurred in the viruses of both groups that may have undermined the protection given by the vaccine. In the season 2016–2017, it was for the first time possible to monitor the effectiveness of the vaccine in almost real time by combining the data in the National Infectious Diseases Register and the National Vaccination Register.

Influenza A infections occurred in all age groups in 2016. In the period between January and April, 1.5 to 2 times more influenza A infections were reported in the age groups 0 to 4 and 25 to 59 compared to the findings reported in October–December. On the other hand, a high number of influenza A infections occurred in October-December especially in the over 75 age group (January–April: 757 compared to October–December: 3,023), but also in the age group 65 to 74. Reasons for the different morbidity of the age groups may include the fact that the dominant group at the beginning of the year was A(H1N1)pdm09 viruses, whereas towards the end of the year, A(H3N2) viruses predominated. Based on information gathered in previous seasons, it is known that during influenza A(H1N1)pdm09 virus seasons, particularly serious infections occur in young and otherwise healthy adults in working age, unlike during A(H3N2) seasons. In influenza A(H3N2) seasons, serious infections occur in older persons more often than in the other age groups, which may be reflected as higher numbers of diagnosed cases in the older age groups.

While the national vaccination programme has offered a free vaccine against seasonal influenza to children in medical risk groups since 1980, and to healthy children aged 6 to 35 months since 2007, the coverage of the influenza vaccines remains low. At best, the coverage for children aged 6 to 35 months was approximately 40% before the pandemic. After the pandemic, the vaccination coverages have been monitored based on the administered doses reported to the national vaccination register, and these figures may have some information system related shortcomings. The register data indicates that the vaccination coverage of young children was some 13% at its lowest but has increased in small steps since. The vaccination coverage was 24% in 2015–2016 as compared to 17% in 2014–2015, and in season 2016–2017, it has continued to increase to

32%. In 2016, the highest number of influenza A cases in children and young people were reported for the age group 0 to 4, especially in 2015–2016 (January–April 2016: 1,346 (in 2016: 2,100).

In those aged 65 or over, the vaccination coverage was 42% in 2015–2016, increasing to 47% in 2016–2017.

Influenza B

As in the year before, a high number of influenza B infections were reported to the National Infectious Diseases Register in 2016 (2016: 4,729 (in 2015: 5,462). The influenza season 2015–2016 was the second consecutive season in which an obvious influenza B epidemic was recorded. Influenza B infections started multiplying in early January, and subsequently, a high number was diagnosed between February and May, with sporadic cases as late as in early June. From March on, the weekly cases of influenza B exceeded the number of influenza A cases. Influenza B infections peaked in weeks 8 to 16. Between mid-November 2016 and February 2017, a small number of influenza B infections occurred steadily throughout the period. Influenza B infections occurred in all age groups in 2016.

Of the two influenza B virus lineages that have circulated the world in recent seasons, the Yamagata lineage has occurred more frequently than the Victoria lineage. For the 2015–2016 season, WHO had recommended that the Yamagata lineage virus be again included as the B virus component of the trivalent vaccine. However, the influenza B viruses that circulated in winter 2016 represented the Victoria lineage and differed antigenically from the vaccine virus (B/Phuket/3073/2017).

Due to the increased occurrence of the Victoria lineage viruses, in February 2016 WHO recommended that the Victoria lineage virus B/Brisbane/60/2008 be included in the trivalent vaccine for 2016–2017. The B viruses that circulated in late 2016 almost exclusively represented the Yamagata lineage.

Vaccine for the epidemic season 2017−2018

At the end of February 2017, WHO issued a new vaccine recommendation for the 201–2018 epidemic season in the Northern hemisphere. This recommendation was based on the data on the epidemic situation collected by early February and an assessment of the type of influenza viruses that were likely to circulate in the forthcoming epidemic season. The new WHO recommendation only concerned replacing the influenza A(H1N1)pdm09 component (A/California/07/2009) by the A/Michigan/45/2015 virus. The recommendation proposed that the influenza A(H3N2) virus component, or the A/Hong Kong/4801/2014 virus, should not be replaced. The use of the Victoria lineage B/Brisbane/60/2008 virus as the influenza B component was further recommended in trivalent vaccines. In addition to these, B/Phuket/3073/2013, another influenza B virus of the Yamagata lineage, was recommended for quadrivalent vaccines.

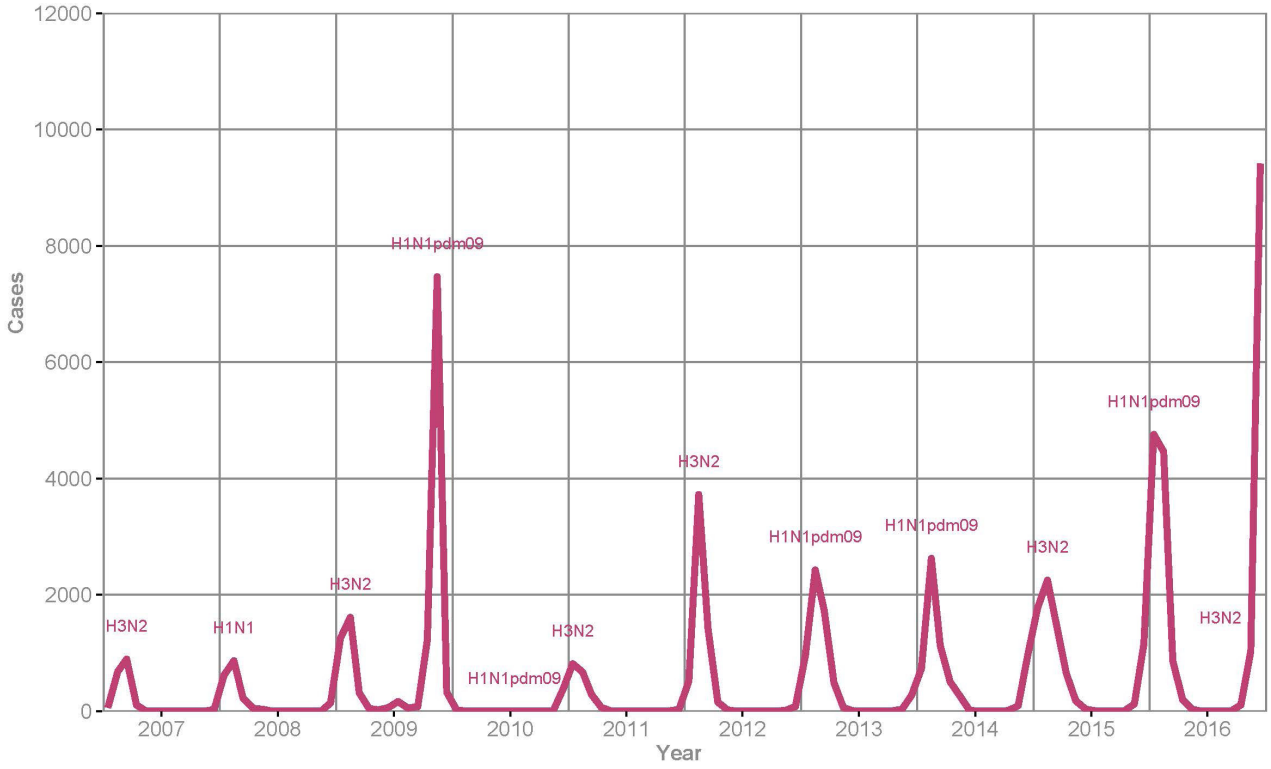

Figure 1. Cases of influenza A by month and epidemic virus serotypes, 2007–2016 (no. of cases).

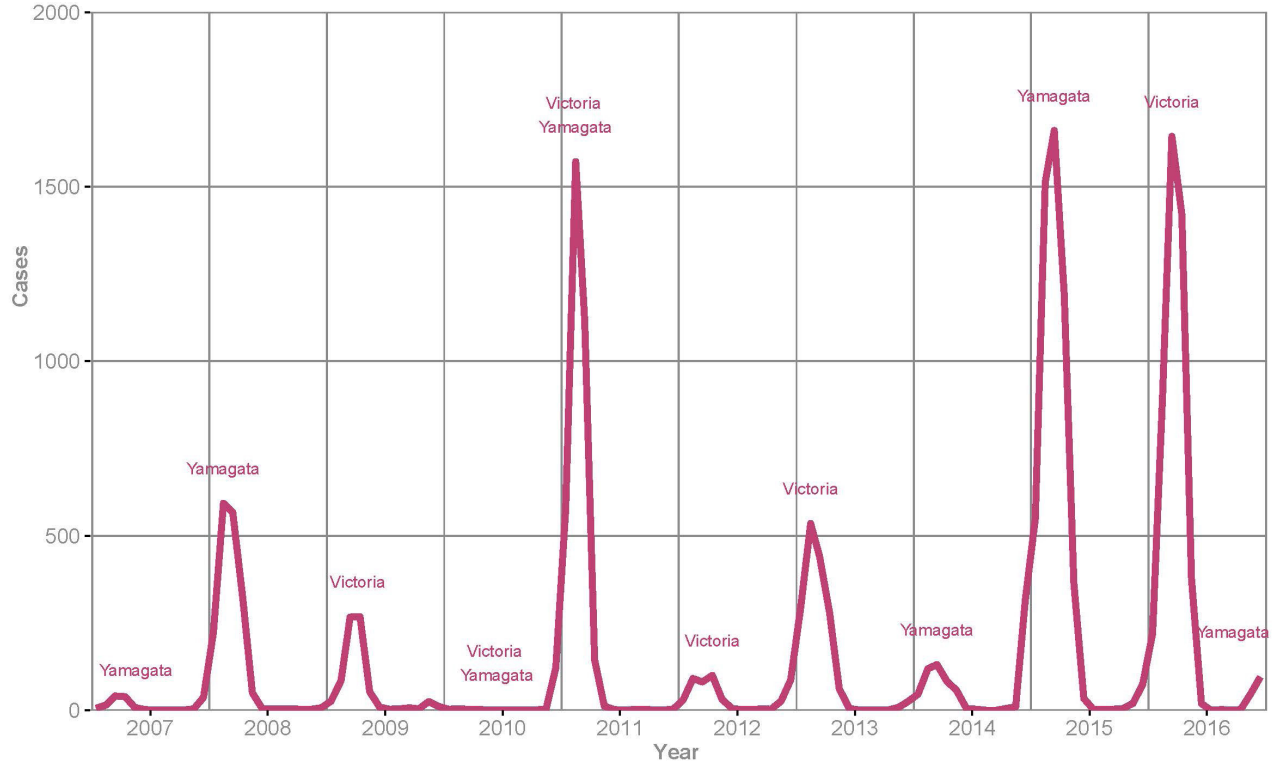

Figure 2. Cases of influenza B by month and epidemic virus serotypes, 2007–2016 (no. of cases).

PARAINFLUENZA

Parainfluenza viruses are grouped under one heading in the National Infectious Diseases Register, even though laboratories usually differentiate between parainfluenza viruses 1, 2, 3 and 4. In 2016, 604 parainfluenza infections were confirmed (2015: 508), most of these in the 0 to 4 age group (266 cases). A moderate number was also reported in the 5 to 9 age group and those aged 65 and over. The case numbers started increasing in November–December 2015 and remained at a relatively high level during the first six months of 2016. The monthly case numbers (64–95 cases/month) peaked in January–June.

Parainfluenza virus infections are found in all age groups. The first parainfluenza infections in children can lead to a severe condition that may require hospitalisation. In an older child or adult, the symptoms of a parainfluenza infection are typically much milder. They often present as an ordinary upper respiratory tract infection and do not necessarily require laboratory diagnostics. In special groups, however, such as immune deficiency patients, parainfluenza viruses may cause severe symptoms.

RHINOVIRUS

In 2016, 1,145 confirmed rhinovirus infections were recorded (2015: 1,088). The numbers were highest in August–December (95 to 195 per month), peaking in September. At other times, rhinovirus infections occurred at a steady rate every month (48 to 84 per month). More than 50% of these infections were diagnosed in children under the age of 4.

Over 150 types of rhinovirus are known. They are the most common cause of mild respiratory infections. While rhinovirus infections are the most common in young children, they are present in all age groups. Since August 2013, rhinoviruses have been included in the surveillance of respiratory virus infections conducted by the Infectious Disease Control unit of the National Institute for Health and Welfare, which may partly contribute to the increase in the number of cases from 2013 to 2016. Laboratories use a PCR test to detect rhinoviruses in clinical samples. This test is highly sensitive and reliable. Specialised virus laboratories are also able to culture rhinoviruses.

RSV

In 2016, 4,946 cases of RSV confirmed by laboratory tests were reported to the National Infectious Disease Register (2015: 2,436). As part of long-term surveillance, a major RSV epidemic is observed in Finland every other winter, often starting in November–December. In addition, minor epidemics occur between the major ones. As expected, the major winter epidemic of 2015 was followed by a minor epidemic that began in November–December 2015 and continued until May. During the winter epidemic of 2016, an exceptionally high number of cases was recorded compared to previous major epidemics. During the epidemic, the number of RSV cases was highest in January to February (1,559 and 1,977 per month respectively), peaking at over 500 cases per week. The peak of the RSV epidemic coincided with the peak numbers of influenza A cases in January and February. Individual cases of RSV infection were diagnosed during the summer. In December, the number of RSV cases again began to increase, indicating the start of another RSV epidemic.

The majority of RSV cases (approximately 60%) were found in children aged 0 to 4. Slightly more cases of RSV, or nearly 20%, were reported in patients aged over 75 than in other age groups. Although RSV infections are present in all age groups, cases requiring hospitalisation and laboratory diagnostics mainly involve infants and young children, and to some extent also older people.

Reliable quick tests for RSV diagnostics have been developed for use at health centres, outpatient clinics and hospitals. In a hospital environment, RSV is easily transmitted between patients. Quick tests make it easier to identify RSV infections and therefore to prevent further transmission. Specialised virus laboratories increasingly use genetic replication methods for diagnosing RSV.

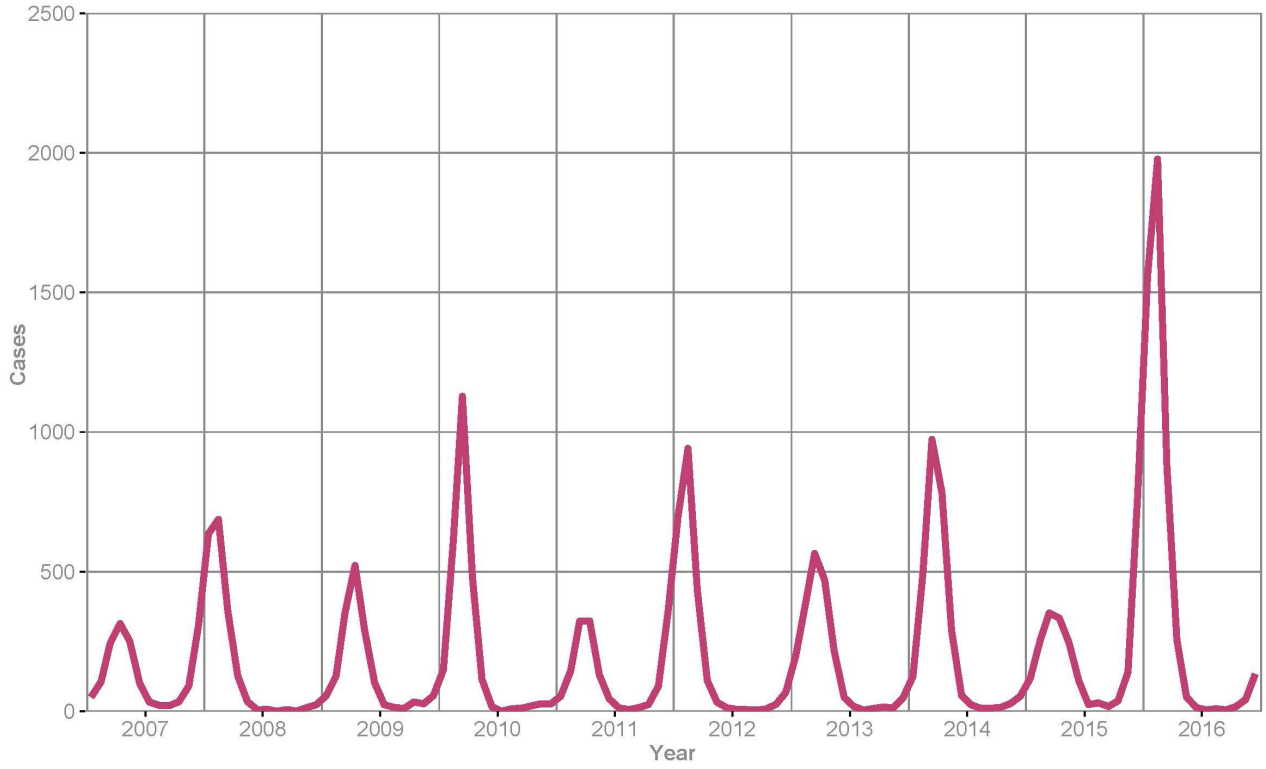

Figure 3. Cases of RSV by month, 2007–2016 (no. of cases).

ENTEROVIRUS

In 2016, 336 cases of enterovirus infection were reported to the National Infectious Diseases Register, considerably more than in 2015 (119) or 2014 (298). Most cases were found in the autumn, which is typical of enteroviruses, and 83% of the cases were diagnosed in August–December. The epidemic peaked in September, with one third of the year's cases being reported in that month (112, 33%). The majority of those infected were children: 145 (43%) were aged under 5, and 85 (25%) were aged 5 to 14. Enterovirus infections were diagnosed in all of the 20 hospital districts. The largest numbers of cases were found in the hospital districts of North Ostrobothnia (85), Southwest Finland (56), North Savo (33), North Karelia (29) and Helsinki and Uusimaa (25). In other hospital districts, the number of enterovirus infections diagnosed remained below 20.

An increased number of infections caused by enterovirus D68 were diagnosed in the autumn in many hospital districts. The highest number, mostly respiratory infections that required hospitalisation in children, was found in Southwest Finland. Around ten enterovirus D68 cases were confirmed in the Helsinki and Uusimaa Hospital District. Most of these were respiratory infections in children. During the autumn, young patients also displayed many symptoms typical of the hand, foot and mouth disease. Sporadic infections with severe symptoms caused by enteroviruses coxsackie A6 and coxsackie B5 were also diagnosed in children.

Enteroviruses also caused epidemics in other parts of Europe in 2016. In France, a higher than usual number of serious enterovirus infections in children was recorded in May to October. Serious neurological symptoms were caused by enterovirus types A71 and D68. In Sweden, an increase in infections caused by enterovirus D68 was reported. The majority of those who were infected were young children, and severe symptoms were found in 13% of them. The Swedish epidemic peaked in August–September.

WHOOPING COUGH

In 2016, 432 cases of whooping cough were reported to the National Infectious Diseases Register (7.9/100,000), which is a significant increase on 2015 (165). As before, the cases were most common in the 0 to 14 age group, with a particularly high incidence in the age group 10 to 14 (28.5/100,000).

Thirty-two cases were diagnosed in patients under 12 months of age, and 14 of them were under 3 months of age, thus too young to have been vaccinated. The diagnosis of patients aged under 12 months was principally based on a PCR test (21/32, 65%). For most patients of other ages, the diagnosis was made on the basis of antibody testing.

Of the children 3 to 23 months of age who contracted whooping cough and whose vaccination data was available (26), two had not been vaccinated as indicated by their age, two had contracted the infection just before they were due the first vaccine, 15 had received one to two doses of vaccine containing acellular component of pertussis, and in seven, the vaccine failed to protect them from the disease. A total of 14 children contracted the infection when aged under 3 months. In 2016, three of the 26 *Bordetella pertussis* strains isolated did not produce pertactin.

As previously, the incidence of whooping cough varied considerably by hospital district (0–15.4/100,000). The incidence was highest in the hospital districts of North Karelia (15.4) and Helsinki and Uusimaa (12.8). No cases were diagnosed in Åland.

Choosing an optimum vaccination strategy for whooping cough is challenging, as the acellular vaccines widely used in Western countries are incomplete in terms of their efficiency and duration. A booster for six-year-olds was added to the national vaccination programme in Finland in 2003. In 2005, the whole-cell vaccine was replaced with an acellular combination vaccine containing the Bordetella pertussis antigen for children in the age groups covered by child care clinics. Until 2007, adolescent vaccinations were given between the ages of 11 and 13. Since 2009, the recommendation has been to vaccinate adolescents at the age of 14 to 15, i.e. from the 8th grade of comprehensive school up. Due to this transition, very few of these vaccinations were administered between 2009 and 2011. This created a temporarily less well protected cohort in adolescent age groups. Illness in infancy indicates insufficient herd immunity. A whooping cough vaccine for conscripts beginning their military service was added to the Finnish Defence Forces' vaccination programme in summer 2012. Consequently, the incidence of whooping cough has decreased considerable among those in the age for participating in military service.

So far, Finland has been spared an extensive whooping cough epidemic that generated more than 40,000 cases in the United States and almost 10,000 cases in the UK during 2012. In 2012, the year the epidemic occurred, it was discovered on the basis of an extensive strain collection in the United States that 60% of *B. pertussis* strains did not produce pertactin. Both countries initiated a whooping cough vaccination campaign for pregnant women, resulting in a significant reduction in the number of whooping cough cases in young infants. With respect to Finland's neighbouring countries, in Sweden the number of whooping cough cases increased almost threefold in 2014 and remained high in 2015 and 2016 (>600 cases).

The National Institute for Health and Welfare will publish a working paper in spring 2017 containing an expert assessment of the epidemiological situation of whooping cough in Finland and other Western countries, proposals for measures, and different vaccination strategies to be followed if the incidence of whooping cough were to increase substantially in Finland.

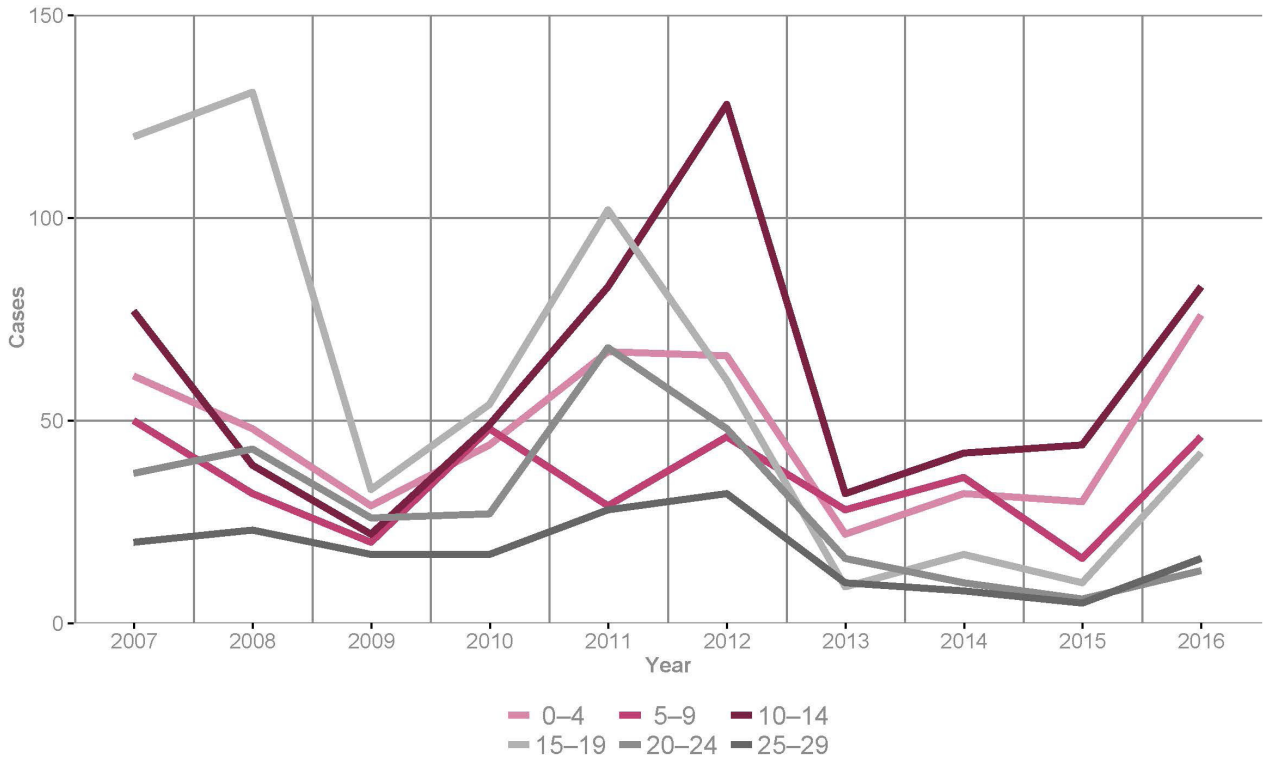

Figure 4. Cases of whooping cough in children's and young adults' age groups, 2007–2016 (no. of cases).

CHLAMYDIA PNEUMONIAE

In 2016, 261 cases of *Chlamydia pneumoniae* were reported based on laboratory verification, mainly antibody testing. This figure has remained relatively stable over the last five years. The highest incidence was reported in the hospital districts of East Savo, Central Ostrobothnia and Vaasa, while the number of cases was the highest in the Helsinki and Uusimaa Hospital District (74). The number of reported infections was highest in the age groups 5 to 24 (46% of cases) and 35 to 59 (40%).

LEGIONELLA

In 2016, 26 cases of legionellosis were reported to the National Infectious Diseases Register, of which 9 were based on the detection of the antigen in urine, 7 on a sputum test, 1 on a PCR test of a needle biopsy and 11 on serological methods. Further investigation revealed that the clinical presentation was consistent with legionellosis in 15 patients, whose chest X-rays revealed changes indicative of pneumonia. The average age of patients was 60 (variation 17 to 87) and 10 (67%) of them were male. Nine (60%) individuals had contracted the infection while travelling abroad, and six (40%) in Finland. Two of the cases proved fatal.

The sources of six cases of infection were examined more closely through environmental samples. Legionella bacteria were detected in domestic (4/7) and hospital (1/3) water supply systems. As the source of infection in four patients was confirmed the home or its close surroundings (home, free-time residence, lawn compost consisting of sewage slurry and peat), and in one patient, the water supply system of a hospital. In three cases, the source of infection was confirmed by genetic analysis of the patient and environmental strains (*Legionella pneumophila* bacteria serotype 1, *L. pneumophila* bacteria serotype 5, *L. anisa*). In two cases there was strong epidemiological evidence (*L. longbeachae, L. pneumophila* bacteria serotype 1). The homes of two patients who had been travelling abroad were investigated, but no source of infection was found. This was the first time that whole genome sequencing (WGS) was used for the genetic comparison of strains.

According to the European guideline for legionella, the threshold for measures requiring the cleaning of household water supply is more than 1,000 cfu/l of legionella. According to the National Building Code of Finland, section D1, the hot water temperature must

be 55 to 65°C, and the recommended maximum temperature of cold household water is ≤ 20°C. The water temperatures on the premises where the water system was found to be the cause of the infection did not comply with these recommendations. Corrective action was taken on all of these premises. Especially on larger hospital and hotel premises, water turnover rates may also vary, which makes the target water temperature more difficult to maintain. Particular care should be taken when using vaporisers and air humidifiers, and sterile water should be used in their maintenance operations as far as possible. Compost and lake water are also potential sources of infection. When spreading compost, attention should be paid to working methods, and protection from the dust emitted by the compost may be needed.

Accommodation data relating to all of the patients who fell ill abroad was reported to the ELDSNET database (European Legionnaires' Disease Surveillance Network), which collects data on travel-related cases of legionellosis. European surveillance indicates that the majority (60 to 70%) of cases are of community origin, some 20% are associated with travel, and fewer than 10% originate in hospitals.

