

FAQ

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Methicillin-resistant *Staphylococcus aureus* (MRSA) – How can people become infected?

→ Changes compared to the version dated 18 November 2014: The data in particular has been updated.

Methicillin-resistant *Staphylococcus aureus* (MRSA) are bacteria which can cause, among other diseases, wound infections and inflammation of the respiratory tract in humans and are resistant to certain antimicrobials. In the past, these bacteria were mainly found in hospitals where they can be transmitted via contact from person to person. However, cases have also been recorded in which people have been infected outside of hospitals.

MRSA have also been detected in livestock and in food which can thus be a source of infection for humans. The German Federal Institute for Risk Assessment (BfR) has compiled Frequently Asked Questions about MRSA and their presence in the food supply chain.

What are MRSA?

The abbreviation “MRSA” stands for “methicillin-resistant *Staphylococcus aureus*”, a group of staphylococci that are insensitive to certain antibiotics. *Staphylococcus aureus* is a widespread bacterium which colonises the skin and mucous membranes of humans and animals. According to the European Centre for Disease Prevention and Control (ECDC), about 30 % of people carry *Staphylococcus aureus* on their skin. Usually the colonisation goes unnoticed. Because of its presence on the skin, *S. aureus* is frequently involved in infections of the skin and mucous membranes.

The methicillin-resistant variant of *S. aureus* is resistant to beta-lactam antibiotics, i.e. to penicillins and cephalosporins. These antibiotics are no longer effective in treating an MRSA infection, i.e. they cannot kill the infectious agent or prevent its multiplication.

What are the consequences of the methicillin resistance of *Staphylococcus aureus*?

The reason why MRSA infections pose a challenge for attending physicians is that standard antibiotics which are used against infections with *Staphylococcus aureus* are not effective. Due to the necessary switch to less well tolerated or less effective alternative medicines, MRSA infections can lead to longer hospital stays and increased death rates.

What groups of MRSA are distinguished?

On the basis of its presence and the most common location of its transmission, MRSA are categorised into three main groups:

- MRSA that are transmitted predominantly in hospitals (hospital-acquired MRSA, HA-MRSA)
- MRSA that are transmitted outside the hospital setting from person to person (community-acquired MRSA, CA-MRSA)
- MRSA that are prevalent among livestock and mainly found in humans who have frequent contact (e.g. occupational) with farm animals (livestock-associated MRSA, LA-MRSA). In Germany, these mainly include MRSA associated with the sequence type (ST) 398, but also with ST9 and ST97.

Do the MRSA groups differ in terms of their properties?

The MRSA groups differ with regard to their configuration with virulence and antibiotic resistance characteristics. The MRSA that occur within livestock in Europe, which means in particular the MRSA that belong to the sequence type (ST) 398, rarely carry the typical disease-causing properties described with HA-MRSA and CA-MRSA, such as toxin genes or genes that enable them to evade the human immune system. The tendency for the pathogens to spread in hospitals also appears to be very low. In recent years, no further spread of ST398 has been detected in German hospitals.

Resistance to antibiotics that would be used in human medicine for clinical infections with MRSA, but which are often not authorised for the treatment of animals, e.g. mupirocin, linezolid, vancomycin, is rarely found in LA-MRSA. However, resistance to substances that are frequently used in animals (e.g. tetracyclines) is much more common in LA-MRSA (particularly the ST398) than in HA- or CA-MRSA.

As many of these properties are located on transmissible genetic elements, there is always the possibility that resistance genes will be exchanged between bacteria and additional properties will be acquired. In individual cases, LA-MRSA types can therefore also occur, which may have an advantage over other types and can, for example, colonise humans more easily. It is therefore important that MRSA is continuously investigated for its occurrence and properties.

How can a person become infected with MRSA?

Infections with MRSA most frequently occur in hospitals, especially in intensive care units. Chronic diseases, a weakened immune system, and the use of antibiotics significantly

increase the risk of contracting an MRSA infection. Direct contact with MRSA-carrying persons and indirect contact via shared objects such as towels and a lack of hygiene constitute the main MRSA transmission paths.

Since 2005, there have been more and more reports of MRSA in persons who had contact with MRSA-positive livestock. This is mainly MRSA from the group LA-MRSA ("LA" stands for livestock-associated MRSA). It has also been reported that LA-MRSA of this kind can be detected in persons who had no direct contact with livestock, especially if they live in regions with a high livestock density. This means that in rural regions of Germany, approx. 20-38 % of cases of the colonisation of humans with MRSA associated with the clonal complex (CC) 398 detected during hospital admissions are not attributable to (in)direct contact with animals. This indicates the possibility of other transmission routes.

In addition to livestock, pets (e.g. dogs and cats) can also be a source of MRSA. Conversely, pets can also be colonised with MRSA from people in the same household.

What is the difference between infection and colonisation with MRSA?

A distinction must be made between infection and colonisation with MRSA. Transmission of the bacteria followed by colonisation does not lead to disease symptoms. However, the person remains a carrier. Individuals colonised with MRSA have a greater risk of contracting MRSA infections after surgical operations, for example. Consumers should discuss with their GP or local health authorities what measures need to be taken in case of MRSA colonisation.

Under all circumstances, affected individuals or individuals belonging to a risk group should state this when they are admitted to a hospital or health care centre. This allows doctors to take precautions during medical procedures to prevent an MRSA infection.

How frequently are healthy individuals colonised with MRSA?

Limited data are available for Germany on the frequency of colonisation of healthy people with MRSA. From these limited investigations, it can be assumed that approximately one to two percent of the population is colonised with MRSA. Higher colonisation rates are found in veterinarians and farmers if these groups have job-related contact with farm animals, in particular pigs. A study in Lower Saxony showed that around 25 % of persons with livestock contact were colonised with MRSA as opposed to one to two percent without livestock contact. In addition to this, screening on admission to hospitals in German regions with a high livestock density showed that roughly 20-30 % of the patients were MRSA-positive, with the vast majority carrying LA-MRSA.

How frequently does MRSA occur in human diseases?

In 2021, 7.4% of invasive *S. aureus* infections were caused by MRSA. Compared to 2009, the year with the highest detection rate of MRSA (24.1 %), this is a decrease of around 70 %. The number of reported bloodstream infections with MRSA has been declining for years, from 4,508 cases in 2012, the year with the highest reporting rate, to 1,124 in 2023, a decrease of 75 % (Survstat, data as at 30 October 2024).

Most MRSA isolates submitted to the National Reference Centre at the Robert Koch Institute from clinical illnesses in hospitals in 2021/22 came from wound infections (28%), bloodstream infections (27%) and abscesses (13.2%). Of these MRSA, 3.4 % belonged to the livestock-associated clonal complex (CC) 398.

Can consumers notice MRSA on their skin?

No, because colonisation does not normally lead to any health impairments. MRSA behaves in the same way as other *S. aureus*.

S. aureus are part of the normal microbial community of the skin, with roughly 30 % of the population carrying this bacterium on their skin. Colonisation with MRSA can only be determined by a laboratory examination. This is normally done by taking a swab of the nasal mucosa.

To what extent is MRSA prevalent in different livestock populations?

Staphylococcus aureus is part of the normal microbial community of the skin and mucous membranes in humans and animals. However, *S. aureus* is also a frequent causative pathogen of inflammation of the mammary gland (mastitis), especially in cattle. This has also been described for MRSA. In other livestock, *S. aureus* plays a subordinate role as a pathogen.

In livestock, a specific type of MRSA is frequently detected, the clonal complex (CC) 398, which is widespread within animal populations. The prevalence of MRSA in livestock is regularly analysed in Germany as part