In Finland, cases of legionellosis are traditionally linked with travel, even if its role in Finnish cases has also had great variations (20 to 100%), and Legionella is therefore often overlooked as a potential pathogen in pneumonia cases of domestic origin. Fast and sensitive molecular methods are available for the diagnostics of Legionella, as well as newer urine antigen tests that also detect other types than *L. pneumophila* serotype 1. In cases of exposure at home, in hospital and in the workplace, awareness of Legionella as a potential cause of the infection is likely to play a critical part. Correct diagnosis is crucial for the targeting of treatment and any prevention measures. Culturing to establish the Legionella strain in question continues to be important for establishing the source of infection.

MYCOPLASMA PNEUMONIAE

In 2016, the total number of *Mycoplasma pneumoniae* cases confirmed in laboratory tests was 2,742. During previous epidemics, more than 4,600 cases were reported in 2012, and more than 7,800 in 2011. In late 2015 and again in early 2016, numerous *M. pneumoniae* cases were diagnosed in Denmark, confirming a double-peak epidemic. The situation in Finland has been similar to other European countries on many occasions. This time, however, no obvious epidemic was observed during the corresponding period, even if an increase in the number of cases can be seen in the statistics towards the end of both 2015 and 2016. It may be that following the high numbers of cases during the previous major epidemic (2011–2012), 'minor' epidemics have gone unobserved.

The highest number of *M. pneumoniae* cases are diagnosed in the 5 to 19 age group (56 % of cases). As in previous years, the majority of cases (almost 900) were recorded in the Helsinki and Uusimaa Hospital District, in which almost twice as many cases were reported compared to the previous year. The incidence was the highest in the Hospital Districts of East Savo, Vaasa and North Savo (>70/100,000 in all districts).

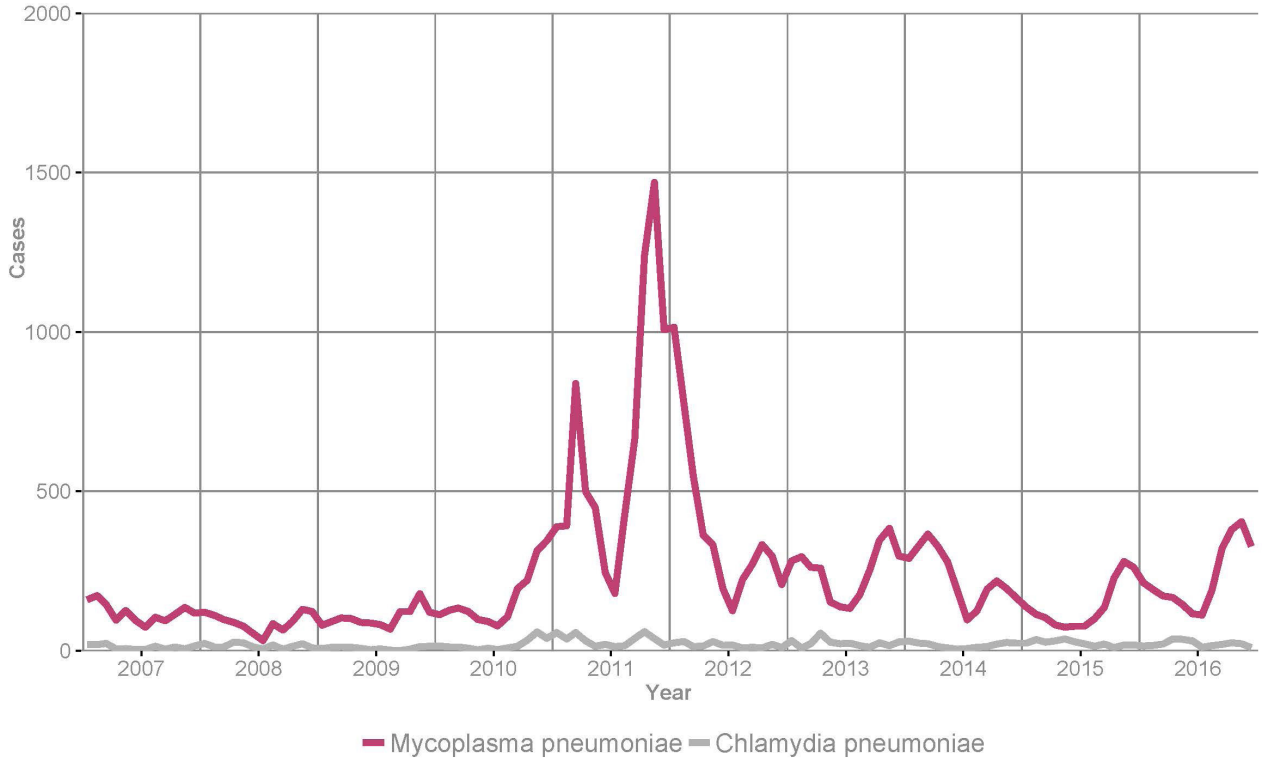

Figure 5. Cases of Mycoplasma pneumoniae and Chlamydia pneumoniae by month, 2007–2016 (no. of cases).

Gastrointestinal infections

- In the March to May period, 22 people in Pirkanmaa contracted an infection caused by *Salmonella* Enteritidis bacteria. The most probably source of the infections was bean sprouts of a foreign origin, the seed batches of which were recalled in the Finnish market.
- As in previous years, the highest number of norovirus infections was recorded in January to May. In late winter, a virus strain of a new type was found in five epidemics occurring in different parts of Finland.
- A new norovirus type caused a wide-spread gastroenteritis epidemic on a cruise ship in May–June 2016.
- In August, more than 200 people in the Helsinki Metropolitan Area contracted gastroenteritis caused by EHEC and EPEC bacteria. EHEC and EPEC strains corresponding to patient samples were found in dishes containing rocket salad that were served at events in which the patients had participated.
- A water-borne epidemic found in Äänekoski in October originated in an air valve unit that contained the air vents for both household water and sewage. Some 400 households were exposed to the contaminated water.
- While the incidence of *Clostridium difficile* cases has remained relatively stable over the last six years, variations between different hospital districts remain significant.
- More than one half of EHEC infections had been contracted in Finland. Hemolytic-uremic syndrome was diagnosed in eight of the patients, and it was suspected that ten people had contracted the infection on a farm.
- There has been a clear increase in domestic campylobacter infections in recent years. The reason for this is not known.
- There has been a clear increase in the number of listeriosis cases since 2009. Five clusters of a few cases were confirmed by means of whole genome sequencing.

FOOD- AND WATER-BORNE OUTBREAKS

Municipal outbreak investigation working groups report suspected food- and water-borne outbreaks to the electronic register (RYMY) maintained by the National Institute for Health and Welfare and the Finnish Food Safety Authority Evira. In 2016, 89 notifications of suspected cases were entered in the RYMY system (2015: 52). The National Institute for Health and Welfare contacted the municipal outbreak investigation working group with regard to 21 notifications. Several other gastrointestinal infection clusters were confirmed as well.

In January, 28 people contracted gastroenteritis at a sports institute in Western Finland. The symptoms, duration of the illness, incubation period and laboratory findings indicated that the epidemic was caused by norovirus. An employee of the sports institute became ill simultaneously with the customers, and norovirus GI.P3 was identified in the employee's stool sample. Customers of the sports institute, their family members and institute employees had already displayed symptoms of gastroenteritis before the epidemic was detected. Consequently, the infections may have been contracted from contaminated surfaces.

An epidemic caused by *Salmonella* Enteritidis was confirmed in Pirkanmaa in March–May: the typing results of strains in 22 patients were a match. The results of a survey and tracing of products indicated that bean sprouts of a foreign origin were the probable source of the infections. The seed batches of these sprouts were recalled in the Finnish market.

GII. P16/GII.2, a new type of norovirus, caused a wide-spread gastroenteritis epidemic on a cruise ship

in May–June 2016. A questionnaire study indicated that more than 250 passengers and staff members had contracted the infection. The response rate among passengers was as low as 8%, and it is thus likely that the number of passengers who fell ill was considerably higher. The infections spread through contact transmission, and passengers who became ill on the ship maintained the contamination of surfaces. Additional cleaning and disinfection as well as isolation of cabins were started immediately after the epidemic was detected, and passengers were informed of the importance of hand hygiene.

In August, more than 200 people in the Helsinki Metropolitan Area contracted gastroenteritis caused by EHEC and EPEC bacteria. None of them were hospitalised. In laboratory tests, 31 EHEC and 62 EPEC infections were confirmed. Several different EHEC and EPEC strains were isolated in the patients (EHEC ONT:H11, EHEC O166:H28, EPEC O111:H8-, EPEC O171:H25 and EPEC ONT:H21). EHEC ONT:H11 and EPEC O111:H8 strains matching the patient samples were found in dishes containing rocket salad served at events in which the patients had participated. By means of a questionnaire study, a link was established between eating foods containing rocket leaves and contracting gastroenteritis. The rocket leaves had been sold in catering packs around Finland. The epidemic originated from events organised by a catering company operating in the Helsinki Metropolitan Area.

A water-borne epidemic detected in Äänekoski in October originated in an air valve unit that contained the air vents for both household water and sewage. A pipe breakage in the system led to a pressure drop, as a consequence of which sewage leaked into the domestic water pipes. Some 400 households were exposed to the contaminated water. In the early phase of the epidemic, sapovirus was diagnosed in patients, and in tests conducted due to prolonged symptoms, *Dientamoeba fragilis* protozoa were confirmed. The extent of the epidemic was investigated by means of a questionnaire study. The analysis of the survey results remains incomplete.

CLOSTRIDIUM DIFFICILE

Of the 5,224 cases of *Clostridium difficile* reported in 2016, 97% involved a toxin-producing strain or toxin gene findings. Women accounted for 57%, people aged 75 or over for 47%, and under 15-year-olds for 4% of the cases; 2% concerned under 2-year-olds. The age and gender distributions have remained similar for a number of years. The incidence of the infection was 92/100,000 inhabitants. This figure has remained relatively stable for the last 6 years (94 to 101/100,000). Differences in incidence between hospital districts remained significant (59 to 183/100,000). The hospital districts may be going through different stages of the epidemic, but differences may also be found in the use of antimicrobials, the rate of sample-taking, the methods used and the actions taken to control infections.

Findings were reported by 22 laboratories, the four largest once submitting over one half of these reports. The rising trend in the use of nucleic acid detection tests, which started in 2014, continued in the selection of laboratory methods: the proportion of these tests increased in 2014–2016 (34–60–74%). There was a corresponding decline in the use of cultures. In 2013, 90% of the findings were cultured, but in 2014–2016, only 52%, 39% and 23% of the findings were obtained using this method. Most laboratories still have capabilities for using cultures, however, which allows the typing of the strains, for example in case of a suspected epidemic. The proportion of antigen findings remained unchanged from the previous year (10%).

The National Institute for Health and Welfare types strains related to suspected epidemics and severe individual cases. The 1,771 strains typed in 2008–2015 represent 146 different ribotypes, of which almost one half were sporadic, or individual strain types. The range of the most common ribotypes has remained relatively stable, and an international ribotype name is given to over 90% of the strains. The remainder are given a Finnish type name. The proportion of ribotypes 027 and 001 has declined, while the percentage of ribotypes 078 and 002 has increased. Of interest have also been strains with a toxin gene profile similar to the so-called hypervirulent ribotype 027 (A, B and binary toxins, 18bp deletion in the tcdC gene) but with a different ribotype profile. They include ribotypes 016, 134 ja 176 which, however, remain rare.

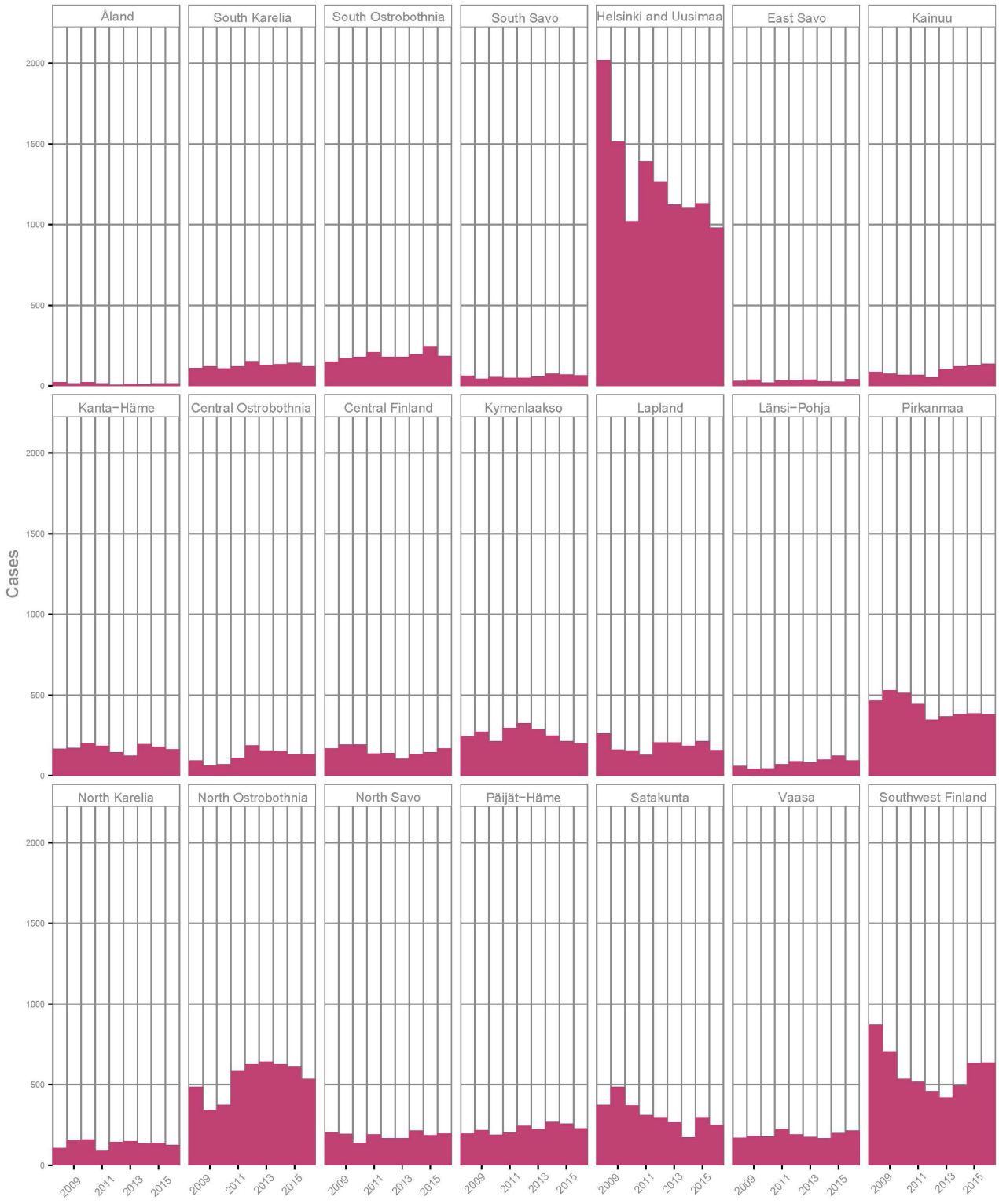

Figure 6. Cases of Clostridium difficile by hospital district and by year, 2008–2016 (no. of cases).

ENTEROHEMORRHAGIC ESCHERICHIA COLI (EHEC)

A total of 144 cases caused by enterohaemorrhagic *Escherichia coli* (EHEC) were reported to the National Infectious Diseases Register. The number of EHEC infections almost doubled from the year before (2015: 74). The incidence was 2.7/100,000 inhabitants across the country, and the highest incidence was recorded in the 0 to 4 age group (7.0/100,000). The highest number of cases was reported in the Helsinki and Uusimaa Hospital District (incidence 5.4/100,000). A wide-spread EHEC epidemic occurred in the area, in which rocket salad was confirmed as the cause of the infection (see a more detailed description in the section on Food- and water-borne outbreaks).

There has been a clear increase in the number of EHEC infections since 2013. Changes in the laboratory diagnostics of EHEC explain the higher number of infections: it is likely that the increasing number of PCR tests has also resulted in higher sensitivity in detecting epidemics. The reporting criterion of EHEC cases is a microbe finding confirmed by culture. Since the PCR test was introduced, some PCR findings not confirmed by culture have also been reported to the National Infectious Diseases Register; in 2016, ten of such findings were reported.

60% (87) of the infections were classified as being of domestic origin. Since 2014, information on symptoms and exposure relating to EHEC infections of domestic origin has been collected using an electronic interview form completed by municipal officials responsible for infectious disease control. The interview data indicates that eight patients were diagnosed with hemolytic uremic syndrome (HUS). Ten EHEC infections had suspected links to contact with a farm, and in two cases, identical EHEC O157 strains were found in the patients and samples taken from the farm.

In compliance with the Communicable Diseases Act, laboratories attach a microbe strain or a sample to their EHEC notifications. The bacterial cultures of 86 (64%) EHEC cases were sent to the National Institute for Health and Welfare's laboratory and confirmed using the PCR test. Strains of serotype O157:H7 caused a total of 28 cases (33%). Seven O157 strains fermented sorbitol. Eighteen of these strains were positive for both stx1 and stx2 genes (all of stx subtype 1a, 2c), while ten had the stx2 gene only (seven strains of stx subtype 2a and three strains of stx subtype 2c). The O157 strains were divided into seven phage types, PT 8 being the most common. Three clusters of infection with four to five cases each caused by the O157 strain were diagnosed by whole genome sequencing. One of the clusters was caused by a sorbitol-positive strain.

There were 58 cases of serogroup Non-O157. In total, 21 serogroups were diagnosed, of which 13 only with the WGS method. The most common serogroups were O26 (8 strains), O55 (4), O103 (4) and O145 (4). The most common stx subtypes were stx2a and stx1a. Three clusters of infection with three to ten cases each caused by the non-O157 strain were diagnosed by WGS: O145, O55 and NT. Ten of the strains linked to the epidemic caused by rocket salad and three other strains could not be serogrouped by the traditional method based on agglutination or WGS.

The strains of six HUS cases were obtained for typing. Three were caused by serotype O157:H7, two by O26:H11 and one by O55:H7. All strains were positive for the eae gene, five had an stx subtype 2a, and one had an stx subtype 2c.

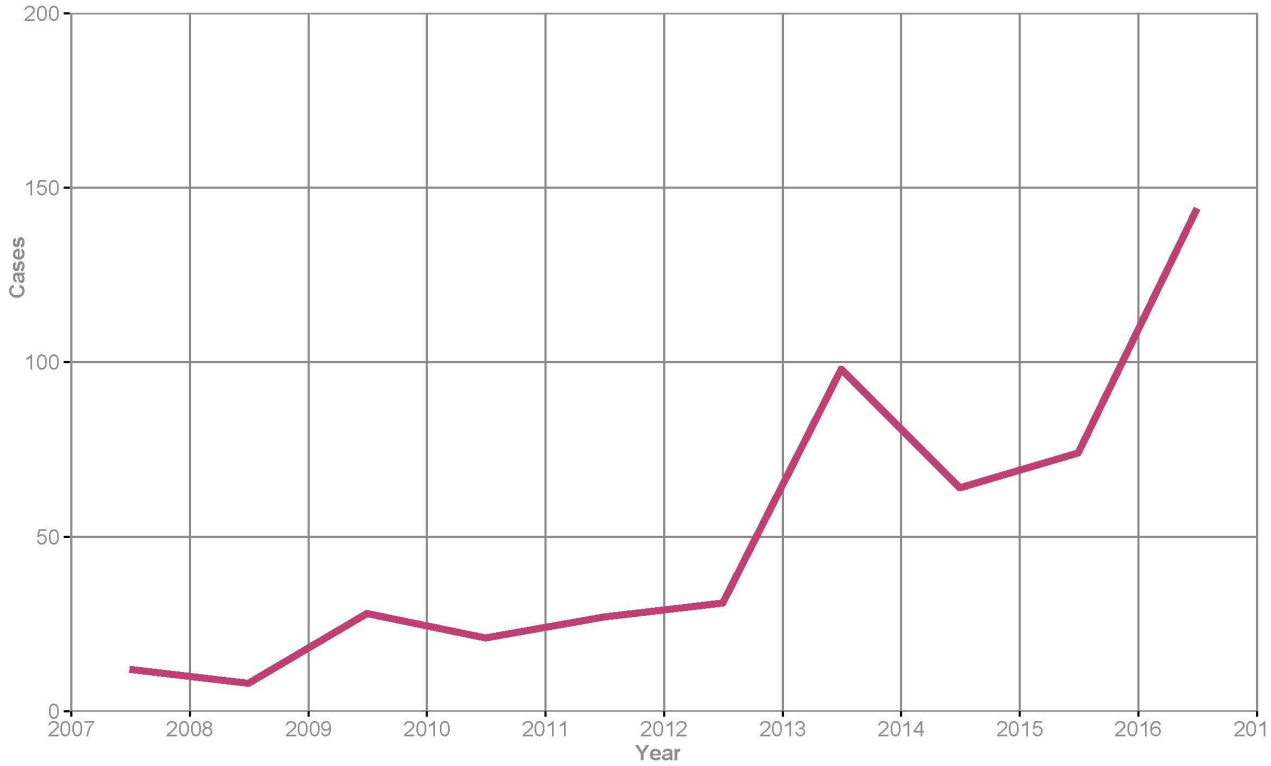

Figure 7. EHEC cases by year, 2007–2016 (no. of cases).

CAMPYLOBACTER

Campylobacter is the most common bacterial cause of gastrointestinal infections in Finland. In 2016, 4,637 findings of campylobacter were reported (2015: 4,589). *Campylobacter jejuni* was by far the most common type of campylobacter (3,928), while 331 cases of *C. coli* were reported. The type was not specified in 122 cases.

The incidence in the entire population was 85/100,000. Men accounted for 54% of the cases. The highest number of infections was reported in the 25 to 29 age group (incidence 144/100,000). Incidence was highest in the Helsinki and Uusimaa Hospital District (incidence 120/100,000). Seasonal variation was typical for campylobacter, as the incidence was highest in July–August.

In 45% of the cases, data was lacking on the country of acquisition. Of the infections, 21% (974) were of domestic origin. The number of domestic infections has increased clearly since 2010. The reason for this is not known. More information on the sources of campylobacter infections would be necessary to target prevention measures.

Whole genome sequencing was used for laboratory testing of strains that were linked to suspected infections contracted from unpasteurised milk in July and a water-borne epidemic in August. The *C. jejuni* strain in a patient who had consumed unpasteurised milk was found to be similar to the strains isolated in fecal samples from bovines on the farm that produced the milk and in an environmental sample. Two *C. jejuni* strains linked to the water-borne epidemic in patients were confirmed to be identical, but no campylobacter were found in the water.

LISTERIA

In 2016, a total of 67 systemic infections caused by the bacterium *Listeria monocytogenes* were diagnosed (2015: 46). Of these patients, one half were aged 74 or over, and 57% (38) were women. The listeria cases were spread out across the country, excluding one hospital district. For the time being, information on pregnancy is not being reported to the National Infectious Diseases Register. However, one pregnancy-related listeria infection was diagnosed based on an interview with the patient. Upon the introduction of electronic notification of infectious diseases by physicians, surveillance data for listeriosis will also be specified.

There has been a clear increase in the number of listeriosis cases since 2009. The reason for this is not known. Listeria infections are food-borne, and foods with a high risk include animal and plant based products and ready-made foods that are refrigerated for long periods. Listeria bacteria may occur in food production environments and contaminate a product after the heat treatment that is part of the production process. In Finland, foods with a particularly high risk include dry-cured and cold smoked fish products. In 2010, dry-cured salmon was confirmed as the source of an epidemic, and in 2012, an epidemic was caused by aspic.

The *L. monocytogenes* strain isolated from the blood and/or cerebrospinal fluid of 65 patients arrived for typing at laboratory. Of these strains, 44 (67%, in 2015: 82%) were of serogroup IIa, two of serogroup IIb, five of group IIc ja 14 of group IVb. The strains represented 27 MLST types, the most common ones of which were ST206 (6 strains), ST37 (5) and ST9, ST18, ST6 and ST1 (4 strains each). Five clusters of at minimum three cases each were confirmed by whole genome sequencing. The largest ones were serotype IIa, MLST 206 (6 cases in January–November) and serotype IVb, MLST 6 (4 cases in September–December). Strains from both clusters were additionally found in early 2017. Five EPIS (Epidemic Intelligence Information System) queries from ECDC concerning listeria were received. Three of these strains were compared to the Finnish strains based on sequencing or PFGE. None of the strains occurred in Finland. PFGE comparisons were not anymore carried out after the first quarter of the year.

SALMONELLA

In 2016, a total of 1,505 salmonella cases were reported (2015: 1,656), of which 55 % were detected in women. The annual incidence in the entire country was 28/100,000. The incidence was highest in the Helsinki and Uusimaa Hospital District (36/100,000) and the lowest in the East Savo Hospital District (0.5/100,000). The highest number of infections was reported in the 20 to 24 age group. *S.* Typhi, which causes typhoid fever, was identified in three persons. Two cases of *S.* Paratyphi (Paratyphi A), which causes paratyphoid fever, were found. All patients had been travelling in Asia.

The bacterial strain of a total of 1,474 cases of salmonella was sent to the National Institute for Health and Welfare. The number of strains was lower than in the previous year (1,583). Of these strains, 1,183 (80%) were of foreign and 259 (18%) of domestic origin. In 33 (2%) cases, the origin of the salmonella infection remained unclear.

Domestic salmonella infections were caused by 50 different serotypes. The three most common ones, including Enteritidis (83 cases), Typhimurium (55) and group B (22), caused 62% of the infections. Most (68%, 2015: 80%) cases were still susceptible to all 12 antimicrobials tested, and the proportion of multiresistant strains increased from the previous years' level to the level typical of earlier years (2016: 19%; 2015: 12%; 2014: 20%; 2013: 21%).

The number of domestic cases caused by the Enteritidis serotype increased from previous years (83, 2015: 59) and they were less often susceptible to all of the antimicrobials tested (45%, 2015: 80%). Enteritidis strains were divided into 16 different phage types, the most common one being PT1 (31%). These changes were due to the bean sprout related epidemic in Pirkanmaa, as the cause of which was confirmed multiresistant Enteritidis PT1, MLVA 3-13-5-4-1.

Of the domestic Typhimurium strains, only 7% were multiresistant (2015: 6%). The Typhimurium strains were divided into 10 different phage types. The proportion of the domestic phage type PT1 (27%) was in the same range as in the year before (2015: 29%). The PT1 strains were susceptible to antimicrobials, except one strain.

The number of domestic group B cases (22) has stabilised after an increase that took place a few years ago. The majority of group B strains were so-called monophasic *S.* Typhimurium strains (20 cases). Almost all monophasic Typhimurium strains isolated from infections of domestic origin were multiresistant; most commonly to ampicillin, treptomycin, sulfonamide and tetracycline.

This resistance gives us reason to suspect that the monophasic Typhimurium strains are actually of foreign origin, e.g. secondary cases related to someone who returned from abroad or originating in an imported food product. Multiresistant monophasic Typhimurium strains are not known to occur in domestic farm animals. The most common monophasic phage type has varied in previous years (PT7A, PT120, PT195). In 2016, the most common type was PT193 (11/20).

The leading countries of acquisition in cases of foreign origin were Thailand (29%), Turkey (11%), Spain (6%), Greece (5%) and Indonesia (5%). The number of strains from the WHO/European countries decreased

from the year before (424 compared to 577), while the number of strains originating outside the WHO/European countries increased from the previous year (791 compared to 661). Of foreign strains, 11% were serotyped, including all invasive strains and a few strains where identifying the species was problematic.

Table 1. The most common serotypes of salmonella cases of domestic origin, 2007–2016 (excluding S. Typhi and S. Paratyphi), no. of cases.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Domestically acquired infections (Source: National Institute for Health and Welfare, Bacterial Infections Unit)										
Salmonella Enteritidis	62	48	51	44	47	83	46	49	59	83
Salmonella Typhimurium	156	85	140	132	94	98	94	92	79	55
Salmonella group B	11	5	7	8	40	35	38	32	30	22
Salmonella Infantis	3	7	2	9	10	36	12	9	10	7
Salmonella Senftenberg	1	2		5	5	1	1	3	1	6
Salmonella Stanley	11	8	6	7	1	3	1	6	6	6
Salmonella Java	0	0	0	0	2	0	2	5	13	6
Salmonella Newport	28	71	9	8	6	7	11	9	27	5
Salmonella Thompson	0	3	2	12	2	5	9	6	0	4
Salmonella Napoli	2	0	2	0	6	3	7	2	2	4
Salmonella Saintpaul	2	6	2	2	0	5	4	4	6	4
Salmonella Kottbus	1	0	3	2	0	0	0	1	3	4

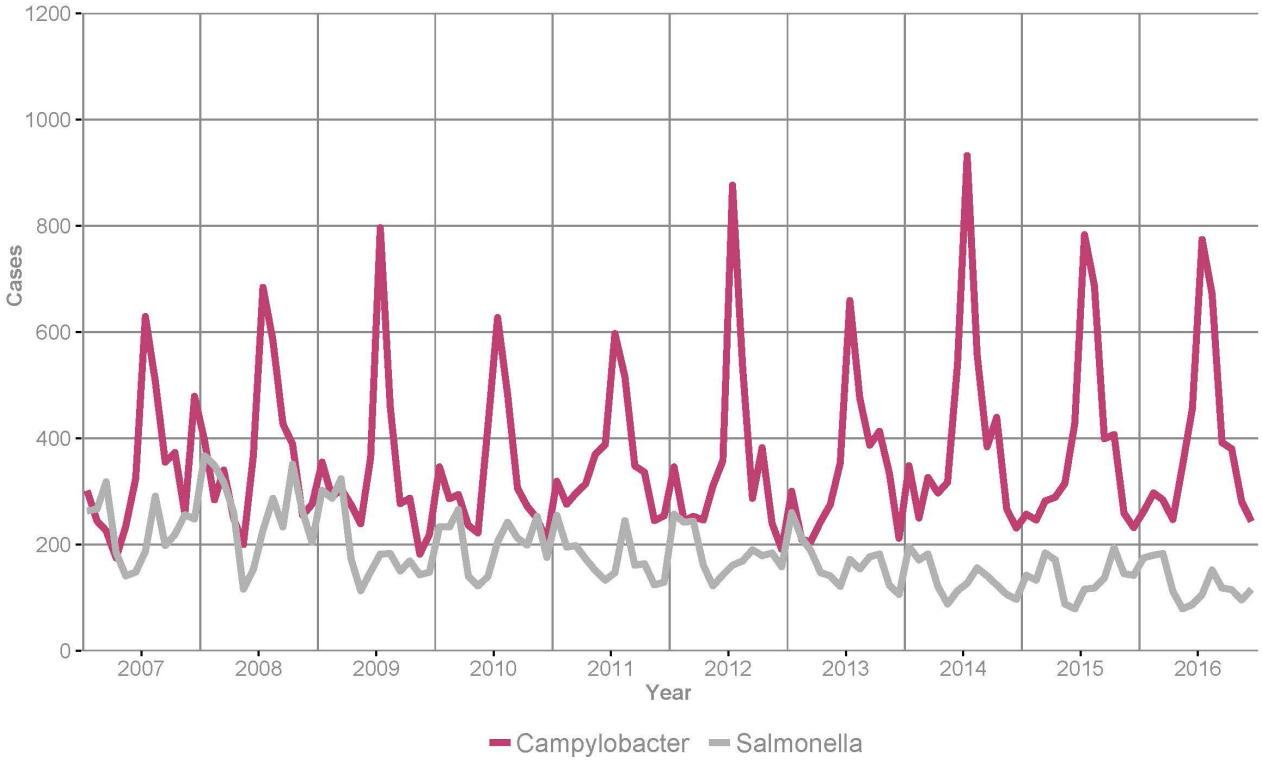

Figure 8. Salmonella and campylobacter cases by month, 2007–2016 (no. of cases).

SHIGELLA

In 2016, the incidence of shigellosis was 1.2/100,000. The total number of cases reported was 66 (2015: 92). Of these, 36 were in men, and the median age was 40 years (variation 1 to 85). The majority of the cases (68%) were reported in the Helsinki and Uusimaa Hospital District. Seven hospital districts had no diagnosed cases. The lack of findings in so many hospital districts gives reason to suspect problems in the primary diagnostics of shigella, which is known to require particular care.

The shigella strains of 61 persons were sent to the National Institute for Health and Welfare's laboratory. Of the total number, 52 infections (85%) were reported as having been acquired abroad and nine in Finland, and in one case the country of acquisition was not reported. As in the previous year, the most common countries of origin continued to be Thailand (5 cases) and India (5 cases). A total of 32 strains (52%) were typed, including all infections of domestic origin and a sample of the foreign ones. The prevailing shigella species were *Shigella sonnei* (19) and *Shigella flexneri* (10). The majority (27 species, 84%) were multiresistant (resistant to at least three of the 12 antimicrobials tested). All domestic strains were multiresistant.

YERSINIA

Yersinia findings are reported to the National Infectious Diseases Register under the Communicable Diseases Decree, which does not, however, require that Yersinia strains be sent to the National Institute for Health and Welfare. The institute only types Yersinia strains in special circumstances, including epidemics or severe infections.

Yersinia enterocolitica

In 2016, 547 cases of *Yersinia enterocolitica* were reported to the National Infectious Diseases Register (2015: 560). The incidence in the entire country was 10/100,000, with the highest incidence in the 25 to 29 age group (18/100,000). Regional variation in *Y. enterocolitica* findings was great. The incidence was highest in the hospital districts of Helsinki and Uusimaa (16/100,000), North Ostrobothnia (14/100,000) and Satakunta (11/100,000). One *Y. enterocolitica* case was reported in the Åland. Information on the country of acquisition was not provided in 67% of the reports (365/547).

Y. enterocolitica is most commonly identified from a stool culture. In 2016, the number of cases confirmed by culture totalled 512, while 45 cases were identified by antibody findings in serum. Fourteen cases were identified by two different methods (PCR and culture or culture and antibody typing). *Y. enterocolitica* findings were reported by 15 laboratories. Of these, ten also reported the biotype and/or serotype, or the results of a virulence plasmid test, at least occasionally. The typing result was given in 48% of the cases: 67% (178/264) were of the biotype BT1A, 21% of the biotype/serotype BT4/O:3, and 8% of the type BT2/O:9. BT 1A is a heterogeneous group of strains that lack the pYV virulence plasmid typical of pathogenic yersinias. However, some BT 1A strains may have other properties affecting their pathogenic capabilities.

Yersinia pseudotuberculosis

In 2016, the number of *Yersinia pseudotuberculosis* cases was 23 (2015: 16). The incidence for the entire country was 0.4/100,000 inhabitants. Unlike previous years, more cases were confirmed by antibodies (18) than by culture (5). The numbers of cases were too low to describe regional differences. In earlier years, epidemics have caused variations in the annual incidence of *Y. pseudotuberculosis* cases.

NOROVIRUS

In 2016, 2,395 cases of norovirus infection were reported to the National Infectious Diseases Register, or slightly more than in 2015 (2,164). Notifications were submitted by all hospital districts and, as in previous years, the majority in January–May (1,652, 69%). Cases occurred in all age groups, but almost one half (47 %) of them in persons over 75 years of age. The percentage of women was 58%.

Norovirus is one of the most common causes of food- and water-borne epidemics. In 2016, 41/89 (46%) suspected epidemics in which the suspected pathogen was norovirus were reported to RYMY, the national outbreak notification system of the National Institute of Health and Welfare and the Finnish Food Safety Authority Evira.

In 2016, the National Institute for Health and Welfare typed norovirus samples from 16 epidemics. Genotype GII.Pe was found in two epidemics in early 2016. The genotype GII.e has developed through mutations from the globally highly common genotype GII.4, detected in Finland for the first time in 2008. In late winter 2016, a virus strain of a new type, GII.P16-GII.2, was found in five epidemics occurring in different parts of Finland. Genotype GII.Pg caused two reported epidemics. Other types of norovirus found in 2016 included GI.2, GI.3 and GII.7.

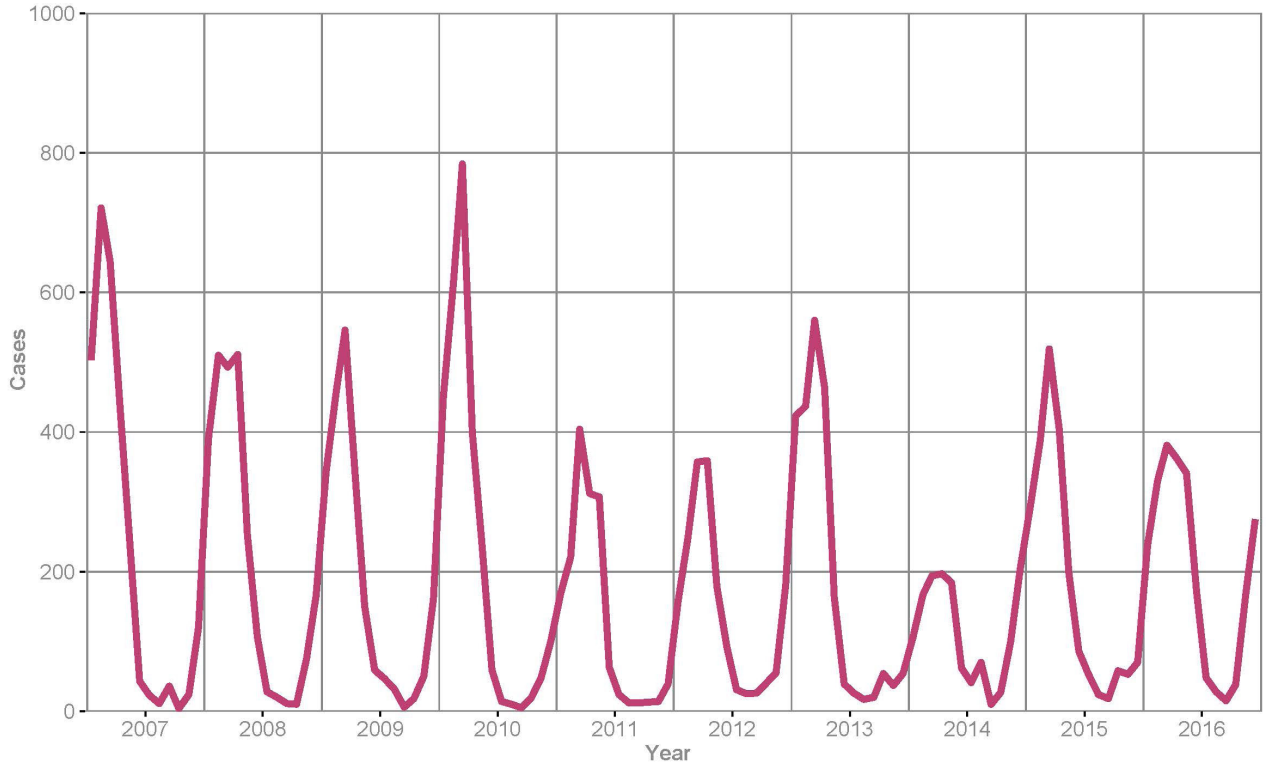

Figure 9. Cases of norovirus infection by month, 2007–2016 (no. of cases).

ROTAVIRUS

In 2016, 150 cases of rotavirus were reported to the National Infectious Diseases Register. The number of cases has remained below 500 since the rotavirus vaccine was introduced to the national vaccination programme in 2009. Comprehensive rotavirus vaccinations for young children have clearly decreased the incidence of rotavirus infections in under 5-year-olds (2016: 23/100,000) in comparison with the average incidence (460/100,000) in this age group prior to the vaccination programme. A continuously increasing percentage of cases occur in patients aged 5 and older (2016: 55 %), whereas the percentage of such cases before the vaccinations was approximately 10%. More than one half of rotavirus cases in children under 5 years of age occurred in unvaccinated individuals.

The National Institute for Health and Welfare maintains the microbial strain collection of rotaviruses in accordance with the Communicable Diseases Act and Decree and is monitoring whether the virus strains that have reduced due to vaccination are being replaced by other virus strains. Rotavirus positive findings sent by clinical laboratories to the National Institute for Health and Welfare are typed on the basis of molecular genetics by the University of Tampere Vaccine Research Center. In 2016, the most common type of rotavirus that caused outbreaks of cases was G9P[8], and the next most common rotavirus types in Finland were G1P[8], G2P[4], G3P[8] and G12P[8]. The total number of G3P[8] findings was 16. None of these were zoonotic. Increasingly rare viruses have been circulating in Finland, including the reassortant animal and human strain G6P[8] and the G29P[9] strain that may be of animal origin.

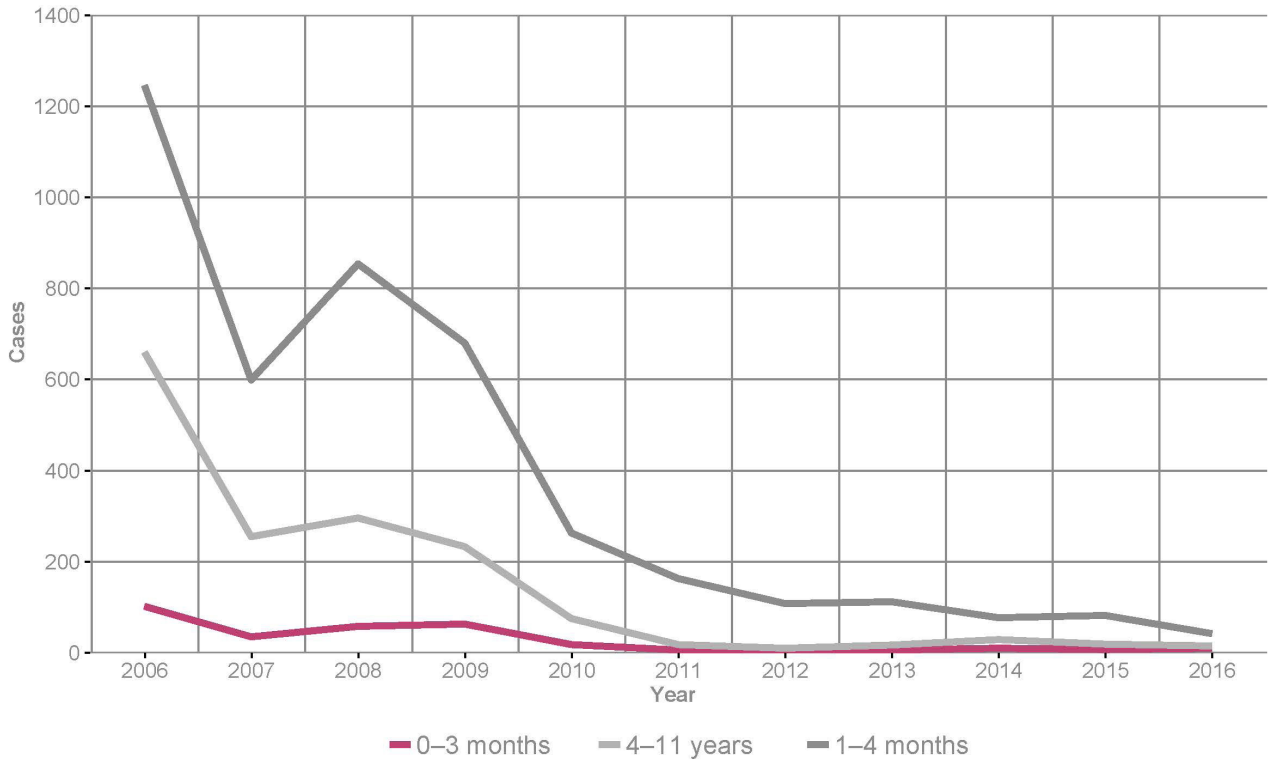

Figure 10. Rotavirus cases by age group in children aged 0 to 4, 2007–2016 (no. of cases).

Hepatitis

- Only six cases of hepatitis A infection were reported to the National Infectious Diseases Register, which was fewer than ever before.
- A significantly lower number of chronic hepatitis B infections was reported than in the previous year. As in earlier years, the majority of the infections were diagnosed in foreigners.
- The majority of patients infected with hepatitis C in Finland were intravenous drug users.

HEPATITIS A

In 2016, only six hepatitis A cases were reported (0.1/100,000), which was less than ever before. Three of the infections had been contracted abroad. The low number of cases is likely to be due to the good vaccine protection of travellers and risk groups. In 2013–2015, 27 to 41 cases were reported. Extensive international food-borne epidemics had an impact on the large case numbers.

HEPATITIS B

Acute hepatitis B

In 2016, 11 (0.2/100,000) acute cases of hepatitis B, i.e. ones that tested positive for IgM antibodies, were reported to the National Infectious Diseases Register. Three of the infected patients were of Finnish and eight of foreign origin. The mode of transmission was reported in three cases only, and in each one of these, it was sexual contact. In one of the cases, it was sex between men. The country of acquisition was reported in four cases: in two cases it was Finland and in the other two a foreign country.

Over the last ten years, the reported annual average number of acute hepatitis B infections has been 20, whereas in the record year of 1998, almost 180 infections were reported. This decrease is mainly due to higher vaccination coverage. Moreover, needle and syringe exchange has probably prevented infections among users of intravenous drugs.

Vaccination of risk groups began in Finland in the 1990s. In 2016, the national vaccination programme was extended to include the following groups: 1) children aged under 5 at day care centres when it is known that one of the children in the group is HBsAg positive, 2) newborns when at least one of the parents comes from a country where hepatitis B is widespread, 3) newborn children of mothers infected by hepatitis C, 4) men who have sex with other men. The vaccination coverage has also been improved by individuals who get the vaccination at their own cost, which has been especially popular among travellers.

Chronic hepatitis B

In 2016, 341 chronic hepatitis B infections were reported (6.2/100,000), which is some 50 cases less than the year before. Most infections (65%) were found in men. The majority (90%) were diagnosed in foreigners. The country of acquisition was known in 42% of the cases, in 92% of which the infection had been contracted abroad. The mode of transmission was only reported in 9% of the cases, with sexual contact and perinatal infection being the most common ones.

Almost one half (46%) of the infections were found in persons who did not have a Finnish personal identity code. This is partly explained by the fact that asylum seekers arriving in Finland are screened for hepatitis B, and the diagnoses of the over 30,000 asylum seekers who arrived as a result of the refugee crisis in 2015 continued to be reported in 2016.

The number of chronic hepatitis B cases has decreased since the peak year of 1996, in which more than 600 cases were reported. The reason for this is a dramatic drop in cases reported in Finnish patients. A similar decrease has not been recorded in infections contracted by foreigners.

HEPATITIS C

In 2016, 1,147 (21/100,000) new cases of hepatitis C were reported to the National Infectious Diseases Register, on a par with previous years. The highest number of infections (33%) was reported in the Helsinki and Uusimaa Hospital District, where the incidence was 23/100,000. The highest incidences were recorded in the hospital districts of Länsi-Pohja (35/100,000), Kymenlaakso (32/100,000) and South Karelia (29/100,000) and the lowest in the hospital districts of Central Ostrobothnia (9/100,000), South Ostrobothnia (13/100,000) and Åland (14/100,000).

Of these patients, 67% were men, and the cases were most frequent in the age group 20 to 39, accounting for 69% of all cases. The incidence was highest (78/100,000) in the age group 20 to 24. The majority of infections (86%) were diagnosed in individuals of Finnish origin. The country of acquisition was known in 57% of the cases. Of these, the majority (88%) were infections contracted in Finland.

Intravenous drug use was the most common method of infection (51%). Information on the mode of transmission was lacking in 40% of cases. Sexual contact was given as the mode of transmission in six per cent. Of these cases, 59% were diagnosed in women. Five infections were reported as being acquired through sexual contact between men.

The majority of hepatitis C infections was reported without a personal identity code in 1995–1997. The high figures for hepatitis C in 1996–2000 (1,800 cases on average per year) may have been partially due to cases without personal identity codes being registered several times, and the probable registration for those years of most cases initially diagnosed before surveillance began. Since 2003, the annual number of cases has varied between 1,100 and 1,200, the lowest figure being recorded in 2009 (1,042).

In all, some 30,000 cases of hepatitis C have been reported to the National Infectious Diseases Register in 1994–2016. However, the total number of those infected and carriers is unknown because the prevalence of hepatitis C has not been studied at population level in Finland. The number of carriers is growing, however, because the number of new infections is clearly higher than the number of cases treated.

The majority of infected patients in Finland are intravenous drug users. A very high percentage, around 75%, of intravenous drug users have been found to have hepatitis C antibodies. Because of this, it is difficult to reduce the number of infections further in this group by means of the current needle and syringe exchange programmes alone. In 2016, the Ministry of Social Affairs and Health published the first Finnish hepatitis C strategy http://urn.fi/URN:ISBN:978-952-00-3845-8. The strategy aims for more effective prevention of new infections, harmonisation of testing and treatment practices, bringing infected patients within the scope of comprehensive monitoring and treatment, more effecting surveillance of infections and the disease situation, and creating a treatment monitoring system. The long-term objective of the strategy is treating all hepatitis C carriers, regardless of the degree of damage to their livers, and decreasing the incidence of hepatitis C and the number of chronic carriers of the virus.

Table 2. All cases of hepatitis C according to physicians' reports, by mode of transmission, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Injecting drugs	478	589	530	641	627	663	652	704	619	590
Sex	72	82	75	83	90	69	91	86	78	76
Perinatal	3	10	10	11	12	8	5	4	3	2
Blood products	24	20	5	14	8	7	11	13	14	6
Other	41	47	50	40	31	42	36	39	25	25
Unknown	575	430	416	380	403	406	380	393	428	458
Total	1,189	1,173	1,083	1,179	1,180	1,185	1,181	1,236	1,181	1,157

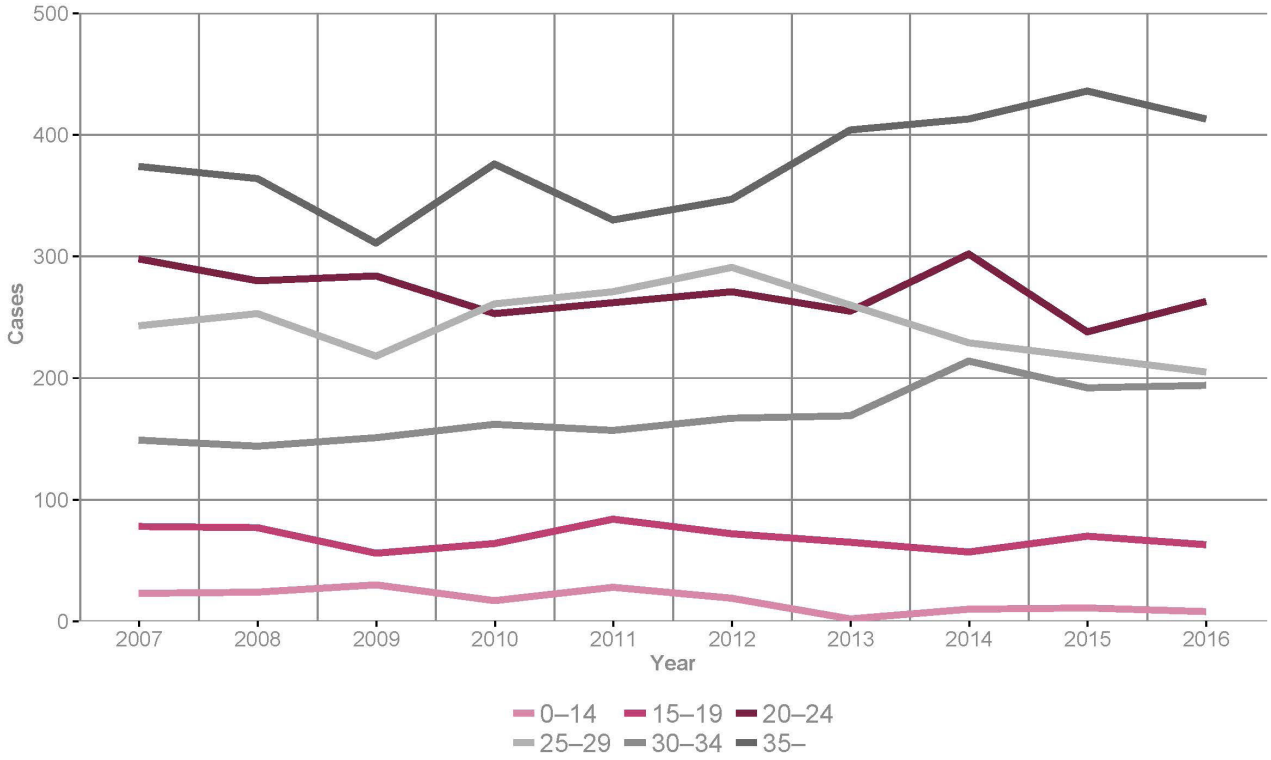

Figure 11. Hepatitis C by age group, 2007–2016 (no. of cases).

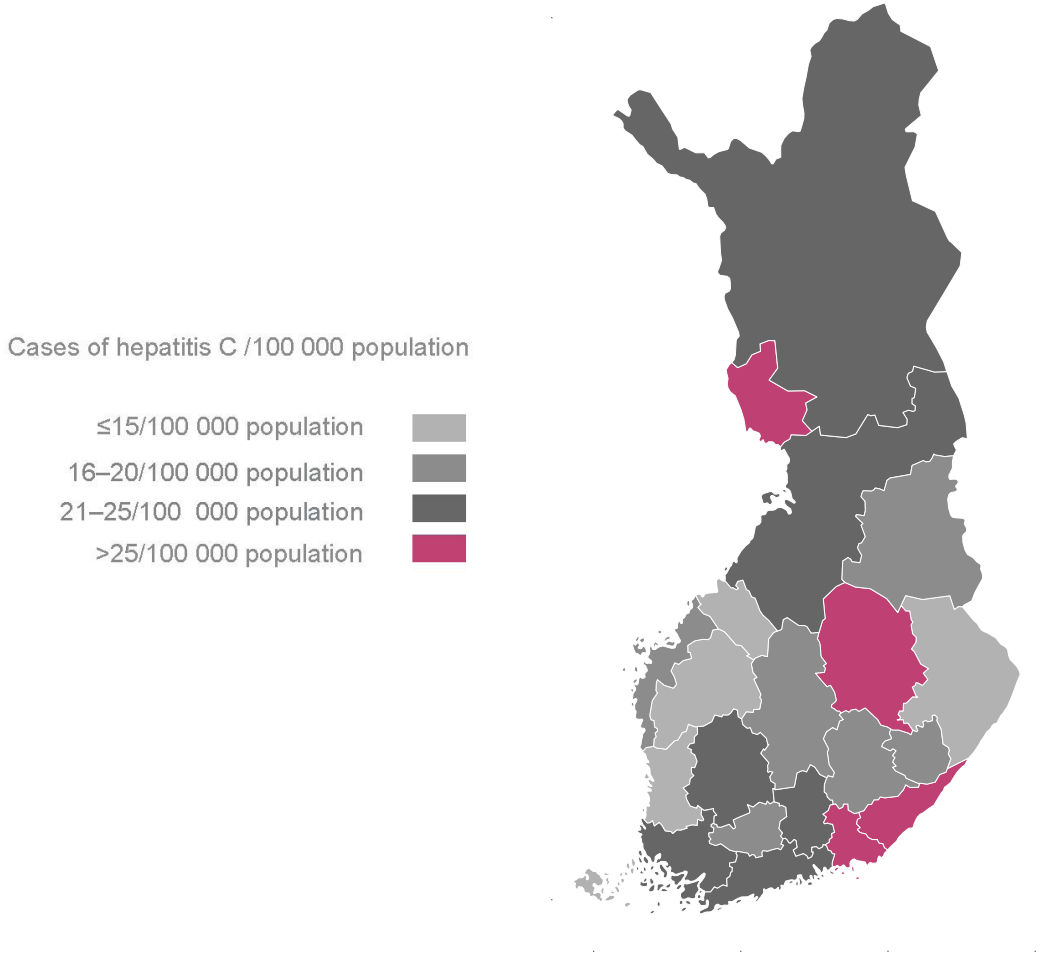

Figure 12. Incidence of hepatitis C (cases/100,000 population) by hospital district, 2016.

Sexually transmitted diseases

- A record-breaking number of chlamydia and gonorrhoea infections was reported in 2016.
- Most gonorrhoea and syphilis infections in persons of Finnish origin were acquired in Finland.
- A significant percentage of HIV, gonorrhoea and syphilis infections contracted by men were the result of sexual contact between men.
- One half of HIV infections are diagnosed late.

CHLAMYDIA (CHLAMYDIA TRACHOMATIS)

In 2016, a total of 14,311 cases of chlamydia were diagnosed (262/100,000), which exceeds the previous year's number by more than 700 and is the largest annual number reported to the National Infectious Diseases Register so far. This increase may partly be explained by the possibility of taking samples at home, which reaches new target groups for testing. The highest number of cases (34%) was reported in the Helsinki and Uusimaa Hospital District but, as in the previous year, the incidence was highest (338/100,000) in the Hospital District of Lapland.

Typically for chlamydia, most cases were diagnosed in women and young adults: 59% of the infections were reported in women and 80% in the age group 15 to 29. The incidence was highest (1,750/100,000) in the age group 20 to 24. The age groups in which infections occur most frequently are younger among women than among men. Almost 80% of infections in the age group 15 to 19, and slightly more than 60% in the age group 20 to 24, were reported in women. In the age group 25 and over, on the other hand, the proportion of men is as a rule some 10% higher than the proportion of women. The majority (92%) of infections were diagnosed in individuals of Finnish origin.

LGV (LYMPHOGRANULOMA VENEREUM)

Eight cases of LGV, which is caused by Chlamydia trachomatis, were reported in 2016. Six of the patients were of Finnish and two of foreign origin. As the mode of transmission was reported sexual contact between men in all cases. Five of the infections were contracted abroad and three in Finland.

Reporting of LVG cases began in 2011. All in all, 27 infections have been reported, all in men and 22 in Finns. The mode of transmission is known in all cases but one, being sexual contact between men in all of them.

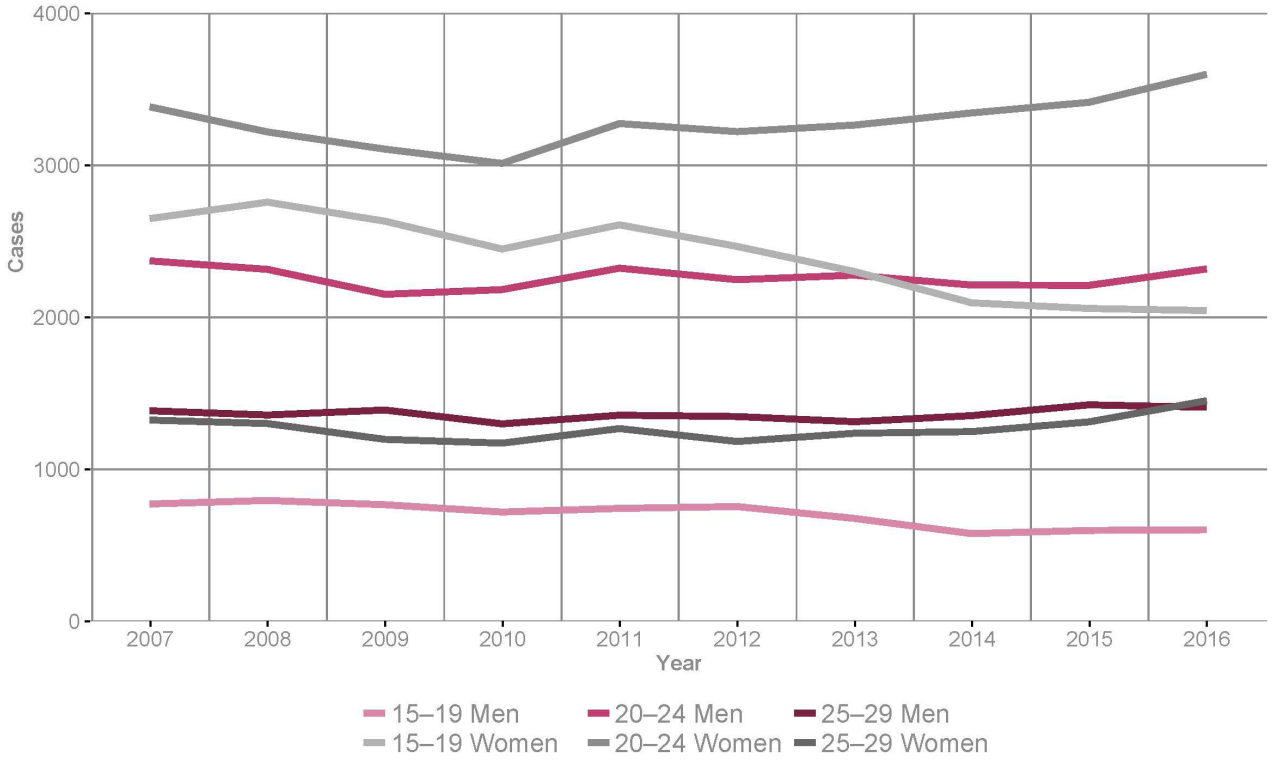

Figure 13. Chlamydia cases in the young adult age groups, 2007–2016 (no. of cases).

GONORRHOEAE (NEISSERIA GONORRHOEA)

In 2016, a total of 416 cases of gonorrhoea were diagnosed (7.6/100,000), which exceeds the previous year's number by 135 and is the largest annual number reported to the National Infectious Diseases Register so far. The number of cases increased in both men and women, with both groups showing an increase of some 50% compared to the year before. The increase in diagnosed infections may partly be explained by more effective testing: a combination test for chlamydia and gonorrhoea is used more widely, and taking the sample at home is now possible.

The highest number of infections, accounting for 65% of all cases, was reported in the Helsinki and Uusimaa Hospital District, where the incidence was also highest (16.8/100,000). As in previous years, the majority of infections (76%) was reported in men. Most cases occurred in the age group 20 to 35, accounting for slightly more than one half of all cases. The incidence was highest (25.2/100,000) in the age group 25 to 29. The majority of infections (77%) were diagnosed in individuals of Finnish origin.

The country of acquisition was reported in 82% of cases. Of these, the majority of infections in both Finns and foreigners had been contracted in Finland (66%). As in previous years, the majority (26) of the infections contracted abroad originated in Thailand.

The gender of the sexual contact was reported in 72% of the cases in men. The percentage of sexual contact between men was significant (64%). Most infections where the mode of transmission was sex between men were contracted in Finland, and the majority of the cases were reported in the Helsinki and Uusimaa Hospital District.

In most cases, the infection is diagnosed by nucleic acid detection. Antimicrobial susceptibility was only known in about one half of the gonorrhoea cases in 2015. No Gonococcus strains resistant to ceftriaxon had been reported in Finland by the end of 2015 (Finres 2015, http://urn.fi/URN:ISBN:978-952-302-716-9).

SYPHILIS (TREPONEMA PALLIDUM)

In 2016, 232 syphilis infections were diagnosed (4.3/100,000). While this is slightly less than the year before, it however is the second largest annual number reported to the National Infectious Diseases Register. The figure includes both active infections and old

serological scars. Since 2016, an effort has been made to distinguish between these two. However, the stage of the illness was only reported in 13% of cases.

Almost one half (44%) were reported in the Helsinki and Uusimaa Hospital District. The highest incidence was reported in the South Karelia Hospital District (9.1/100,000).

As in previous years, the majority of infections (77%) were reported in men. The cases were most frequent in the age group 25 to 49, which accounted for 67% of all cases. The incidence was highest (10.7/100,000) in the age group 40 to 45. Individuals of foreign origin accounted for 58% of the cases. It is likely that the majority of these concerned serological scars.

The country of acquisition was reported in 67% of all cases. Infections acquired in the home country dominated in individuals of Finnish origin with 77%.

The gender of the sexual contact was reported in 54% of the cases in men. The percentage of sexual contact between men was significant: 57% of infections among men were contracted in this way. Of these, two out of three had been acquired in Finland.

HIV AND AIDS

In 2016, 183 new HIV infections were diagnosed (3.4/100,000). More than one half, or 55%, were reported in the Helsinki and Uusimaa Hospital District, where the incidence was also highest (6.2/100,000). Twenty-seven new cases of AIDS were diagnosed. In 20 of these, a HIV infection had also been diagnosed in 2016.

Most HIV infections (68%) were found in men. The proportion of Finnish men was significantly higher than that of foreign men (88% compared to 47%). Individuals of foreign origin accounted for 60% of the infections. The cases were the most frequent in the age group 25 to 49, accounting for 71% of all cases. The incidence was highest (8.7/100,000) in the age group 35 to 39. At the time of diagnosis, the average age of Finnish patients was clearly higher than that of foreigners (48 compared to 36 years).

The mode of transmission was reported in 74% of all cases. The majority of infections (90%) were acquired through sexual contact. In the total number of infections, the share of heterosexual contact was 58%, sex between men 32%, injecting drugs 3%, blood products 3% and mother to child infections 1%.

Seventy-eight infections acquired through heterosexual contact were reported. The most cases were reported in men (58%) and persons of foreign origin (58%). The country of acquisition was known in 84% of cases; 78% of these were acquired abroad. As in previous years, Thailand was a prominent source of infection for Finns who had acquired the infection abroad.

The number of infections acquired through sexual encounters between men was 44. Of these, individuals of Finnish origin accounted for 61%. The country of infection was known in 88% of cases: of these, approximately one half had been acquired in Finland and one half abroad. Two thirds of cases among Finns were contracted in the home country, however.

Six cases were diagnosed in which the infection was related to intravenous drug use, all of these in individuals of foreign origin. Since the epidemic at the turn of the millennium, efficient prevention methods have helped to keep the number of infections contracted in Finland at a low level.

One mother to child infection acquired abroad was reported. Because of comprehensive screening at maternity clinics and efficient HIV medication, no mother to child infections have been diagnosed in Finland since 2000.

In five cases, all in foreigners, blood products were reported as the source of infection. However, in four out of these cases, sexual contact was also mentioned as a possible mode of transmission. Since HIV testing of donated blood began in Finland in 1985, no cases of infection through blood products have been reported in Finland.

In 2016, 27 new cases of AIDS were reported, two thirds of these in individuals of Finnish origin. The majority of these were related to a late diagnosis of a HIV infection. The CD4 value at the time of diagnosis was reported in 74% of the cases. The percentage of late detection of infections (CD4 lower than 350) was 52%. The challenge therefore lies in detecting HIV infections earlier than at present, thus preventing the development of AIDS and the spread of infections.

By the end of 2016, the total number of HIV infections diagnosed in Finland was 3,734. The reported number of HIV positive patients who died was 471, with 28 deaths in 2016. Because of efficient HIV medication, the majority of deaths in the 2000s were due to reasons other than HIV.

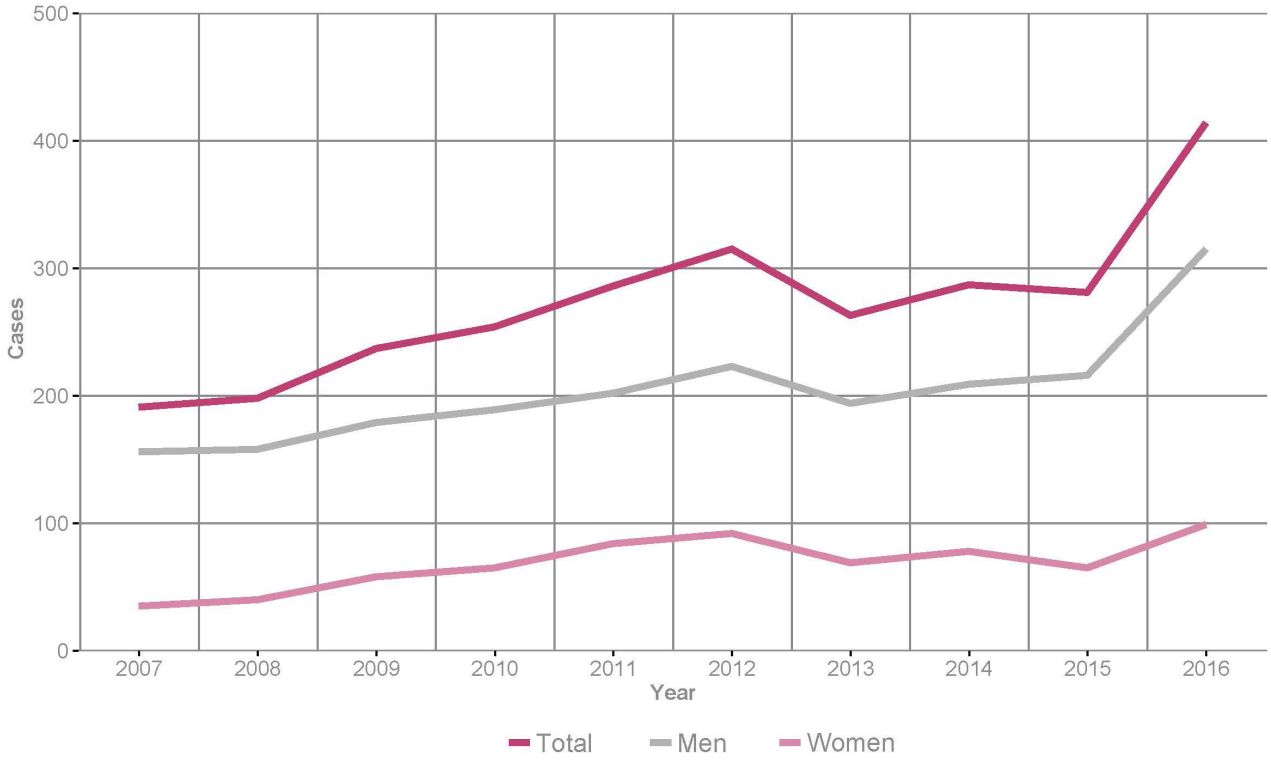

Figure 14. No. of gonorrhoea cases by gender, 2007–2016.

Figure 15. No. of syphilis cases by gender, 2007–2016.

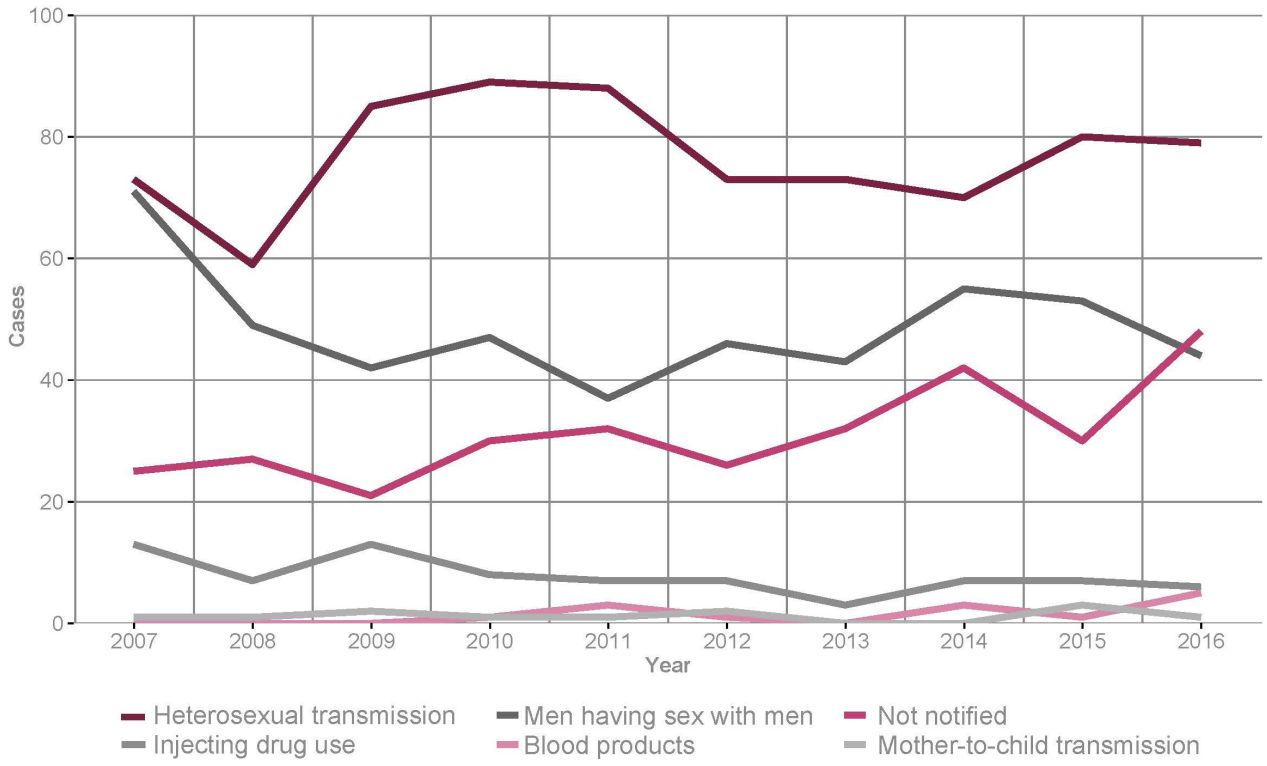

Figure 16. HIV cases by mode of transmission, 2007–2016 (no. of cases).

Antimicrobial resistance

- The number of MRSA infections, and also that of blood cultures, was significantly higher than in the previous year.
- The percentage of MRSA findings increased in the 20 to 24 age group, and the number of MRSA cases in children also went up.
- While the number of VRE cases increased from the year before, no blood culture findings were made.
- The total number of *E. coli* ESBL findings increaced from the previous year.
- While the number of CPE findings remains relatively low in Finland, it has continued to increase since surveillance began in 2009. In recent years, three clusters of infections caused by KPC-3 positive *K. pneumoniae* (ST512) in care institutions have been found in Finland.
- More than one half of the CPE infections had probably been acquired abroad.

MRSA

In 2016, 1,700 new cases of MRSA (methicillinresistant *Staphylococcus aureus*) were reported, considerably more than in the year before (2015: 1,274). The number of MRSA cases confirmed through blood culture findings was also higher than in the previous year (2016: 49; 2015: 40). Of the MRSA blood culture findings, 23 were in the Helsinki and Uusimaa Hospital District (1.4/100,000) and six in Pirkanmaa (1.1/100,000), while the other hospital districts reported zero to two cases, totalling 20. Most (30/49) invasive cases occurred in men and in the 65 and over age group (32/49), while three occurred in children. The total number of cases was highest in the hospital districts of Helsinki and Uusimaa (604) and Pirkanmaa (291), and the incidence was highest in Pirkanmaa (55/100,000) and Päijät-Häme (51/100,000). Unlike before, a larger percentage of the findings were made in the age group 20 to 24 (2016: 26%, 2015: 18%), while a smaller proportion was in those aged 65 and over (2016: 34%, 2015: 39%). The number of MRSA cases in children also increased (2016: 194, 2015: 140).

Patients arriving at hospital are screened for MRSA if they have been in a refugee camp or hospitalised abroad in the last 12 months. In 2016, 374 patients who did not have a Finnish personal identity code were diagnosed as MRSA carriers (2015: 161 findings). This group is highly likely to include not only tourists but also a significant number of asylum seekers.

The MRSA strain was typed in 1,796 individuals. There were 262 different spa types among the MRSA strains (2015: 247; 2014: 205). The three most common spa types were the same as in previous years, albeit in a slightly different order: t008 12% (2015: 8%, 2014: 11%), t172 10% (2015: 16%, 2014: 19%) and t067 8% (2015: 6%, 2014: 10%). The next most common spa types were t304 7%, t223 4%, t127 4% and t044 4%.

Of these, in particular t304 (2015: 4% 2014: 1%), t223 (2015: 3% 2014: 2%) and t127 (2015: 4% 2014: 2%) have increased their prevalence significantly in the last two years. In the same period, the prevalence of spa type t386 has increased from a few sporadic cases in 2014 to the top ten of the most common spa types in 2016 (2016: 3%, 2015: 2%, 2014: 0%).

t008 was present in 16 hospital districts, and t172 in 14 different hospital districts. Unlike previous years, the occurrence of spa type t067 was most frequent in the Helsinki and Uusimaa Hospital District, in which a cluster caused by this strain was detected. The second highest occurrence of spa type t067 was reported in Pirkanmaa where, after a few years with a declining trend, the strain occurred more frequently than in the year before.

The two most common spa types among patients aged 75 and over were t008 19% (2015: 7%), t067 17% (2015: 12%) and t172 13% (2015: 21%). The most common spa types among children under the age of 16 were t304 13% (2015: 5%), t223 12% (2015: 5%), t002 7% (2015: 5 %) t008 7% (2015: 7%) and t386 6% (2015: 3%).

An invasive MRSA strain was typed in 45 individuals. The most common spa types were : t008 (2016: 9 and 2015: 6), t067 (2016: 6 and 2015: 0), t172 (2016: 4 and 2015: 10) and t437 (2016: 3 and 2015: 0). There were two cases each of spa types t020, t034 and t304, and the remaining cases (17/45) each represented different spa types.

In 2016, five MRSA strains with the *mecC* gene were isolated from clinical samples (2015: 4), all of which represented spa type t843.

Spa types of the MRSA CC398 complex related to production animals were found in the samples of 49 individuals. In 2016, it accounted for 2.9% of new MRSA cases (2015: 3.2%, 2014: 1.3%).

Spa type t034 is clearly the most common strain of the CC398 complex in Finland (2016): 37/49) (2015: 33, 2014: 14, 2013: 5, 2012: 2). So far, there have been five MRSA CC398 findings in blood in Finland (2016: 2 t034; 2015: t034 and t1250; 2013: t12593). Other spa types of the CC398 complex found in Finland include t011, t108, t571, t899, t1250, t1255, t2582, t2741 and t12593.

Table 3. MRSA findings and their percentage of S. aureus blood culture findings, 1995–2016 (no. of cases and %).

Year	MRSA findings	S.aureus blood culture findings	MRSA blood culture findings and S.aureus methicillin resistance (%)
1995	89	627	2 (0.3)
1996	110	667	0 (0.0)
1997	121	747	4 (0.5)
1998	190	719	5 (0.7)
1999	212	813	8 (1.0)
2000	266	850	4 (0.5)
2001	340	887	4 (0.5)
2002	600	989	9 (0.9)
2003	859	981	7 (0.7)
2004	1,479	1,059	30 (2.8)
2005	1,374	1,013	27 (2.7)
2006	1,331	1,240	37 (3.0)
2007	1,254	1,179	33 (2.8)
2008	1,728	1,260	40 (3.2)
2009	1,266	1,289	30 (2.3)
2010	1,267	1,374	26 (1.9)
2011	1,328	1,484	43 (2.9)
2012	1,287	1,492	30 (2.0)
2013	1,282	1,590	29 (1.8)
2014	1,342	1,925	46 (2.4)
2015	1,274	2,051	40 (2.0)
2016	1,700	2,209	49 (2.2)

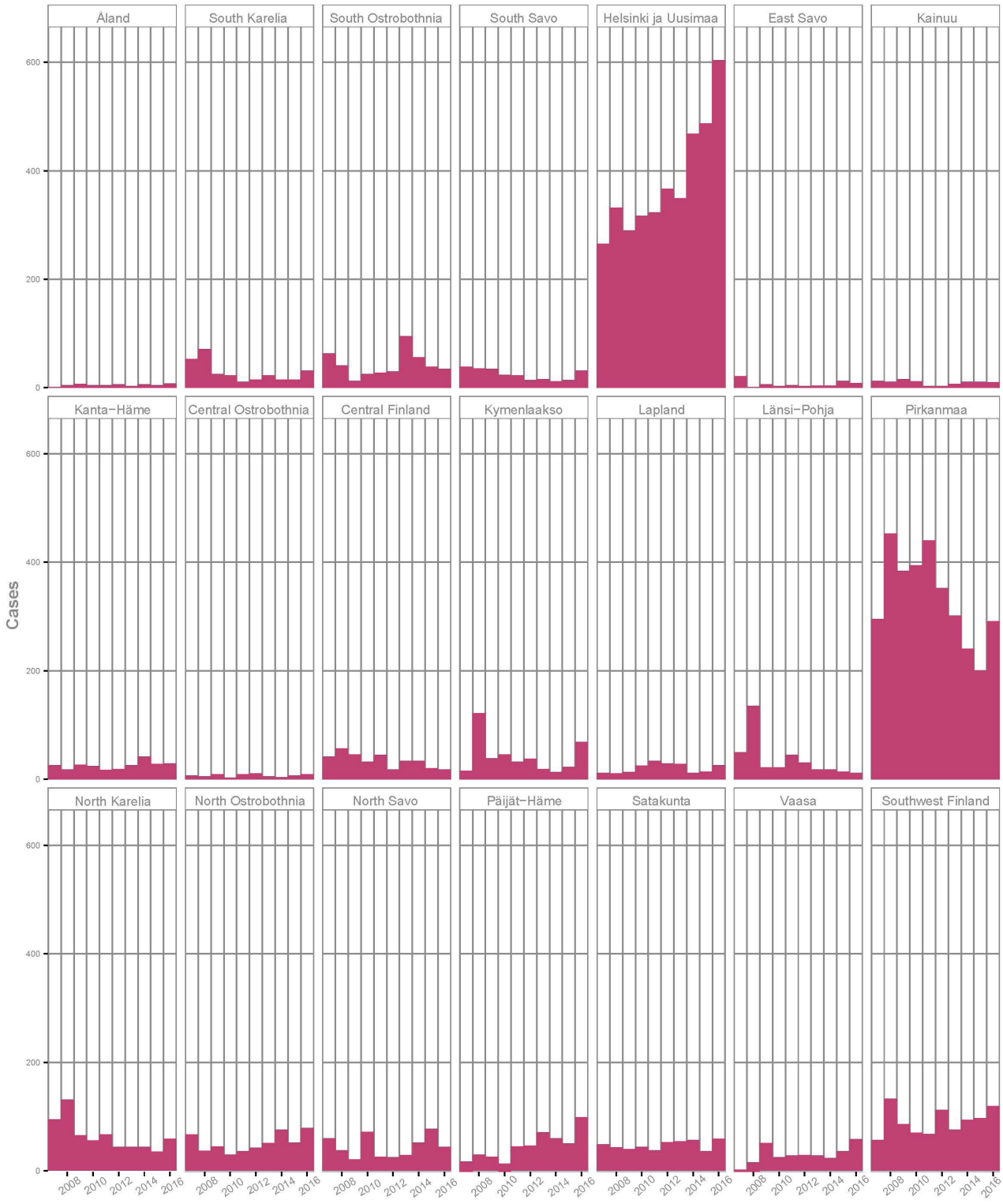

Figure 17. MRSA cases by hospital district and by year, 2007–2016 (no. of cases).

VRE

The number of reported cases of vancomycin resistant enterococcus (VRE) in 2016 increased from the previous year (2016: 71, 2015: 13). The highest number of findings were made in the hospital districts of North Karelia (22), North Ostrobothnia (21) and Helsinki and Uusimaa (13). In the other hospital districts, the number of findings varied from zero to three. None of the findings were based on a blood sample, and in general, VRE has rarely been found in blood (2015: 1, 2014: 0, 2013: 0).

In total, 71 VRE findings were sent to the microbial strain collection, of which 66 were of the species *Enterococcus faecium* (44 *vanA*, 25 *vanB*) and five were *E. faecalis* (3 *vanA*, 2 *vanB*). A cluster of 19 patients caused by *vanA* positive *E. faecium* (ST17) was found in the North Karelia Hospital District. *vanB*-positive *E. faecium* (ST780), on the other hand, infected a cluster of 15 patients in the North Ostrobothnia Hospital District. A cluster of five patients caused by *vanA* positive *E. faecium* (ST80) was found in the Helsinki and Uusimaa Hospital District. In addition, two small local clusters of two patients and one cluster of three patients were found. The remainder of the typed strains (26/71) were isolated findings.

In 2016, all VRE strains were for the first time typed using whole genome sequencing (WGS). This method based on investigating the entire genome of bacteria replaces the former PFGE typing method (pulsed-field gel electrophoresis) in confirming clusters and investigating epidemics.

ESBL – ESCHERICHIA COLI AND KLEBSIELLA PNEUMONIAE

Since the beginning of 2008, third-generation *Escherichia coli* and *Klebsiella pneumoniae* exhibiting reduced susceptibility or resistance to cephalosporin (I for intermediate and R for resistant, respectively) have been reported to the National Infectious Diseases Register. An estimated 90 percent of these bacteria are extended-spectrum beeta-lactamase-producing cephalosporins and so-called ESBL strains producing enzymes that degrade all penicillins.

In 2016, the majority of findings were *E. coli* (4,690; in 2015: 4,175), and a small minority were *K. pneumoniae* strains (407; in 2015: 288). *E. coli* ESBL findings were made in all age groups, 73% in women and one half in patients aged 65 or over. More than one half of the findings (56%) were based on urine cultures. While the largest number of cases was found in the Helsinki and Uusimaa Hospital District (1,452, 90/100,000), the incidence was highest in the hospital districts of Kymenlaakso (153/100,000) and Åland (135/100,000). The number of blood culture findings exceeded the figures for 2015 (286 compared to 232) (the proportion of ESBL in *E. coli* blood cultures: 286/4,966, 5.8% compared to the figure in 2015: 5.1%). Of these, 29% were in the Helsinki and Uusimaa Hospital District (5/100,000). However, the incidence of blood culture findings was highest in the hospital districts of South Savo, Länsi-Pohja, Kainuu and Kymenlaakso (9–10/100 000).

One half of ESBL findings involving *K. pneumoniae* were diagnosed in patients aged 65 and over but, at 61%, the percentage of women was smaller than in E. coli ESBL findings. Less than one half of diagnoses (41%) were based on urine. The largest number of cases was recorded in the hospital districts of Helsinki and Uusimaa (113) and Southwest Finland (52), while the incidence was highest in the hospital districts of Lapland, Kymenlaakso and Southwest Finland. Twenty-seven of the findings (2015: 15) were based on blood (the ESBL proportion in *K. pneumoniae* blood cultures: 2016: 27/770, 3.5% compared to 2015: 2.3%).

After a short-lived drop, the increase in the number of *E. coli* findings exhibiting resistance to third-generation cephalosporin seems to continue in Finland. In younger age groups, the steady increase in resistance continued, which indicates continuing growth in the percentage of carriers within the population. As a whole, the incidence in blood and cerebrospinal fluid findings continued to grow.

In 2016, an *E. coli* ESBL finding was made in 316 individuals with no Finnish personal identity code (2015: 194 findings), and a *K. pneumoniae* ESBL finding in 32 (2015: 23 findings). This increase may partly be explained by the screening of bacteria resistant to antimicrobials in patients arriving in hospital, including not only tourists but probably also a significant number of asylum seekers.

Table 4. E. coli findings with reduced susceptibility to third-generation cephalosporins (possible ESBL, extended-spectrum β-lactamase) and ESBL percentage, 2008–2016 (no. of cases and %).

	ESBL findings	E. coli blood culture findings	ESBL E. coli blood culture findings and percentage of ESBL E. coli (%)
2008	1,674	2,814	43 (1.5)
2009	2,177	2,989	77 (2.6)
2010	2,559	3,226	111 (3.4)
2011	3,138	3,475	149 (4.3)
2012	3,686	3,463	203 (5.9)
2013	4,464	3,876	233 (6.0)
2014	4,190	4,366	232 (5.3)
2015	4,175	4,532	232 (5.1)
2016	4,690	4,966	286 (5.8)

Table 5. K. pneumoniae findings with reduced susceptibility to third generation cephalosporins (possible ESBL, extended-spectrum β-lactamase) and ESBL percentage, 2008–2016, (no. of cases and %).

	ESBL findings	K. pneumoniae blood culture findings	ESBL K. pneumoniae blood culture findings and percentage of ESBL K. pneumoniae (%)
2008	116	418	3 (0.7)
2009	156	480	6 (1.3)
2010	190	508	16 (3.1)
2011	242	453	10 (2.2)
2012	242	583	10 (1.7)
2013	238	570	12 (2.1)
2014	307	634	20 (3.2)
2015	288	670	15 (2.3)
2016	407	770	27 (3.5)

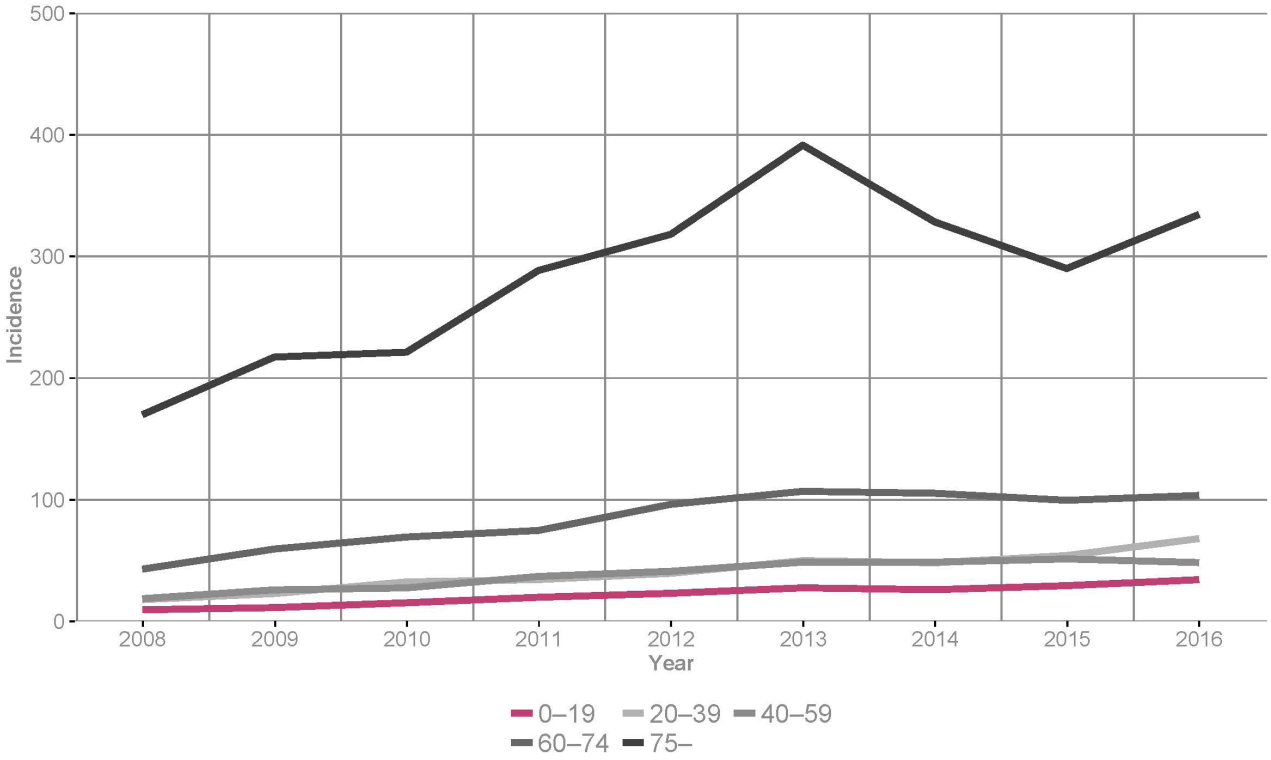

Figure 18. Incidence of E. coli findings (cases/100,000 population) with reduced susceptibility and resistance to third-generation cephalosporins (possible ESBL, extended-spectrum β-lactamase) by age group 2008–2016.

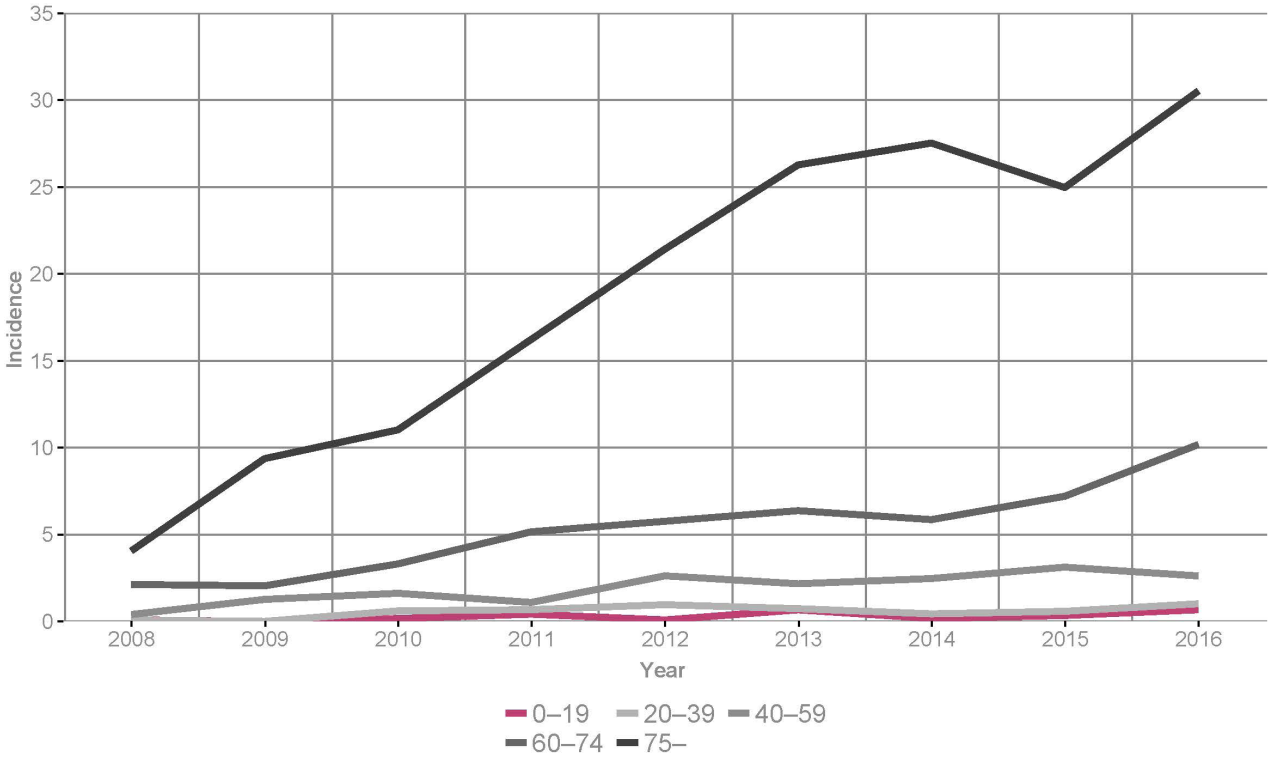

Figure 19. Incidence of E. coli findings (blood and cerebrospinal fluid findings /100,000 population) with reduced susceptibility and resistance to third-generation cephalosporins (possible ESBL, exteded-spectrum β-lactamase) by age group 2008–2016.

CPE (CARBAPENEMASE-PRODUCING ENTEROBACTERIA)

In 2016, 63 findings were reported to the National Infectious Diseases Register showing enterobacteria with reduced susceptibility (intermediate, I) or resistance (resistent, R) to carbapenemase, i.e. the bacterial strain was possibly CPE. Of the findings, 27 were *Escherichia coli*, 17 *Klebsiella pneumoniae* and 19 *Enterobacter cloacae*. In 33 cases, the bacterial strain was sent to the laboratory of the National Institute for Health and Welfare for further tests. Of these strains, 24 were confirmed as actual CPE strains. In addition, 118 possible CPE strains were sent to the National Institute for Health and Welfare, of which 12 proved to be carbapenemase-producing. The total number of confirmed CPE findings was 36, or slightly more than in 2015. Most findings involved *E. coli* strains (17), while *K. pneumoniae* was also common (14). In addition to these, other individual species of enterobacteria with the carbapenemase gene were isolated, including two *Citrobacter freundii* strains with the carbapenemase gene (KPC-2). The most common carbapenemases were KPC-3, NDM-5 and OXA-48. The majority of CPE strains were isolated in colonisation samples. The median age of patients was 53.

More than one half of the CPE infections had probably been acquired abroad. In 2013–2016, three clusters of infections caused by KPC-3 positive *K. pneumoniae* (ST512) in care institutions have been found in Finland. One transmission of a KPC-2 positive *C. freundii* strain from patient to patient was found.

K. pneumoniae is the most common finding (approximately 53%). Findings to be reported to the National Infectious Diseases Register (*K. pneumoniae, E. coli* and *E. cloacae*) account for 92% of all CPE findings. While the number of CPE findings remains relatively low in Finland, it has continued to increase since surveillance began in 2009. In particular, an increase has been recorded in carbapenemase-producing strains NDM and OXA-48. In most cases, these involve *E. coli*.

Table 6. Carbapenemase-producing enterobacteria (CPE), 2009–2016, (no. of cases).

	CPE findings	
Year	New bacterial strains	New patients
2009	5	5
2010	8	8
2011	12	11
2012	9	8
2013	21	20
2014	17	14
2015	29	29
2016	36	34

Table 7. Carbapenemase-producing enterobacteria (CPE) in 2016, (no. of cases).

Carbapenemase	Citrobacter freundii	Enterobacter aerogenes	Enterobacter cloacae	E. coli	K. pneumoniae
KPC-2	2		1		1
KPC-3					8
NDM-1				1	4
NDM-5				8	
NMC-A			1		
OXA-244				2	
OXA-48		1		6	1

Tuberculosis

- The number of tuberculosis cases was smaller than in 2015.
- All children who contracted tuberculosis were of foreign origin.
- The percentage of foreigners among patients contracting tuberculosis was 46%, which was a small increase year-on-year.
- The number of drug-resistant *Mycobacterium tuberculosis* strains has increased slightly in recent years.

TUBERCULOSIS (MYCOBACTERIUM TUBERCULOSIS)

Incidence of tuberculosis in 2016

The number of tuberculosis cases was 231 (4.2/100,000), 40 (15%) less than in 2015 (271; 5.0/100,000). Of these, 170 (74%) were cases of pulmonary tuberculosis, 54 (32%) of which produced a positive sputum stain test. There were 184 cases of tuberculosis confirmed by culture (80%), 31 less than in 2015 (215).

The increase in the number of tuberculosis cases in Finland in 2007 and 2008 compared to 2006 can be explained by the introduction in 2007 of the broader EU definition of tuberculosis cases. The annual numbers of cases confirmed by culture are comparable throughout the monitoring period.

The distribution of cases by age group was as follows: 6 (2%) in the age group under 15, 66 (29%) in the age group 15 to 29, 35 (15%) in the age group 30 to 44, 24 (10%) in the age group 45 to 59, 47 (20%) in the age group 60 to 74, and 53 (23%) in patients aged over 75. Population reduction among the age groups in whose youth the incidence of tuberculosis in Finland was high and the increasing number of young immigrants have led to a notable decrease in the average age of tuberculosis patients between 2000 and 2016, from 64 to 50 years. In 2016, all six children who were diagnosed with tuberculosis were of foreign origin.

The patient was reported to be foreign in 106 of all cases (46%), i.e. born abroad and assumed to have other than Finnish citizenship unless the data indicate otherwise. This was one more than the year before. Of the cases, 68 (64%) had pulmonary tuberculosis, and 38 (36%) other forms of tuberculosis. Information on the patient's country of birth or citizenship was missing in 10 cases (4%). Thirty-eight cases (16%) were diagnosed in individuals who did not have a Finnish personal identity code. The majority of these are asylum seekers.

In five (2%) of the tuberculosis cases reported in 2016, the patient also had an HIV infection. In three of these cases, the HIV infection was reported as a new case in 2016, while the HIV infection of the two other patients had been registered before. Two of the patients were of Finnish and three of foreign origin.

Tuberculosis strain susceptibility to medication in 2016

Although susceptibility to medication is still fairly good, the number of *Mycobacterium tuberculosis* strains resistant to tuberculosis medication has grown. Of all cultured strains, 91% had full susceptibility and, in 17 cases, resistance to one or several drugs was diagnosed. Of the six MDR cases diagnosed during the year, one case was an extended-drug resistant (XDR) tuberculosis. One of the MDR cases was in a patient born in Finland, while the others were from Somalia, Eritrea and Afghanistan. Four MDR cases were diagnosed in asylum seekers.

Tuberculosis genotyping findings 2016

M. tuberculosis strains were analysed using the internationally standardised spoligotyping and MIRU-VNTR methods, and whole genome sequencing was also used in investigations of epidemics. The most common spoligotypes were SIT53 (18 strains) and the so-called Beijing type SIT1 (16 strains). Seventy-two (39%) strains belonged to a cluster sharing the same spoligo and MIRU-VNTR type. No major clusters were

observed in 2016, as each cluster consisted of no more than four strains. One MDR-TB strain represented a cluster found among asylum seekers in the EU area, and one XDR-TB strain was linked to mass exposure in Romania.

Tuberculosis outcome surveillance in 2011–2015

Table 9 shows the distribution of treatment outcomes between 2011 and 2015. Cases where the pathogen is an MDR strain are reported separately and are not included in Table 9. An outcome evaluation is performed 12 months after the case is registered.

A significant number (130) of outcome evaluation reports for 2015 were missing when the annual report was written, but the treatment outcome was good in 76% of the cases in 2015 (75 cases). This falls clearly short of the international target set by WHO at 85%, but is on a par with the average for most EU Member States. Mortality (before beginning treatment or during treatment) was 19% in 2015.

Other mycobacteria

A total of 617 non-tuberculotic, environmental mycobacteria were identified (incidence 11.3/100,000). The most common of these found in patient samples were *Mycobacterium gordonae* (163), *Mycobacterium avium* (149) and *Mycobacterium intracellulare* (63). Seven of these were diagnosed in children under the age of 5.

Table 8. Incidence of tuberculosis (cases/100,000 population) and percentage of culture-confirmed cases in Finland, 1995–2016 (no. of cases and %).

	Pulmonary tuberculosis				Other tuberculosis		All cases				Foreigners	
	Cases	Incidence	Cases with positive sputum smear	Incidence	Cases	Incidence	Cases	Incidence	Culture-con-firmed	Culture-conf.%	Cases	%
1995	436	8.6	243	4.8	223	4.4	659	12.9	472	71.6	30	4.6
1996	451	8.8	243	4.7	206	4.0	657	12.8	511	77.8	36	5.5
1997	359	7.1	188	3.7	214	4.3	573	11.4	440	76.8	43	7.5
1998	399	7.8	207	4.0	213	4.1	612	11.9	493	80.6	50	8.2
1999	399	7.7	183	3.5	193	3.7	592	11.5	506	85.5	41	6.9
2000	372	7.2	225	4.4	170	3.3	542	10.5	455	83.9	42	7.7
2001	316	6.1	155	3.0	182	3.5	498	9.6	416	83.5	58	11.6
2002	297	5.7	136	2.6	178	3.4	475	9.1	394	82.9	44	9.3
2003	293	5.6	147	2.8	122	2.3	415	8.0	351	84.6	39	9.4
2004	233	4.5	127	2.4	102	2.0	335	6.4	291	86.9	33	9.9
2005	269	5.1	137	2.6	103	2.0	372	7.1	324	87.1	41	11.0
2006	206	3.9	99	1.9	90	1.7	296	5.6	271	91.6	47	15.9
2007	229	4.4	93	1.8	118	2.2	347	6.6	251	72.3	67	19.3
2008	213	4.0	105	2.0	127	2.4	340	6.4	246	72.4	46	13.5
2009	289	5.5	94	1.8	124	2.4	413	7.9	303	73.4	116	28.1
2010	225	4.2	85	1.6	92	1.7	317	5.9	250	78.9	101	31.9
2011	232	4.3	84	1.6	92	1.7	324	6.0	252	77.8	80	24.7
2012	194	3.6	83	1.5	82	1.5	276	5.1	223	80.8	81	29.3
2013	213	3.9	92	1.7	58	1.1	271	5.0	204	75.3	87	32.1
2014	196	3.6	80	1.5	64	1.2	260	4.8	213	81.9	86	33.1
2015	195	3.6	62	1.1	76	1.4	271	5.0	215	61.6	105	38.7
2016	170	3.1	54	1.0	61	1.1	231	4.2	184	79.7	106	45.9

Table 9. Results of outcome evaluation for treatment of microbiologically confirmed pulmonary tuberculosis, 2009–2015 (no. of cases and %).

	2011	2012	2013	2014	2015
Favourable	131 (69%)	164 (98%)	142 (78%)	117 (75%)	57 (76%)
Cured	74	65	82	67	34
Treatment completed	57	59	60	50	23
Non-favourable	38 (20%)	26 (15%)	33 (18%)	29 (18%)	14 (19%)
Deceased	37	26	32	28	14
Interrupted treatment	0	0	0	1	0
Treatment failure	1	0	1	0	0
Unknown	21 (11%)	18 (11%)	8 (4%)	11 (7%)	4 (5%)
Treatment continues at 12 months	8	8	4	5	1
Unknown	13	10	4	6	3
Total	190	168	183	157	75

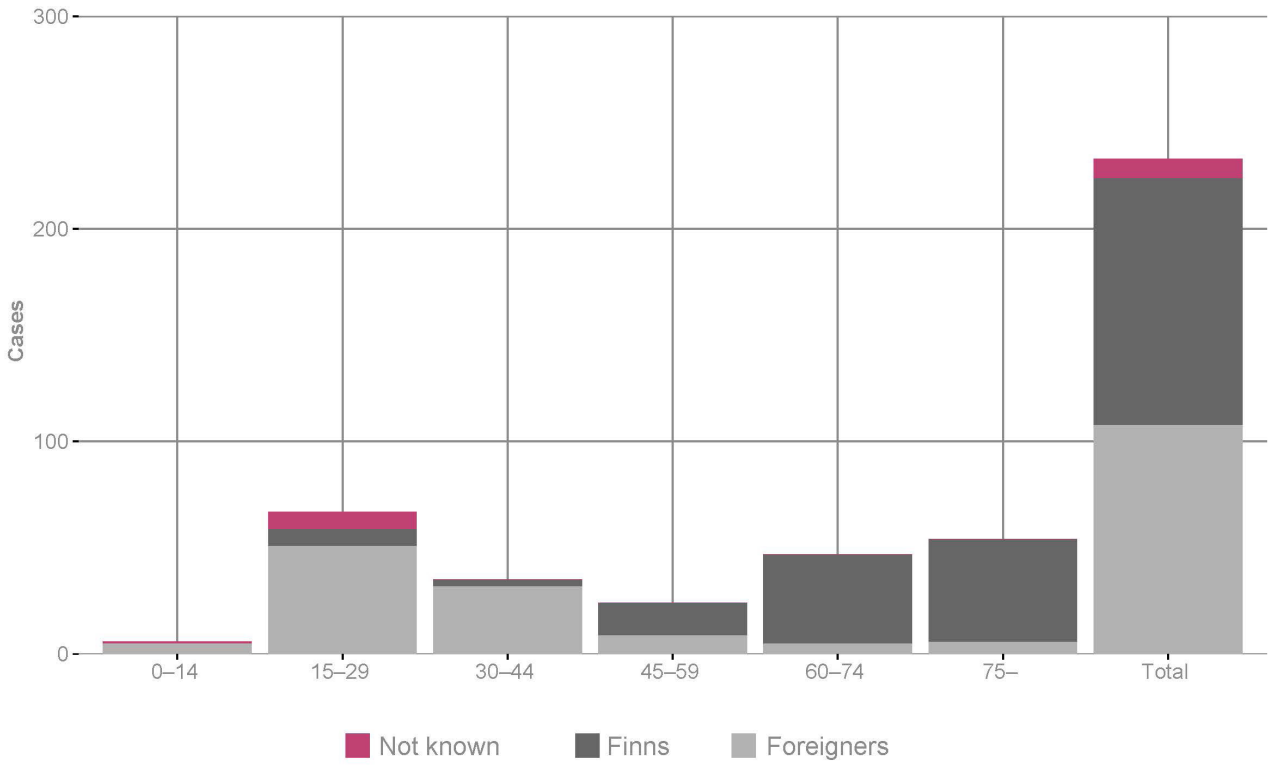

Figure 20. Tuberculosis cases by age group and origin in 2016, (no. of cases).

Other infections

- A similar number of severe pneumococcal infections was diagnosed as in the year before.
- The incidence of pneumococcal infection increased slightly in children under 5 due to the more frequent occurrence of serotypes not included in the vaccine.
- Since the vaccination programme was introduced, severe pneumococcal infections caused by PCV10 vaccine serotypes have been almost totally eliminated in young children, and they continued to decline in 2016 especially in adult age groups.
- Nineteen meningococcal infections were reported, which figure was on a par with the previous year. Exceptionally, the majority of these were diagnosed in women.
- Four measles infections were diagnosed; two of these had been acquired abroad. None of the patients had had the MMR vaccination.
- A total of 1,931 Borrelia cases were reported, which is a slight increase on the record number in 2015.
- Slightly fewer tick-borne encephalitis (TBE) cases were reported than in the peak year of 2015. In mainland Finland, most TBE infections were contracted in known risk areas.
- More cases of Puumala virus were reported than in 2015. The vole populations increased again, especially in Southern and Eastern Finland, which was reflected as a higher number of cases.
- More cases of Pogosta disease were reported than in the year before.
- A significant increase in tuleramia cases was recorded compared to recent years; the number of these cases exceeded the total number reported in the last six years.
- A total of 60 people were exposed to rabies abroad, most commonly in Indonesia and Thailand. Almost one half of the cases of exposure abroad were related to a dog bite, and one third to a monkey bite.
- All cases of malaria, except one, originated in Africa. Approximately one half of the patients were immigrants coming from a malarious area who had travelled in their former home region.
- Six infections caused by the zika virus were diagnosed in Finnish tourists.
- The number of cultured blood samples from children has remained unchanged, and slightly more than one half of the findings were made in infants aged under 12 months.
- The number of early-onset GBS cases in newborns was record-breakingly low at 11 (0.2 cases per 1,000 live births). This is probably due to improved preventive practices.
- Almost 16,000 bacterial findings were detected in cultured blood samples from adults. These findings have constantly increased, particularly in patients aged 65 or over. *Escherichia coli* was the most common finding in both the working age population and in patients aged 65 and over. Other common findings included *Staphylococcus aureus*, a significant percentage of which is known to be treatment-related infections.
- The number of invasive group A streptococcus infections increased in 2016 compared to the year before.

INVASIVE PNEUMOCOCCAL DISEASE (STREPTOCOCCUS PNEUMONIAE)

The number of invasive, severe cases of pneumococcal disease, in which the pathogen was identified in a blood or cerebrospinal fluid culture, was 817 (incidence 15.0/100,000). This equals the figure from 2015 (815; 14.9/100,000). In addition, the number of cases reported merely on the basis of nucleic acid detection totalled nine. No serotype data is available for these cases, and they are not included in the statistics below. Of the patients, 4.0% were under the age of 5 and 50.8% over 65.

The incidence of pneumococcal disease increased slightly in children under 5 due to the higher occurrence of serotypes not included in the vaccine. In older children and the adult age groups, the incidence did not change (Table 10). As before, the incidence was higher in men than in women (16.8 compared to 13.1/100,000). In some hospital districts, the incidence was three times that of others (8.7–25.5/100,000). This may be associated with regional differences in how actively blood cultures are taken. The peak period for these infections was in December, in which month 137 cases were reported to the National Infectious Diseases Register. It coincided with a high number of influenza A cases.

The serotype of 813 (99.5%) cases of pneumococcal disease confirmed by culture was identified. These cases were divided into 36 serotypes or serogroups. Serotypes 3 and 19A caused approximately one fifth each (serotype 3, 167; 20.4% and type 19A, 160; 19.6%) of all cases, and serotype 22F caused more than one out of ten (101; 12.4%) of all cases (Figure 21). These three serotypes were common pathogens, particularly in the elderly. 19A was the most common serotype in children under 5, in whom it caused 45.5% (15/33) of all infections. Together, serotypes 3, 19A and 22F caused more than one half (52%) of all cases reported to the National Infectious Diseases Register (in 2015, 45%).

The 10-valent pneumococcal conjugate vaccine (PCV10) has been included in the national vaccination programme for children since September 2010. Severe pneumococcal diseases caused by serotypes in the PCV10 vaccine (1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F, 23F) have been almost totally eliminated in young children and continued to decrease in 2016, particularly in the 18 to 64 and 65 and over age groups (Table 11). This is an indirect consequence of the vaccination programme for children. In children under 2 years of age, two cases caused by PCV10 serotypes were diagnosed, both in children who had not been vaccinated.

The incidence of serotypes not included in the PCV10 vaccine has increased since the vaccination programme was initiated as the vaccine strains were replaced by others. In 2016, 85% of all infections were caused by serotypes not included in the PCV10 vaccine. The incidence increased year-on-year in all age groups, excluding those aged over 65, in which group a long-term rising trend was halted. For more detailed statistics by age and serotype, please see the National Institute for Health and Welfare website.

The Institute no longer tests the pneumococcus bacteria sent to its strain collection for antimicrobial sensitivity. As before, national statistics on antimicrobial sensitivity collected from clinical microbiology laboratories are published in the annual Finres report.

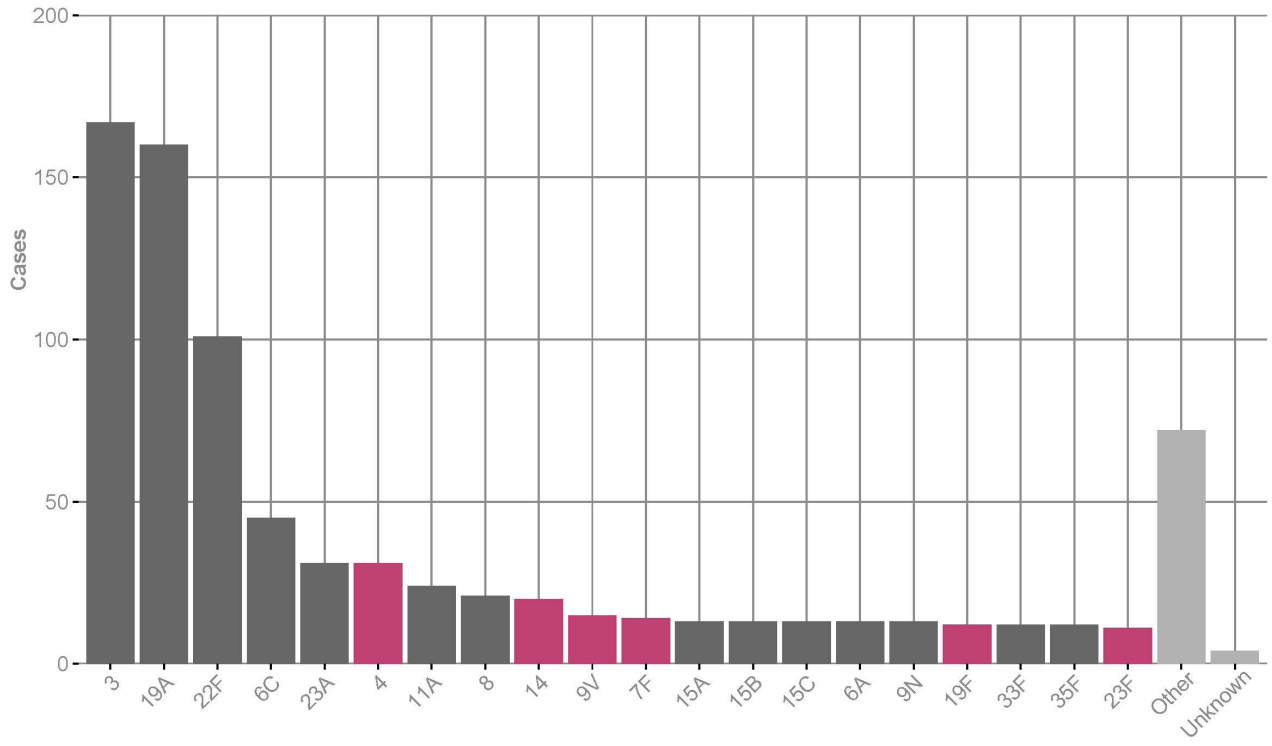

Figure 21. Serotypes of Pneumococcus findings in blood and cerebrospinal fluid 2016 (no. of cases). The column "Other" includes serotypes that caused fewer than 10 cases and the column "Unknown" includes cases whose strains the National Institute for Health and Welfare did not receive. PCV10 serotypes, red columns.

Table 10. Pneumococci isolated in blood and cerebrospinal fluid by age groups 2006–2016, no. of cases and incidence (cases/100,000 population).

	0—1		2—4		5—17		18—64		65—		Total	
year	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I
2006	82	71.3	31	18.4	19	2.3	345	10.5	271	32.3	748	14.2
2007	78	67.4	45	26.5	20	2.5	351	10.7	291	33.9	785	14.9
2008	65	55.1	32	18.4	23	2.9	479	14.4	328	37.5	927	17.5
2009	62	52.2	31	17.6	32	4.2	434	13.0	295	33.1	854	16.3
2010	61	50.6	41	23.8	17	2.2	410	12.2	304	33.4	833	15.6
2011	45	37.0	27	15.7	21	2.7	386	11.6	297	31.7	776	14.5
2012	15	12.3	17	9.4	15	1.9	361	10.8	342	34.9	750	13.9
2013	19	15.8	14	7.6	14	1.8	358	10.8	319	31.3	724	13.3
2014	13	11.0	14	7.6	18	2.3	303	9.1	355	33.6	703	12.9
2015	11	9.5	12	6.5	14	1.8	351	10.6	427	39.2	815	14.9
2016	16	14.2	17	9.5	16	2.1	353	10.8	415	37.1	817	15.0

Table 11. Pneumococci isolated in blood and cerebrospinal fluid by age and vaccine serotypes in 2006–2016, no. of cases and incidence (cases/100,000 population).

	PCV10 vaccine serotypes												Non-vaccine serotypes												Unknown	
	0—1		2—4		5—17		18—64		65—		Total		0—1		2—4		5—17		18—64		65—		Total		All age groups	
year	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I	Cases	I
2006	67	58.3	26	15.4	15	1.8	227	6.9	161	19.2	496	9.4	14	12.2	5	3.0	3	0.4	105	3.2	101	12.5	228	4.3	24	0.5
2007	63	54.5	38	22.4	12	1.5	226	6.9	176	20.5	515	9.8	15	13.0	5	3.0	6	0.8	116	3.5	111	12.9	253	4.8	17	0.3
2008	49	41.5	26	15.0	18	2.2	288	8.7	198	22.6	579	10.9	14	11.9	6	3.5	4	0.5	174	5.2	119	13.6	317	6.0	31	0.6
2009	47	39.6	26	14.8	23	2.9	277	8.3	165	18.5	538	10.3	12	10.1	4	2.3	8	1.0	141	4.2	118	13.2	283	5.4	33	0.6
2010	51	42.3	35	19.7	10	1.3	244	7.3	168	18.5	508	9.5	8	6.6	5	2.8	5	0.6	148	4.4	122	13.4	288	5.4	37	0.7
2011	34	28.0	16	8.9	15	1.9	217	6.5	149	15.9	431	8.0	11	9.5	11	6.1	6	0.8	166	5.0	145	15.5	339	6.3	6	0.1
2012	8	6.6	16	8.8	7	0.9	190	5.7	150	15.3	371	6.9	7	5.8	1	0.6	8	1.3	169	5.6	187	19.9	372	6.9	7	0.1
2013	6	5.0	3	1.6	9	1.2	163	4.9	113	11.1	294	5.4	13	10.8	11	6.0	5	0.7	191	5.7	206	20.2	426	7.9	4	0.1
2014	2	1.7	3	1.6	8	1.3	99	3.0	93	8.8	205	3.8	11	9.3	11	6.0	10	1.3	202	6.9	258	24.4	492	9.0	6	0.1
2015	1	0.9	3	1.6	4	0.5	81	2.5	75	6.9	164	3.0	10	8.6	9	4.9	10	1.3	268	8.1	349	32.0	646	11.8	5	0.1
2016	2	1.8	0	0.0	0	0.0	59	1.8	56	5.0	117	2.1	14	12.5	17	9.4	16	2.1	291	8.9	358	32.0	696	12.7	4	0.1

HAEMOPHILUS (HAEMOPHILUS INFLUENZAE)

The total of 69 (1.26/100,000) infections caused by the *Haemophilus influenzae* bacterium and diagnosed in blood or cerebrospinal fluid represent an increase of about one third from the average for the last ten years. More than a third (24/69, 35%) were diagnosed in patients aged 75 years and over, and almost an equal amount in the age group 60 to 74 (23/69, 33%). In one case, the patient was under 5.

All cases were diagnosed through culture findings, mainly based on blood cultures (65/69, 94%). As in earlier years, the majority (57/69, 83%) were caused by unencapsulated strains of *Haemophilus influenzae* (NTHi). The number of NTHi infections went up by approximately one third compared to 2015, especially in those aged 75 and over. Only one infection caused by serotype b was found. The patient was an adult individual in whose childhood the Hib vaccine was not yet part of the national vaccination programme. Serotype f caused an infection in eight people, one of whom was a 4-year-old child, one a 16-year-old and the remainder adults. Serotype e caused two infections, both in elderly adults. In one case, the National Institute for Welfare and Health did not obtain the strain, and its serotype remains unknown.

Children born in 1985 or later have been given the Hib vaccine at their child care clinics. While the vaccination programme has succeeded in effectively reducing the number of serious infections caused by bacteria of serotype b and the circulation of the bacteria within the population, cases may still occur in children with incomplete vaccination coverage.

Table 12. Cases of Haemophilus influenzae by serotype in 2007–2016, (no. of cases).

	Unencapsulated	a	b	e	f	Unknown	All cases
2007	44	0	6	1	1	2	54
2008	33	0	3	0	8	1	45
2009	30	0	6	2	7	2	47
2010	30	0	5	2	3	1	41
2011	57	0	4	2	2	1	66
2012	73	0	4	0	4	0	81
2013	40	1	1	1	5	0	48
2014	48	0	5	0	6	0	59
2015	40	0	1	2	9	0	52
2016	57	0	1	2	8	1	69

MENINGOCOCCUS (NEISSERIA MENINGITIDIS)

The number of meningococcal infections detected in blood or cerebrospinal fluid totalled 19 (0.35/100,000), which is on par with the previous three years. Exceptionally, the majority of these findings were in women (15/19, 79%): in previous years, men usually have had slightly more of these infections than women. Of the patients, one (5%) was under the age of 3 months, six (32%) were aged 16 to 20, and the remainder (12/19, 63%) were in the age group 25 to 88. It was reported that one patient had been in military service when the disease was diagnosed.

Eighteen cases were diagnosed through a bacterial culture finding and one through nucleic acid detection. All bacterial strains were serogrouped and analysed through full genome sequencing. 6 (33%) were of serogroup B, 5 (28%) of serogroup Y, 4 (22%) of serogroup C, and three (17%) of serogroup W. The serogroup of one case diagnosed through nucleic acid detection remained unknown. One of the infections caused by serogroup B was diagnosed in a child aged 3 months, and the remainder in the age group 20 to 80; 83% (5/6) were in women. Serogroups C, Y and W caused infections across the board from young people to older age groups (16 to 88); serogroups C and W occurred especially frequently in women. Three of the serogroup C cases were part of an epidemic found in Southern Finland in the autumn that was caused by the C:P1.5,2:F3-3:ST-11(cc11) bacteria, which represent a hypervirulent clone. No other epidemics or clusters were found.

Except for the serogroup C strain that caused the epidemic, most of the bacterial strains were different and represented several different types. Serogroup B bacteria represented five different types that were divided into three clonal groups. Two types of serogroup C bacteria were identified. One of these, or (C:P1.5,2:F3-3:ST-11(cc11)), caused the cases associated with the cluster in Southern Finland, while the other, or (C:P1.7,16-29:F3-3:ST-32(cc32)), occurred in an isolated case in Pirkanmaa; in 2015, the latter strain caused two cases in Western Finland. The serogroup W strains were divided into three types, two of which were genetically close. Both represent the hypervirulent cc11 clone, which has become more common in recent years, particularly in England and Wales, and which caused three severe cases in Finland in 2015. However, serogroup W meningococcus remains extremely rare in Finland (2016: 0.05/100,000). There were five different types of serogroup Y bacteria, and typically of the strains in this group, four of these represented the cc23 clone.

In sporadic cases of meningococcal infection, all persons in close contact with the patient – except for health care personnel – should be given prophylactic medication and a vaccination, if infection with the strain in question can be prevented by vaccination. Finland has vaccines against the meningococcal serotype groups A, C, W and Y. Since the 1970s, the Defence Forces have administered a polysaccharide vaccination to all recruits. In recent years, cases in conscripts confirmed by cultures have been caused by the serogroup B, against which the currently used vaccine does not give protection. Conjugated meningococcal vaccines are mainly used in connection with epidemics and travel. The Defence Forces are also introducing a conjugated ACWY vaccine, as the polysaccharide vaccination is no longer being manufactured. Two new recombinant protein vaccines have also been launched in the EU market that gives protection against group B meningococcal strains.

Table 13. Meningococcal infections by serogroup, 2007–2016 (no. of cases).

	A	B	C	W	Y	Unknown	Total
2007	0	29	8	0	5	0	42
2008	0	18	8	0	1	1	28
2009	0	24	3	0	5	1	33
2010	0	14	4	1	13	2	34
2011	0	19	6	1	7	1	34
2012	0	17	3	1	8	4	33
2013	0	10	2	0	8	0	20
2014	0	7	5	1	5	3	21
2015	0	8	5	4	3	2	22
2016	0	6	4	3	5	1	19

MMR DISEASES (MEASLES, MUMPS, RUBELLA)

In 2016, the occurrence of diseases prevented by the MMR vaccine was slightly higher than in previous years in Finland.

Four cases of measles were diagnosed (2015: 2). Two individuals had acquired the infection abroad. Two diagnoses were later made in the home town of one of these patients, where this individual had been the source of infection. None of those who contracted the disease had been vaccinated. All the patients were of Finnish origin and aged 17 to 44.

Six cases of mumps were diagnosed (2015: 2). Four of the infections had been acquired abroad, while in two cases the source of infection remained unclear. Two of the patients had received the two MMR vaccinations that are part of the vaccination programme as children; more than 20 years had elapsed since the latest vaccination had been administered in both cases. One had received a single dose of the vaccine more than ten years before falling ill, two were unvaccinated, and the vaccination history of one was unknown.

No cases of rubella were diagnosed in 2016.

VARICELLA VIRUS

The number of varicella findings reported to the National Infectious Diseases Register was 519 in 2016, which corresponds to the previous years' levels (2013: 455, 2014: 478, 2015: 505). Virus findings were reported among all age groups, the youngest being one month and the oldest 94 years old. Of these findings, 39% were diagnosed by antigen detection, 31% by nucleic acid detection, and 29% by serological diagnostics. The number of reports based on diagnosis from cerebrospinal fluid was 60 (11%). The majority of these (90%) involved nucleic acid detection, while the role of diagnoses based on antibodies and antigen detection was minor.

Childhood varicella or chicken pox is a very common disease, with an estimated 57,000 cases in Finland every year. Most people contract the infection when aged under 5. In most cases, it is diagnosed on the basis of symptoms and does not result in a laboratory sample being taken. In contrast herpes zoster, or shingles, caused by the varicella virus being reactivated, is common, particularly in the elderly and requires the use of health care services, which can be seen in the age distribution of the virus findings: the proportion of patients aged 65 or over in the reported cases was 30%, while the percentage of those aged under 5 was as low as 10%.

Varicella vaccination is currently recommended for persons in close contact with immunocompromised individuals and everyone aged 13 or over who has not had the chicken pox. The varicella vaccination will be included in the national vaccination programme in autumn 2017; in the future, all children will be vaccinated at the ages of 18 months and 6 years. Initially, the varicella vaccine will be administered to all children aged 1.5-12 years who have never had chickenpox.

BORRELIA (LYME DISEASE)

The laboratories reported a total of 1,931 Borrelia findings in 2016, which is a slight increase on the record number in 2015 (1,912). Of these reports, 8 were based on nucleic acid detection, 1,895 on a serological test, and 28 on a combination of these methods. Cases were reported in all parts of the country. While the average incidence was 35/100,000, regional variation was considerable. As in previous years, the incidence was highest in Åland (2,114/100,000), the 613 cases diagnosed there accounting for almost a third of all cases of Borrelia in Finland. As before, the frequency of Borrelia was highest in the autumn, the majority of cases occurring from August to October. The majority of cases (76%) were diagnosed in patients aged 45 and over. No differences between genders were observed. The Borrelia findings in the National Infectious Diseases Register do not give an up-to-date picture of the borreliosis epidemiology, and the cases mainly represent late-stage borreliosis. In the early stage, the disease is diagnosed based on clinical symptoms, and these cases are reported in the outpatient care register of the public health services.

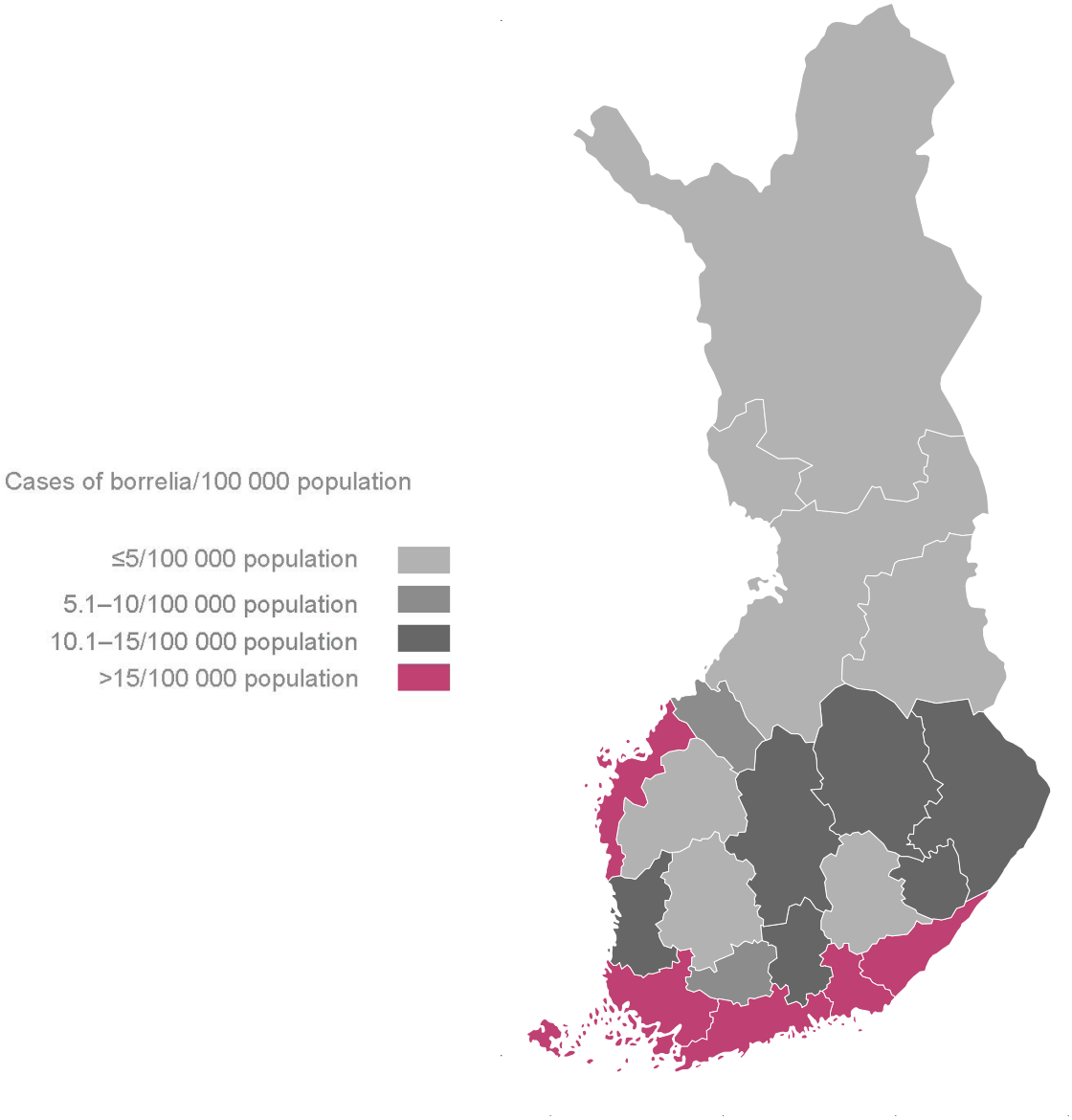

Figure 22. Incidence of Borrelia (cases/100,000 population) by hospital district, 2016.

TICK BORNE ENCEPHALITIS (TBE)

In 2016, 61 TBE antibody findings were reported to the National Infectious Diseases Register, or somewhat less than the record-breaking figure of the year before (67). Positive findings were diagnosed in April–November, mainly in August. Patients who contracted TBE were aged between 4 and 84 (average age 51), and one elderly person died.

In order to identify the place of acquisition, the National Institute for Health and Welfare interviewed patients who had been diagnosed with TBE and/or studied their patient records. Six patients contracted TBE on the Åland Islands, 49 in mainland Finland, five abroad (Estonia, Sweden) and, in the case of one individual, the place of infection remained unclear. All residents of Åland have been entitled to a TBE vaccination free of charge since 2006, and in 2017, these vaccinations have also been offered to residents in the municipalities of Parainen and Simo.

In mainland Finland, most TBE infections were contracted in known risk areas: the Turku archipelago (16), of which 15 occurred in Parainen; Kirkkonummi (5), the Lappeenranta region (3), and the region of Simo and Kemi (3). Other places of infection included Lohja (3), Espoo (3, more specifically Espoonkartano and Matinkylän shore), the Raahe archipelago (2), Helsinki (3, more specifically Karhusaari in one case), Turku (2), the Sipoo archipelago (2, Röysy), the Western Uusimaa archipelago (1, no further details), Ilomantsi (1), Salosaari in Ruokolahti (1), Kaakkuri in Oulu (1), Luoto (1) and Rauma (1). Unlike the previous year, no diagnosed infections were contracted in the Kotka archipelago. Rautjärvi (1) emerged as a potential new area of infection.

The TBE virus was identified in ticks not only in Åland, but also in the Turku archipelago and the Lappeenranta region decades ago, and in collections performed in the following risk areas in recent years: Isosaari in Helsinki, the Kokkola archipelago and Maksniemi in Simo. Individual findings have recently also been confirmed in traditional lower-risk areas (Tampere region, Ilomantsi).

If a patient falls ill with meningitis or encephalitis between May and November, even if he or she has not noticed a tick bite, TBE should be suspected, especially if the case occurs in a known high-risk area. Because new endemic TBE regions may continue to emerge, however, the possibility of TBE infection should be considered even beyond currently known risk areas.

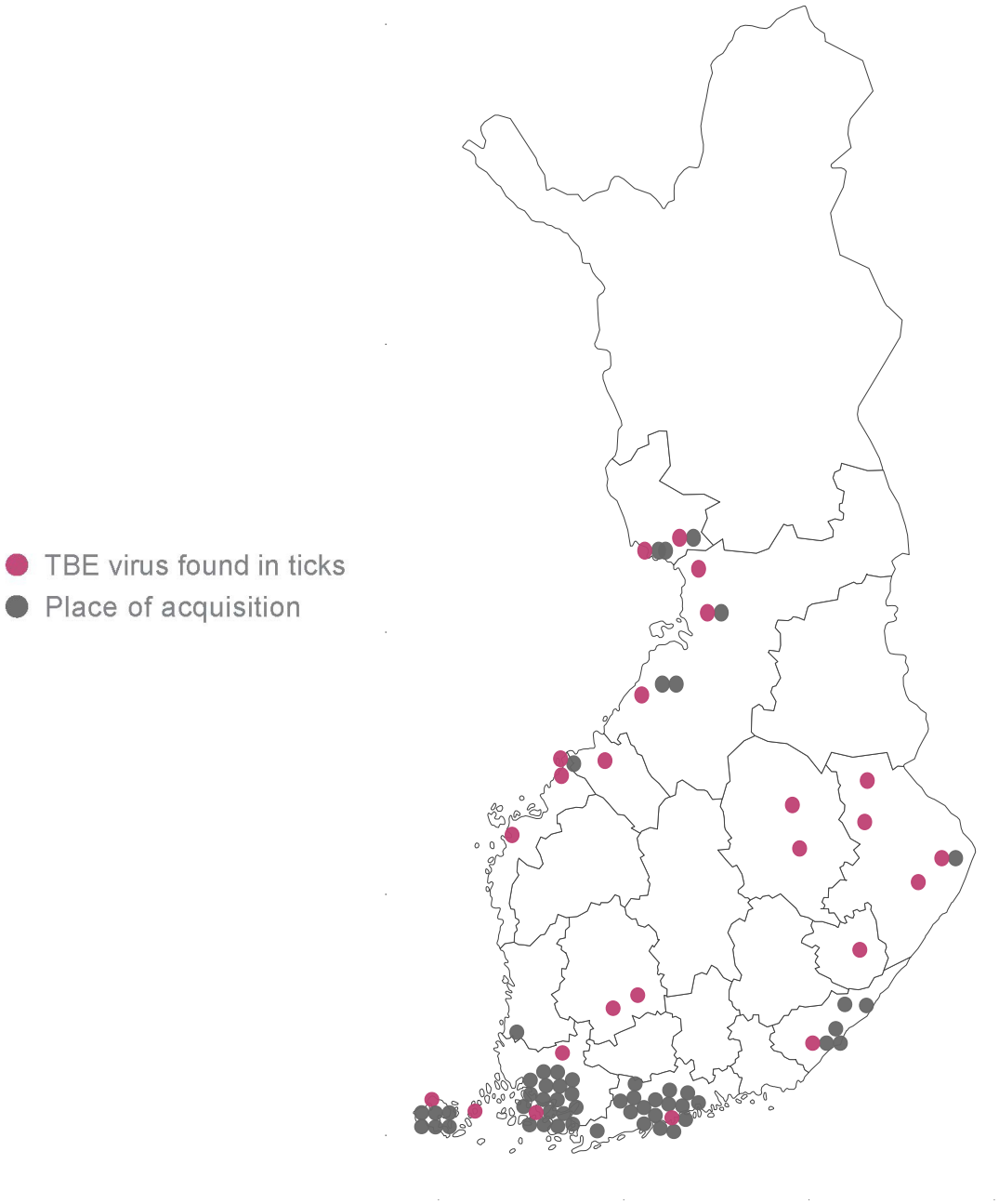

Figure 23. Cases of TBE by location of acquisition, 2016, and TBE virus findings in ticks, 1996–2016.

PUUMALA VIRUS

In 2016, a total of 1,662 cases of Puumala virus infection were reported (30.4/100,000), which exceeds the figure for 2015 (1,463). The incidence of the virus varies depending on the virus reservoir, i.e. the size of the bank vole population, following a three- or four-year cycle, in accordance with the geographical region. The previous peaks occurred in 2005, 2008, 2011 and 2014. The vole populations increased again in 2016, especially in Southern and Eastern Finland, which was reflected as a higher number of cases.

Of the patients, 59% were men and most patients were of working age. Sixty-four (3.9%) cases occurred in patients under 20 years of age. The incidence was the highest in the hospital districts of East Savo (203/100,000) and North Karelia (>87/100,000).

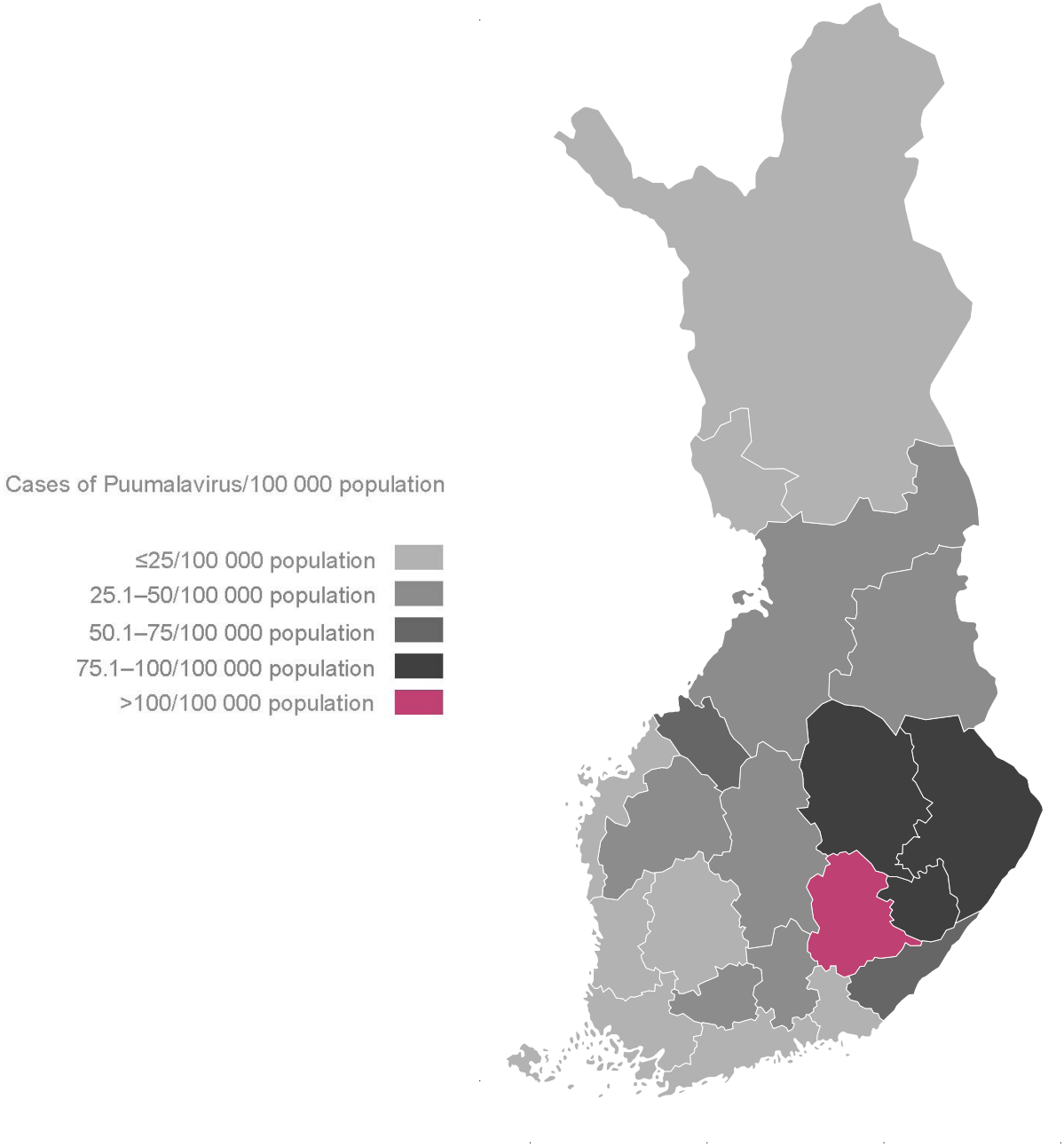

Figure 24. Incidence of Puumala virus (cases/100,000 population) by hospital district, 2016.

POGOSTA DISEASE (SINDBIS VIRUS)

In 2016, 31 cases of Pogosta disease, confirmed by antibody testing, were diagnosed in Finland. This exceeded the previous year's figure (15). The incidence was highest in the Central Ostrobothnia Hospital District (5.1/100,000). Only six cases were confirmed in the North Karelia Hospital District, historically a high incidence area (3.6/100,000). Almost all (30/31) of the patients were in working age (age group 15 to 64), 71% were women, and 81% of the cases were diagnosed in August–September.

Pogosta disease has previously followed a regular seven-year cycle. The epidemic peaked in 1981, 1995 and 2002. In 2009, however, the cycle was not repeated as expected, and the number of cases in 2016 remained very low compared to years with epidemics.

TULAREMIA (FRANCISELLA TULARENSIS)

In 2016, 699 tularemia cases were reported (incidence 12.8/100,000). This was a significant increase compared to recent years; the number of these cases exceeded the total number reported in the last six years. The incidence was highest in the hospital districts of Central Ostrobothnia (115/100,000) and South Ostrobothnia (100/100,000). Most cases were diagnosed in August–September (605/699, 87%). The annual incidence of tularemia varies considerably (between 0.2 and 18/100,000) and local epidemics break out every few years, particularly in the regions of Ostrobothnia and Central Finland, usually following years with plentiful vole populations. The weather conditions also affect the number of mosquitoes and thus the scale of the outbreaks.

RABIES

Doctors are required to report cases where risk assessment after exposure has led to the administration of a course of rabies vaccinations and, possibly, rabies immunoglobulin treatment. In 2016, 85 reports were made, which was a clear increase on 2015 (40).

The number of patients who had been exposed while travelling abroad was 60 (70%): 16 in Indonesia and 15 in Thailand. Cases of exposure in the following countries were also reported: 4 in Russia, 3 in India, 2 in Malaysia, 3 in Turkey, 3 in Estonia, 2 in Greece and 2 in Serbia. Others were individual cases of exposure in different countries.

More than one half of the cases of exposure abroad were related to a dog bite (28). The number of reported cases related to a monkey bite was 21, which was a considerable increase on 2015 (6). The remaining individual cases of exposure abroad related to contact with cats, bats and rats. Three of the reports did not specify the animal involved.

Twenty-four cases of exposure in Finland were reported, 12 of which were related to bats and the others to contacts with a dog or a raccoon dog. Six of the reports did not specify the animal involved. No cases of exposure to rabies bait vaccine were reported in 2016.

TRAVEL-RELATED INFECTIONS

Malaria

Malaria was diagnosed in 47 patients in Finland in 2016. There were 37 cases of *Plasmodium falciparum*, nine cases of *P. ovale* and a single case of *P. vivax*. Of these infections, 46 (98%) originated in Africa, while one was acquired in Afghanistan. Of the patients, 26 (55%) were immigrants from a malaria area who had returned to visit their former home region; 7 (15%) were immigrants who had fallen ill immediately after arriving in Finland; and one was a visitor to Finland. Ten of the patients (21%) were native Finns who had taken a trip of less than six months to a malaria region, and two were Finns residing in a malaria region. The countries of acquisition and risk groups of malaria have changed little from previous years.

One half of the malaria cases were diagnosed in the Helsinki Metropolitan Area, while the remainder were found in other areas of Finland. Of the malaria patients, 35 (74%) were treated at university hospitals, while 12 (26%) were treated at central hospitals. No malaria deaths were reported.

Table 14. Malaria cases in Finland in 2016 by country of acquisition.

Continent	Country	Cases
Asia	Afghanistan	1
	Total	1
Africa	Angola	1
	Benin	3
	South Sudan	2
	Ethiopia	1
	Gambia	1
	Ghana	7
	Guinea	1
	Cameroon	4
	Kenya	4
	Democratic Republic of Congo	2
	Malawi	1
	Nigeria	10
	Ivory Coast	1
	Rwanda	1
	Zambia	4
	Sierra Leone	1
	Somalia	1
	Tanzania	1
	Total	46
Grand total		47

Chikungunya

No chikungunya infections were diagnosed in Finnish tourists in 2016. The year before, the number of cases was seven. In 2016, approximately 350,000 infections caused by the chikungunya virus were reported in the Caribbean and Americas, clearly fewer than in previous years, indicating that the outbreak is abating in this area. Outbreaks of minor epidemics were also reported in the Pacific islands.

Dengue fever

The annual number of dengue fever infections has varied between 35 and 90. In 2016, laboratories reported 66 findings; the majority of which (64/66) occurred in the age group 15 to 59. Diagnoses were made at all times of the year, the highest number in January–March (25) and the lowest in July–September (6). Of the infections, 15 were reported as having been contracted in Asia (Thailand 4, Indonesia 5, the Philippines 1, the Maldives 1, Bangladesh 1, Vietnam 1 and Laos 1), and 4 in South America and the Caribbean (Argentina 2, the Dominican Republic 1, Mexico 1). Information on the country of acquisition is not available for the National Infectious Diseases Register in all cases.

Zika virus

In 2016, six infections caused by the zika virus were diagnosed in Finnish tourists. Through intensified surveillance, data on the countries of acquisition and other details were obtained. Of the infections, five had been acquired in the South and Central American area (Brazil 2, Costa Rica 2, the Caribbean 1), where the zika virus was spreading rapidly in 2016. One infection had been contracted in Asia (the Philippines). It is likely that mosquitoes were the source of all the infections. The patients were aged 24 to 39, and 4 of them were women.

Other travel-related infections

A significant percentage of the following infections are travel-related: legionella, salmonella, campylobacter, shigella, EHEC, hepatitis A, hepatitis B, gonorrhoea, syphilis, HIV and AIDS, carbapenem-resistant gram-negative bacilli, MMR diseases and exposure to rabies. Data on the country of acquisition and means of transmission is discussed separately for each of these diseases in the respective section of this report.

BLOOD AND CEREBROSPINAL FLUID FINDINGS IN CHILDREN

Blood culture findings in children

In 2016, 439 cases of bacterial findings were diagnosed in blood cultures from children under 15 years of age. In comparison with previous years, the number has remained largely unchanged (in 2012−2015: 452 on average, variation 440−461), whereas in earlier years, the number of findings was clearly higher (in 2007–2011: 608 on average, variation 551–662).

Slightly more than one half of the findings (234/439) were made in children aged under 12 months. In infants, *Staphylococcus epidermidis* and other coagulase-negative staphylococci caused 34% of blood culture positive infections (Table 15). Although these bacteria belong to normal skin flora, they typically cause treatment-related late-onset sepsis in newborn babies in intensive care. *Streptococcus agalactiae* (Group B streptococcus, GBS), typically contracted from the mother's birth canal during labour and causing an infection (early-onset sepsis) in the newborn baby

during its first days of life, caused 9% of the findings. The number of *Escherichia coli* (21% of all findings) and Klebsiella (4%) findings had increased clearly from previous years. *Staphylococcus aureus* (9%) and *Enterococcus faecalis* (6%) continued to be other common causes of infections.

In the age group 1 to 14 years, *S. aureus* (26%) was the most common cause of blood culture positive infections in 2016 (Table 16). The number of *S. pneumoniae* findings decreased quickly after the introduction of a pneumococcus vaccination to the national vaccination programme in 2010; in 2012–2015, 27 to 35 cases were diagnosed annually (12–17% of all findings), while in 2016, the number of pneumococcus findings was 38 (19%). Other common findings in this age group were coagulase-negative staphylococci (19%), *E. coli* (7%), *Streptococcus pyogenes* (5%) and the *Streptococcus viridans* group (4%).

Fungal findings are rare in children's blood cultures. However, in 2016 *Candida albicans* was diagnosed in two children, and *Candida parapsilosis* in two children aged 0 to 14 based on blood cultures.

Cerebrospinal fluid findings in children

The number of cerebrospinal fluid findings related to children's central nervous system infections remained on a par with previous years, as did the distribution of pathogens. The total number of findings reported in 2016 was 14 (in 2007−2015: 28 on average, variation 22–37). Eight of these infections were diagnosed in children under the age of 12 months.

Bacteria found in the age group under 12 months included *S. agalactiae*, coagulase-negative staphylococci, *E. coli, S. pneumoniae* and *Neisseria meningitidis* (Table 17); the findings in the age group 1 to 14 were sporadic and included *S. pneumoniae* and *Haemophilus influenzae* (Table 18). There were no fungal findings in cerebrospinal fluid samples.

GBS in newborns

Between 1995 and 2014, an average of 31 cases per year of early-onset GBS in newborns (diagnosed from blood and/or cerebrospinal fluid in children under the age of 7 days) were reported; the variation was 17 to 57 cases per year, and the incidence was 0.3 to 1.0 per 1,000 live births. In 2015, the number of cases was clearly lower: 13 (0.2 cases per 1,000 live births), and in 2016, as low as 11 (0.2/1,000 live births). The majority of early-onset GBS cases can be prevented by administering an antimicrobial prophylaxis to mothers whose GBS colonisation puts the newborn at risk of a GBS infection. The preventive practices have improved in recent years, which is likely to explain the reduction of infections in newborns. An average of 14 annual cases of late GBS disease detected at the age of more than 7 days have occurred in 1995–2015 (range 6 to 24; incidence 0.1 to 0.4 cases per 1,000 live births). There were 9 cases in 2016 (0.2 cases per 1,000 live births). Antimicrobial prophylaxis during labour does not prevent early-onset GBS in newborns.

Table 15. Blood culture findings in infants (under 12 months), 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Escherichia coli	42	38	37	45	48	25	41	37	38	50
Staphylococcus epidermidis	92	87	64	71	76	50	62	46	49	46
Staphylococcus, other coagulase-negative	43	34	43	32	35	26	33	45	34	33
Streptococcus agalactiae	51	49	51	54	42	36	33	31	26	20
Staphylococcus aureus	25	23	22	24	21	31	22	20	28	20
Enterococcus faecalis	8	5	10	20	12	15	16	9	10	13
Klebsiella species	6	7	9	3	7	6	6	4	3	10
Enterobacter species	8	6	3	3	10	5	4	2	7	10
Streptococcus pneumoniae	21	26	25	20	11	8	8	6	6	8
Streptococcus, other beta-haemolytic	0	0	4	2	0	1	1	1	1	5
Streptococcus viridans group	9	8	9	16	13	6	8	8	9	5
Serratia species	3	4	1	2	4	0	1	0	4	2
Pseudomonas aeruginosa	0	2	0	2	1	0	0	0	3	1
Propionibacterium species	1	0	0	0	1	0	0	0	0	1
Neisseria meningitidis	3	3	5	4	1	2	4	3	1	1
Citrobacter species	0	0	1	1	0	1	0	0	0	1
Bacteroides fragilis group	1	1	0	1	0	0	0	0	0	1
Bacillus	4	4	2	1	1	1	1	1	5	1
Acinetobacter	2	1	1	3	2	1	2	0	0	1
Enterococcus faecium	0	1	2	2	1	2	1	1	0	1
Streptococcus pyogenes	3	2	4	2	0	6	1	2	0	0
Streptococcus bovis group	0	0	2	0	0	0	0	0	0	0
Stenotrophomonas maltophilia	2	0	2	2	0	0	0	0	0	0
Pseudomonas, other than aeruginosa	0	0	0	0	0	0	0	1	0	0
Proteus mirabilis	1	0	0	0	0	0	0	0	0	0
Prevotella species	0	1	0	0	0	0	0	0	0	0
Peptostreptococcus and Peptococcus	0	0	0	1	0	0	0	0	0	0
Listeria monocytogenes	1	0	1	2	0	1	1	1	0	0

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bacteroides, other than fragilis group	0	0	0	0	0	0	0	0	1	0
Yersinia enterocolitica	0	0	0	0	0	0	0	1	1	0
Salmonella, other than Typhi or Paratyphi	0	0	1	0	0	0	1	1	1	0
Haemophilus, other than influenzae	0	1	0	0	1	0	0	0	0	0
Haemophilus influenzae	1	2	2	1	0	4	1	2	1	0
Enterococcus, other or unidentified	0	0	2	0	0	1	0	0	0	0
Clostridium, other than perfringens	0	0	0	0	0	1	0	0	0	0
Other bacteria	7	7	5	5	9	8	3	6	5	4
Bacteria total	334	312	308	319	296	237	250	228	233	234
Other candida species	2	1	0	0	1	2	0	1	0	1
Candida albicans	2	3	1	2	1	1	2	3	2	1
Other fungi	0	0	0	0	0	0	0	0	0	0
Fungi total	4	4	1	2	2	3	2	4	2	2

Table 16. Blood culture findings in children (aged 1 to 14), 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Staphylococcus aureus	42	40	36	43	42	47	48	40	54	53
Streptococcus pneumoniae	115	87	92	95	74	35	35	32	27	38
Staphylococcus epidermidis	33	22	31	37	29	17	25	28	26	22
Staphylococcus, other coagulase-negative	19	13	17	21	13	11	9	19	23	17
Escherichia coli	12	14	12	15	11	14	9	17	20	14
Streptococcus pyogenes	13	11	11	6	15	9	8	14	13	10
Streptococcus viridans group	21	21	25	37	23	27	27	14	10	9
Streptococcus milleri group	0	2	2	2	1	1	0	2	2	7
Klebsiella species	6	5	2	4	2	6	3	0	1	5
Bacteroides fragilis group	0	0	1	0	2	0	0	1	1	4
Enterococcus faecalis	6	6	4	6	3	5	1	2	3	3
Streptococcus, other beta-haemolytic	4	0	2	3	1	1	1	1	4	3
Citrobacter species	2	2	1	1	0	0	0	3	0	2
Stenotrophomonas maltophilia	3	4	2	2	0	1	1	1	0	2
Clostridium, other than perfringens	1	1	1	4	4	1	1	2	0	1
Haemophilus influenzae	2	3	3	2	5	0	3	5	1	1
Bacillus	0	6	3	3	2	5	5	4	6	1
Enterobacter species	2	4	3	2	3	1	0	0	6	1
Propionibacterium species	0	0	0	0	0	2	1	0	0	1
Pseudomonas aeruginosa	2	1	3	7	4	3	4	9	1	1
Serratia species	1	0	0	1	0	0	1	0	0	1
Clostridium perfringens	2	0	1	1	0	0	0	0	0	0
Corynebacterium diphteriae	0	0	0	0	0	0	0	1	0	0
Enterococcus faecium	4	2	7	7	0	2	2	1	0	0
Enterococcus, other or unidentified	2	3	0	1	0	0	1	0	0	0
Haemophilus, other than influenzae	0	0	0	0	0	1	1	0	1	0
Salmonella Paratyphi	0	0	0	0	0	0	0	0	0	0
Salmonella Typhi	2	0	0	0	2	0	1	0	0	0

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Salmonella, other than Typhi or Paratyphi	5	2	0	6	2	3	4	1	1	0
Yersinia enterocolitica	0	0	0	0	0	0	0	0	0	0
Yersinia pseudotuberculosis	0	0	0	0	0	0	0	0	0	0
Acinetobacter	2	2	4	1	0	1	3	1	3	0
Bacteroides, other than fragilis group	0	0	0	0	0	0	0	0	0	0
Fusobacterium species	5	5	1	1	1	1	1	1	0	0
Listeria monocytogenes	0	0	0	0	0	0	1	0	0	0
Mycobacterium species	0	0	0	0	1	0	0	0	1	0
Neisseria meningitidis	3	4	0	6	2	2	3	1	1	0
Peptostreptococcus and Peptococcus	0	0	0	0	2	1	0	0	1	0
Proteus mirabilis	1	0	0	0	0	0	0	0	0	0
Pseudomonas, other than aeruginosa	1	0	3	0	0	0	0	0	1	0
Streptococcus agalactiae	2	1	0	0	0	0	0	0	0	0
Streptococcus bovis group	0	0	0	0	0	0	0	0	1	0
Veillonella species	0	0	0	1	0	0	0	0	0	0
Other bacteria	15	10	13	24	11	14	9	12	20	9
Bacteria total	328	271	280	339	255	211	208	212	228	205
Other candida species	3	1	0	0	3	0	1	0	1	1
Candida albicans	0	2	0	2	0	1	2	1	1	1
Fungi total	3	3	0	2	3	1	3	1	2	2

Table 17. Cerebrospinal fluid culture findings in infants (under 12 months), 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Streptococcus agalactiae	8	3	6	10	3	4	1	7	3	3
Staphylococcus, other coagulase-negative	0	4	1	0	0	2	0	0	0	2
Streptococcus pneumoniae	4	3	2	3	2	1	2	2	0	1
Neisseria meningitidis	2	1	2	1	0	3	3	2	0	1
Escherichia coli	1	1	1	2	1	0	0	2	2	1
Streptococcus, other beta-haemolytic	0	0	0	0	0	0	0	0	0	0
Streptococcus viridans group	0	0	2	0	1	0	0	0	0	0
Streptococcus pyogenes	0	0	1	0	0	0	0	0	0	0
Enterococcus faecalis	1	0	0	0	0	0	0	0	0	0
Staphylococcus epidermidis	2	1	2	2	2	1	3	2	0	0
Staphylococcus aureus	1	2	2	1	0	3	2	1	1	0
Propionibacterium species	0	0	0	0	0	0	0	1	0	0
Mycobacterium species	0	0	0	1	0	0	0	0	0	0
Bacillus	0	0	0	0	0	0	0	1	0	0
Haemophilus influenzae	0	0	1	0	0	0	0	1	0	0
Bacteroides, other than fragilis group	1	0	0	0	0	0	0	0	0	0
Klebsiella species	0	0	1	0	0	1	0	0	0	0
Citrobacter species	1	0	0	1	0	0	0	1	0	0
Other bacteria	0	0	1	0	0	0	1	1	0	0
Bacteria total	21	15	22	21	9	15	12	21	6	8
Candida albicans	0	0	1	0	0	0	0	0	0	0
Fungi total	0	0	1	0	0	0	0	0	0	0

Table 18. Cerebrospinal fluid culture findings in children (aged 1 to 14), 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Staphylococcus epidermidis	1	5	2	1	2	1	0	3	3	1
Streptococcus pneumoniae	5	2	4	2	3	0	4	2	1	1
Streptococcus viridans group	0	0	0	0	0	0	0	0	2	1
Propionibacterium species	0	0	0	0	1	0	0	1	2	1
Haemophilus influenzae	0	0	0	0	1	0	0	1	0	1
Enterobacter species	0	0	1	0	0	1	0	0	0	1
Streptococcus, other beta-haemolytic	0	0	1	0	0	0	0	0	0	0
Streptococcus pyogenes	0	0	0	0	0	1	0	0	0	0
Enterococcus faecalis	0	0	0	1	0	0	0	0	1	0
Staphylococcus, other coagulase-negative	0	0	1	0	0	0	1	0	1	0
Staphylococcus aureus	2	3	3	2	2	2	1	0	1	0
Neisseria meningitidis	6	3	2	3	4	2	3	1	2	0
Escherichia coli	0	0	0	0	0	1	0	0	0	0
Other bacteria	0	2	1	1	0	0	1	1	1	0
Bacteria total	14	15	15	10	13	8	10	9	14	6
Candida albicans	0	0	0	0	0	1	0	0	0	0
Fungi total	0	0	0	0	0	1	0	0	0	0

BLOOD AND CEREBROSPINAL FLUID FINDINGS IN ADULTS

Blood culture findings in adults

In 2016, the total number of bacterial findings in adults' blood culture samples was 15,907. The number of findings has increased continuously, and the year-on-year increase was considerable (9%). The majority (69%, 10,921/15,907) of the blood culture findings were made in the age group 65 and over. Gram-positive bacteria were more common in the working-age population (aged 15 to 64) and gram-negative bacteria among those aged 65 and over. The number of fungi findings in adults' blood cultures has remained stable (in 2007–2015, 209 cases on average, variation 174 to 252). In 2016, a total of 209 findings were made (1.3% of all blood culture findings in those aged 15 or over).

Escherichia coli was the most common finding in both the working age population (24% of findings) and in patients aged 65 and over (34%). Other common bacterial findings (Tables 19 and 20) were *Staphylococcus aureus* (working age 17%, aged 65 and over 12%), coagulase-negative staphylococci (working age 9%, 65 and over 7%), *Streptococcus pneumoniae* (working age 7%, 65 and over 4%), and Klebsiella species (working age 5%, 65 and over 7%). It is estimated that one half of *Staphylococcus aureus* findings and almost all coagulase-negative staphylococci findings are treatment-related. Anaerobic bacteria constituted around 4% of all blood culture positive findings among adults.

Cerebrospinal fluid findings in adults

In 2016, the total number of microbial findings in adults' cerebrospinal fluid was 118, which corresponds to their numbers in 2007–2015 (137 on average, variation 110 to 173). Patients aged 65 and over accounted for 38% of the cases. One finding of a fungus was reported.

In the working-age population, coagulase-negative staphylococci accounted for 26% of the findings (Table 22). The most common actual pathogens were *S. aureus* (18%) and *S. pneumoniae* (16%). In patients aged 65 years or older, the most common findings were coagulase-negative staphylococci (24%), *Listeria monocytogenes* (18%), *S. pneumoniae* (13%), Propionibacterium species (9%), and *S. aureus* (7%) (Table 23).

Group A streptococcus

The number of invasive group A streptococcus (*Streptococcus pyogenes*) infections increased in 2016 compared to the year before (2016: 229 and 2015: 178). The two most prevalent emm types of group A streptococci, or emm28 and emm89, were the same as in previous years (Table 21). Emm types emm1 and emm4 occurred at a steady rate. The emm-type that has prevailed for several years, emm12, increased its proportion (2016: 10%; 2015: 5%; 2014: 5%). The numbers of macrolide-resistant type emm33 began to decline in 2015, and there were no findings in 2016. Although new emm types are continuously emerging, the four most common emm types – emm28, emm89, emm1 and emm12 – accounted for 74% of all emm types (Table 21).

Table 19. Blood culture findings in patients aged 15 to 64, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Escherichia coli	837	872	884	931	934	942	951	1070	1113	1182
Staphylococcus aureus	544	526	539	579	641	617	645	800	785	858
Streptococcus pneumoniae	352	479	440	413	391	364	356	307	350	352
Klebsiella species	159	186	189	207	166	218	221	222	206	243
Staphylococcus, other coagulase-negative	147	156	139	140	144	104	154	191	209	242
Staphylococcus epidermidis	265	279	313	265	223	182	211	240	270	214
Streptococcus, other betahaemolytic	129	128	122	139	154	133	177	173	156	202
Bacteroides fragilis group	82	108	68	110	108	103	101	132	125	164
Streptococcus milleri group	65	73	57	68	86	79	98	127	128	148
Streptococcus viridans group	116	137	144	147	157	150	148	129	108	118
Streptococcus pyogenes	133	157	116	113	104	126	105	122	97	118
Enterobacter species	70	69	82	99	86	96	90	85	97	108
Enterococcus faecalis	105	83	107	86	97	102	83	104	110	98
Streptococcus agalactiae	83	96	95	110	75	89	96	89	113	88
Enterococcus faecium	81	91	89	91	108	95	97	113	71	85
Pseudomonas aeruginosa	72	74	78	91	92	79	91	74	81	75
Bacillus	24	25	21	32	34	27	42	60	54	55
Peptostreptococcus and Peptococcus	11	12	27	15	30	18	22	38	36	48
Fusobacterium species	31	31	27	37	32	48	41	47	37	39
Serratia species	19	24	27	20	32	26	32	31	39	39
Salmonella, other than Typhi or Paratyphi	52	43	23	39	32	32	36	28	25	39
Citrobacter species	19	23	29	31	28	25	23	35	30	37
Campylobacter species	8	7	11	10	4	6	8	33	26	33
Clostridium, other than perfringens	18	24	29	23	20	32	29	43	30	28
Haemophilus influenzae	26	18	19	18	22	25	23	18	22	28
Proteus mirabilis	14	14	18	26	17	24	22	23	32	27
Prevotella species	8	13	13	15	16	16	10	12	10	23
Morganella morganii	7	14	8	6	8	7	18	12	13	14

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Propionibacterium species	5	3	9	6	9	7	9	11	8	13
Capnocytophaga canimorsus	8	8	11	11	17	13	14	15	12	11
Acinetobacter	21	13	18	14	21	14	11	15	18	11
Listeria monocytogenes	9	8	9	15	7	17	11	18	9	10
Stenotrophomonas maltophilia	5	15	12	12	9	7	14	16	20	8
Bacteroides, other than fragilis group	3	5	10	1	7	3	7	8	5	8
Clostridium perfringens	12	10	16	16	8	11	8	13	12	7
Neisseria meningitidis	21	9	12	13	17	12	5	10	12	7
Streptococcus bovis group	7	1	6	7	6	6	4	5	8	6
Haemophilus, other than influenzae	3	3	0	2	3	10	5	6	8	6
Pseudomonas, other than aeruginosa	3	5	6	6	8	8	8	14	11	5
Hafnia alvei	1	3	6	2	2	2	1	2	2	4
Enterococcus, other or unidentified	4	7	13	13	12	20	8	5	14	3
Mycobacterium species	5	2	2	2	4	3	8	4	3	2
Salmonella Paratyphi	6	5	3	3	1	3	1	2	2	2
Salmonella Typhi	4	1	3	9	3	1	5	5	1	2
Proteus vulgaris	3	2	3	2	2	3	2	4	4	2
Yersinia enterocolitica	1	0	1	1	0	0	0	0	2	1
Veillonella species	4	3	6	5	12	5	7	8	5	0
Yersinia pseudotuberculosis	0	1	0	0	0	1	1	1	0	0
Other bacteria	78	94	107	92	99	112	131	157	150	173
Bacteria total	3,680	3,960	3,967	4,093	4,088	4,023	4,190	4,677	4,679	4,986
Candida albicans	55	55	55	57	74	56	64	53	47	52
Other candida species	26	41	29	37	34	31	45	44	50	32
Other fungi	4	2	3	1	3	2	3	3	1	1
Fungi total	85	98	87	95	111	89	112	100	98	85

Table 20. Blood culture findings in patients aged 65 or over, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Escherichia coli	1759	1888	2053	2233	2479	2482	2876	3242	3360	3721
Staphylococcus aureus	568	671	691	729	780	797	876	1065	1184	1278
Klebsiella species	339	381	464	472	476	539	563	675	735	806
Streptococcus, other beta-haemolytic	181	193	232	279	285	308	335	442	465	527
Staphylococcus epidermidis	275	298	271	326	316	300	344	366	394	419
Streptococcus pneumoniae	290	326	294	303	295	342	319	355	425	415
Staphylococcus, other coagulase-negative	144	171	161	149	162	170	252	293	367	383
Enterococcus faecalis	220	217	222	229	275	287	301	375	334	372
Bacteroides fragilis group	135	146	164	178	203	183	202	253	295	301
Pseudomonas aeruginosa	188	191	184	218	196	250	230	233	253	273
Enterobacter species	105	131	128	156	157	174	188	172	217	257
Enterococcus faecium	132	126	175	180	197	182	209	257	204	200
Streptococcus viridans group	113	140	135	132	168	175	191	161	162	195
Streptococcus agalactiae	77	94	104	126	113	117	129	170	162	191
Proteus mirabilis	93	99	102	106	98	130	118	156	150	190
Streptococcus milleri group	54	53	62	59	59	65	92	127	144	152
Citrobacter species	35	65	59	76	59	95	100	97	113	129
Serratia species	33	50	37	59	56	64	81	72	89	114
Streptococcus pyogenes	58	50	61	50	49	75	67	73	68	101
Clostridium, other than perfringens	33	30	39	44	38	45	39	60	69	82
Peptostreptococcus and Peptococcus	25	14	29	36	26	24	32	44	42	71
Clostridium perfringens	39	34	49	40	51	56	34	57	61	68
Listeria monocytogenes	26	26	20	45	30	36	45	43	32	49
Morganella morganii	26	11	18	29	30	16	30	39	40	45
Haemophilus influenzae	25	21	22	19	37	51	20	32	28	37
Fusobacterium species	15	10	8	17	14	19	18	22	26	35
Streptococcus bovis group	17	15	25	14	13	21	29	19	22	31
Bacillus	9	11	12	7	13	7	17	24	12	25

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Enterococcus, other or unidentified	15	24	20	25	33	34	17	21	33	22
Campylobacter species	3	5	6	3	1	4	4	13	20	20
Prevotella species	8	11	15	13	14	7	11	16	18	19
Acinetobacter	11	12	16	16	17	19	21	16	28	17
Hafnia alvei	6	8	7	7	1	8	6	4	7	14
Salmonella, other than Typhi or Paratyphi	8	19	6	8	7	13	9	14	3	13
Pseudomonas, other than aeruginosa	10	11	10	10	8	11	12	18	13	12
Propionibacterium species	4	5	9	10	13	6	7	12	18	12
Bacteroides, other than fragilis group	5	8	13	8	8	16	12	10	11	10
Stenotrophomonas maltophilia	8	3	6	7	4	8	12	7	16	8
Proteus vulgaris	9	4	4	8	8	12	14	16	15	8
Neisseria meningitidis	2	6	6	6	6	5	4	2	3	7
Capnocytophaga canimorsus	2	3	2	2	6	7	12	9	9	6
Haemophilus, other than influenzae	1	1	1	1	0	3	8	4	5	6
Mycobacterium species	1	4	0	5	1	1	1	2	5	2
Yersinia enterocolitica	1	0	1	1	0	3	0	0	0	2
Veillonella species	4	8	5	2	5	5	10	8	3	0
Yersinia pseudotuberculosis	1	0	3	1	0	1	0	0	0	0
Salmonella Paratyphi	0	0	0	0	0	0	0	0	1	0
Other bacteria	82	120	121	115	134	143	186	236	255	276
Bacteria total	5,195	5,714	6,072	6,559	6,941	7,316	8,083	9,332	9,916	10,921
Candida albicans	56	66	49	93	65	70	77	72	71	72
Other candida species	26	26	42	31	47	39	60	44	45	47
Other fungi	7	8	3	3	4	1	3	0	2	5
Fungi total	89	100	94	127	116	110	140	116	118	124

Table 21. Group A streptococcus blood findings by emm type, 2007–2016 (no. of cases and %).

Each emm type includes all variants detected.

Year	Analysed strains	emm1	emm28	emm4	emm89	emm33	emm12	Others
2007	205	57 (28%)	26 (13%)	7 (3%)	12 (6%)	0 (0%)	13 (6%)	90 (45%)
2008	218	51 (23%)	46 (21%)	4 (2%)	10 (5%)	0 (0%)	18 (8%)	89 (41%)
2009	191	24 (13%)	56 (29%)	8 (4%)	28 (15%)	0 (0%)	8 (4%)	67 (35%)*
2010	171	22 (13%)	38 (22%)	6 (4%)	24 (14%)	0 (0%)	13 (8%)	68 (39%)
2011	161	24 (15 %)	37 (23%)	6 (4%)	30 (19%)	0 (0%)	16 (10%)	48 (30%)
2012	207	22 (11%)	65 (31%)	13 (6%)	58 (28%)	5 (2%)	14 (7%)	30 (14%)
2013	176	18 (10%)	58 (33%)	11 (6%)	43 (24%)	13 (7%)	9 (5%)	24 (14%)
2014	205	10 (5%)	62 (30%)	17 (8%)	47 (23%)	12 (6%)	11 (5%)	46 (23%)
2015	173	19 (11%)	60 (35%)	15 (9%)	33 (19%)	2 (1%)	8 (5%)	36 (20%)*
2016	222	24 (11%)	77 (35%)	15 (7%)	41 (18%)	0 (0%)	23 (10%)	42 (19%)

*One untyped finding in 2009 and 2015.

Table 22. Cerebrospinal fluid culture findings in patients aged 15 to 64, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Staphylococcus aureus	16	13	13	12	20	15	11	9	14	13
Streptococcus pneumoniae	14	26	20	15	12	19	13	11	17	12
Staphylococcus epidermidis	17	27	18	11	10	21	12	17	20	11
Propionibacterium species	5	4	4	7	4	5	6	13	12	10
Staphylococcus, other coagulase-negative	7	14	11	8	6	7	12	9	11	8
Neisseria meningitidis	16	4	8	5	7	6	1	1	3	4
Enterobacter species	2	9	3	1	2	4	2	2	1	3
Listeria monocytogenes	1	1	2	1	1	1	2	2	3	2
Haemophilus influenzae	0	3	1	0	2	1	2	3	0	2
Serratia species	3	0	0	0	1	0	0	0	1	2
Streptococcus, other beta-haemolytic	0	1	2	1	2	1	0	1	0	1
Streptococcus viridans group	2	1	2	2	4	2	2	2	0	1
Streptococcus pyogenes	0	2	2	1	1	0	0	2	0	1
Mycobacterium species	1	2	0	0	1	2	0	0	1	1
Pseudomonas aeruginosa	3	4	5	3	1	4	1	2	1	1
Streptococcus milleri group	0	1	0	0	0	0	0	1	0	0
Streptococcus bovis group	0	0	0	1	0	0	0	0	0	0
Streptococcus agalactiae	5	2	0	2	0	1	1	1	4	0
Enterococcus, other or unidentified	1	1	0	0	1	0	0	0	0	0
Enterococcus faecium	1	0	1	0	2	2	1	0	0	0
Enterococcus faecalis	5	4	3	4	3	3	0	1	2	0
Clostridium, other than perfringens	0	0	0	0	0	0	0	1	0	0
Bacillus	4	3	0	0	0	2	0	0	1	0
Peptostreptococcus and Peptococcus	0	0	1	0	0	0	0	0	0	0
Stenotrophomonas maltophilia	1	0	0	0	1	0	0	0	0	0
Haemophilus, other than influenzae	1	0	0	0	2	0	0	0	1	0
Capnocytophaga canimorsus	0	0	1	0	0	1	0	1	0	0
Campylobacter species	0	0	0	0	0	0	1	0	0	0

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Acinetobacter	5	2	3	0	2	2	0	1	2	0
Bacteroides, other than fragilis group	0	0	0	0	0	0	0	1	0	0
Pseudomonas, other than aeruginosa	0	1	1	0	1	0	0	0	0	0
Salmonella, other than Typhi or Paratyphi	0	2	0	0	1	0	0	0	0	0
Proteus mirabilis	0	0	0	0	1	0	0	0	0	0
Morganella morganii	0	0	0	0	0	0	0	1	0	0
Klebsiella species	1	4	2	1	2	0	1	5	0	0
Escherichia coli	3	3	4	1	1	2	1	1	0	0
Citrobacter species	1	0	0	1	0	1	0	0	1	0
Other bacteria	3	2	4	0	1	2	1	5	2	1
Bacteria total	118	136	111	77	92	104	70	93	97	73
Other candida species	3	0	1	1	0	1	0	1	2	1
Candida albicans	1	0	0	0	0	1	0	0	1	0
Fungi total	4	0	1	1	0	2	0	1	3	1

Table 23. Cerebrospinal fluid culture findings in patients aged 65 or over, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Listeria monocytogenes	2	2	2	6	4	4	4	4	6	8
Streptococcus pneumoniae	4	7	10	6	8	4	8	1	12	6
Staphylococcus, other coagulase-negative	2	4	3	3	1	3	5	6	3	6
Staphylococcus epidermidis	12	10	6	3	4	7	8	8	2	5
Propionibacterium species	0	2	2	1	1	2	2	9	5	4
Staphylococcus aureus	2	3	6	5	5	2	10	4	4	3
Escherichia coli	0	1	1	1	2	1	1	0	3	2
Streptococcus viridans group	1	0	3	1	0	3	1	0	0	1
Streptococcus milleri group	0	0	1	0	0	0	0	0	0	1
Streptococcus agalactiae	0	0	1	1	0	0	1	1	1	1
Enterococcus faecium	0	0	2	0	0	1	0	0	0	1
Enterococcus faecalis	3	0	1	0	0	2	0	2	0	1
Mycobacterium species	0	1	1	0	1	0	0	1	1	1
Haemophilus influenzae	2	1	1	0	1	0	0	0	0	1
Pseudomonas, other than aeruginosa	0	0	0	0	0	0	0	0	0	1
Serratia species	0	0	0	0	0	0	0	0	1	1
Klebsiella species	0	1	1	0	0	0	0	0	0	1
Enterobacter species	1	0	0	1	1	1	1	0	0	1
Streptococcus, other beta-haemolytic	0	0	1	0	0	0	1	0	0	0
Bacillus	0	1	0	0	2	1	0	0	1	0
Peptostreptococcus and Peptococcus	0	0	0	0	0	1	0	0	0	0
Neisseria meningitidis	0	1	0	2	0	1	1	0	0	0
Acinetobacter	1	0	0	0	0	0	0	0	0	0
Bacteroides fragilis group	0	0	1	0	0	0	0	0	0	0
Pseudomonas aeruginosa	0	2	0	0	0	1	2	0	0	0
Proteus mirabilis	0	1	1	0	0	0	0	0	0	0
Citrobacter species	0	0	0	0	1	0	1	0	1	0
Other bacteria	0	0	0	1	0	0	1	2	2	0

	2007	2008	2009	2010	2011	2012	2013	2014	2014	2015
Bacteria total	30	37	45	32	31	34	47	38	42	45
Candida albicans	0	1	0	0	0	1	0	0	0	0
Other candida species	0	0	1	0	1	0	0	1	0	0
Fungi total	0	1	1	0	1	1	0	1	0	0

Table 24. Blood culture findings in all age groups, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Escherichia coli	2,650	2,812	2,986	3,224	3,472	3,463	3,877	4,366	4,531	4,967
Staphylococcus aureus	1,179	1,260	1,288	1,375	1,484	1,492	1,591	1,925	2,051	2,209
Klebsiella species	510	579	664	686	651	769	793	901	945	1064
Streptococcus pneumoniae	778	918	851	831	771	749	718	700	808	813
Streptococcus, other beta-haemolytic	314	321	360	423	440	443	514	617	626	737
Staphylococcus epidermidis	665	686	679	699	644	549	642	680	739	701
Staphylococcus, other coagulase-negative	353	374	360	342	354	311	448	548	633	675
Enterococcus faecalis	339	311	343	341	387	409	401	490	457	486
Bacteroides fragilis group	218	255	233	289	313	286	303	386	421	470
Enterobacter species	185	210	216	260	256	276	282	259	327	376
Pseudomonas aeruginosa	262	268	265	318	293	332	325	316	338	350
Streptococcus viridans group	259	306	313	332	361	358	374	312	289	327
Streptococcus milleri group	119	128	121	129	146	145	190	256	274	307
Streptococcus agalactiae	213	240	250	290	230	242	258	290	301	299
Enterococcus faecium	217	220	273	280	306	281	309	372	275	286
Streptococcus pyogenes	207	220	192	171	168	216	181	211	178	229
Proteus mirabilis	109	113	120	132	115	154	140	179	182	217
Citrobacter species	56	90	90	109	87	121	123	135	143	169
Serratia species	56	78	65	82	92	90	115	103	132	156
Peptostreptococcus and Peptococcus	36	26	56	52	58	43	54	82	79	119
Clostridium, other than perfringens	52	55	69	71	62	79	69	105	99	111
Bacillus	37	46	38	43	50	40	65	89	77	82
Clostridium perfringens	53	44	66	57	59	67	42	70	73	75
Fusobacterium species	51	46	36	55	47	68	60	70	63	74
Haemophilus influenzae	54	44	46	40	64	80	47	57	52	66
Listeria monocytogenes	36	34	30	62	37	54	58	62	41	59
Morganella morganii	33	25	26	35	38	23	48	51	53	59
Campylobacter species	11	12	17	13	5	10	12	46	46	53

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Salmonella, other than Typhi or Paratyphi	65	64	30	53	41	48	50	44	30	52
Prevotella species	16	25	28	28	30	23	21	28	28	42
Streptococcus bovis group	24	16	33	21	19	27	33	24	31	37
Acinetobacter	36	28	39	34	40	35	37	32	49	29
Propionibacterium species	10	8	18	16	23	15	17	23	26	27
Enterococcus, other or unidentified	21	34	35	39	45	55	26	26	47	25
Stenotrophomonas maltophilia	18	22	22	23	13	16	27	24	36	18
Bacteroides, other than fragilis group	8	13	23	9	15	19	19	18	17	18
Hafnia alvei	7	11	13	9	3	10	7	6	9	18
Capnocytophaga canimorsus	10	11	13	13	23	20	26	24	21	17
Pseudomonas, other than aeruginosa	14	16	19	16	16	19	20	33	25	17
Neisseria meningitidis	29	22	23	29	26	21	16	16	17	15
Haemophilus, other than influenzae	4	5	1	3	4	14	14	10	14	12
Proteus vulgaris	12	6	7	10	10	15	16	20	19	10
Mycobacterium species	6	6	2	7	6	4	9	6	9	4
Yersinia enterocolitica	2	0	2	2	0	3	0	1	3	3
Salmonella Paratyphi	6	5	3	3	1	3	1	2	3	2
Salmonella Typhi	6	1	3	9	5	1	6	5	1	2
Corynebacterium diphteriae	0	0	0	0	0	0	0	1	0	0
Veillonella species	8	11	11	8	17	10	17	16	8	0
Yersinia pseudotuberculosis	1	1	3	1	0	2	1	1	0	0
Other bacteria	182	231	246	236	253	277	329	411	430	462
Bacteria total	9,537	10,257	10,627	11,310	11,580	11,787	12,731	14,449	15,056	16,346
Candida albicans	113	126	105	154	140	128	145	129	121	126
Other candida species	57	69	71	68	85	72	106	89	96	81
Other fungi	11	10	6	4	7	3	6	3	3	6
Fungi total	181	205	182	226	232	203	257	221	220	213

Table 25. Cerebrospinal fluid culture findings in all age groups, 2007–2016 (no. of cases).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Streptococcus pneumoniae	27	38	36	26	25	24	27	16	30	20
Staphylococcus epidermidis	32	43	28	17	18	30	23	30	25	17
Staphylococcus, other coagulase-negative	9	22	16	11	7	12	18	15	15	16
Staphylococcus aureus	21	21	24	20	27	22	24	14	20	16
Propionibacterium species	5	6	6	8	6	7	8	24	19	15
Listeria monocytogenes	3	3	4	7	5	5	6	6	9	10
Neisseria meningitidis	24	9	12	11	11	12	8	4	5	5
Enterobacter species	3	9	4	2	3	6	3	2	1	5
Streptococcus agalactiae	13	5	7	13	3	5	3	9	8	4
Haemophilus influenzae	2	4	3	0	4	1	2	5	0	4
Streptococcus viridans group	3	1	7	3	5	5	3	2	2	3
Serratia species	3	0	0	0	1	0	0	0	2	3
Escherichia coli	4	5	6	4	4	4	2	3	5	3
Mycobacterium species	1	3	1	1	2	2	0	1	2	2
Streptococcus, other betahaemolytic	0	1	4	1	2	1	1	1	0	1
Streptococcus pyogenes	0	2	3	1	1	1	0	2	0	1
Streptococcus milleri group	0	1	1	0	0	0	0	1	0	1
Enterococcus faecium	1	0	3	0	2	3	1	0	0	1
Enterococcus faecalis	9	4	4	5	3	5	0	3	3	1
Pseudomonas, other than aeruginosa	0	1	1	0	1	0	0	0	0	1
Pseudomonas aeruginosa	3	6	5	3	1	5	3	2	1	1
Klebsiella species	1	5	4	1	2	1	1	5	0	1
Streptococcus bovis group	0	0	1	1	0	0	0	0	0	0
Enterococcus, other or unidentified	1	1	0	1	1	0	0	0	0	0
Clostridium, other than perfringens	0	0	0	0	0	0	0	1	0	0
Bacillus	4	4	0	0	2	3	0	1	2	0
Peptostreptococcus and Peptococcus	0	0	1	0	0	1	0	0	0	0
Stenotrophomonas maltophilia	1	0	0	0	1	0	0	0	0	0

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Haemophilus, other than influenzae	1	0	0	0	2	0	0	0	1	0
Capnocytophaga canimorsus	0	0	1	0	0	1	0	1	0	0
Campylobacter species	0	0	0	0	0	0	1	0	0	0
Acinetobacter	6	2	3	0	2	2	0	1	2	0
Bacteroides, other than fragilis group	1	0	0	0	0	0	0	1	0	0
Bacteroides fragilis group	0	0	1	0	0	0	0	0	0	0
Salmonella, other than Typhi or Paratyphi	0	2	0	0	1	0	0	0	0	0
Proteus mirabilis	0	1	1	0	1	0	0	0	0	0
Morganella morganii	0	0	0	0	0	0	0	1	0	0
Citrobacter species	2	0	0	2	1	1	1	1	2	0
Other bacteria	3	4	6	2	1	2	4	9	5	1
Bacteria total	183	203	193	140	145	161	139	161	159	132
Other candida species	3	0	2	1	1	1	0	2	2	1
Candida albicans	1	1	1	0	0	3	0	0	1	0
Fungi total	4	1	3	1	1	4	0	2	3	1

Authors

Respiratory infections

Adenovirus
Niina Ikonen, Outi Lyytikäinen (THL)

Influenza A and B
Niina Ikonen, Outi Lyytikäinen, Hanna Nohynek (THL)

Parainfluenza
Niina Ikonen, Outi Lyytikäinen (THL)

Rhinovirus
Carita Savolainen-Kopra, Outi Lyytikäinen (THL)

RSV
Niina Ikonen, Outi Lyytikäinen (THL)

Enterovirus
Soile Blomqvist (THL)

Whooping cough
Jussi Sane, Emmi Sarvikivi, Hanna Nohynek (THL)

Legionella
Mari Kinnunen, Sari Jaakola, Jaana Kusnetsov, Silja Mentula, Pia Räsänen, Outi Lyytikäinen (THL)

Mycoplasm
Mirja Puolakkainen (University of Helsinki)

Chlamydial pneumonia
Mirja Puolakkainen (University of Helsinki)

Gastrointestinal infections

Food-borne epidemics
Ruska Rimhanen-Finne, Saara Salmenlinna (THL)

Clostridium difficile
Silja Mentula, Outi Lyytikäinen (THL)

EHEC
Sari Huusko, Ruska Rimhanen-Finne, Saara Salmenlinna (THL)

Campylobacter
Ruska Rimhanen-Finne, Saara Salmenlinna (THL)

Listeria
Ruska Rimhanen-Finne, Saara Salmenlinna (THL)

Salmonella
Ruska Rimhanen-Finne, Aino Kyyhkynen, Saara Salmenlinna (THL)

Shigella
Ruska Rimhanen-Finne, Saara Salmenlinna, Aino Kyyhkynen (THL)

Yersinia
Sari Huusko, Ruska Rimhanen-Finne, Saara Salmenlinna (THL)

Norovirus
Sari Huusko, Ruska Rimhanen-Finne, Haider Al-Hello (THL)

Rotavirus
Mari Kinnunen, Tuija Leino, Haider Al-Hello (THL)

Hepatitis

Hepatitis A
Ruska Rimhanen-Finne, Tuija Leino, Mia Kontio (THL)

Hepatitis B
Markku Kuusi, Tuija Leino, Henrikki Brummer-Korvenkontio, Kirsi Liitsola (THL)

Hepatitis C
Markku Kuusi, Henrikki Brummer-Korvenkontio, Kirsi Liitsola (THL)

Sexually transmitted diseases

Chlamydia
Kirsi Liitsola (THL)
Eija Hiltunen-Back (HUS)

Gonorrhoea
Kirsi Liitsola (THL)
Eija Hiltunen-Back (HUS)

Syphilis
Kirsi Liitsola (THL)
Eija Hiltunen-Back (HUS)

HIV and AIDS
Henrikki Brummer-Korvenkontio, Kirsi Liitsola (THL)

Antimicrobial resistance

MRSA
Outi Lyytikäinen, Laura Lindholm (THL)

VRE
Outi Lyytikäinen, Laura Lindholm (THL)

ESBL
Outi Lyytikäinen, Jari Jalava (THL)

CPE
Outi Lyytikäinen, Jari Jalava (THL)

Tuberculosis

Tuberculosis
Hanna Soini, Outi Lyytikäinen,
Marjo Haanperä (THL)
Tuula Vasankari (Filha)

Other infections

Invasive pneumococcal disease
Maija Toropainen, Outi Nyholm, Arto Palmu,
Pekka Nuorti (THL)

Haemophilus
Emmi Sarvikivi, Maija Toropainen, Tuija Leino (THL)

Meningococcus
Maija Toropainen, Markku Kuusi, Anni Vainio,
Hanna Nohynek (THL)

MMR diseases (measles, mumps, rubella)
Emmi Sarvikivi, Tuija Leino, Mia Kontio (THL)

Varicella virus
Emmi Sarvikivi, Tuija Leino (THL)

Borrelia
Jussi Sane (THL)

Tick-borne encephalitis (TBE)
Jussi Sane, Tuija Leino, Pirjo Turtiainen (THL)
Olli Vapalahti (University of Helsinki)
Jukka Hytönen (University of Turku)

Puumala virus
Jussi Sane (THL)

Pogosta disease
Jussi Sane (THL)

Tularemia
Jussi Sane (THL)

Rabies
Satu Murtopuro, Ruska Rimhanen-Finne,
Eeva Pekkanen (THL)

Travel-related infections

Malaria
Heli Siikamäki (HUS)

Dengue fever
Jussi Sane, Eeva Pekkanen (THL)

Chikungunya
Jussi Sane, Eeva Pekkanen (THL)

Other travel-related infections
Eeva Pekkanen (THL)

Blood and cerebrospinal fluid findings in children
Mari Kinnunen, Emmi Sarvikivi (THL)

Blood and cerebrospinal fluid findings in adults
Mari Kinnunen, Emmi Sarvikivi (THL)

Group A streptococcus
Hanne-Leena Hyyryläinen (THL)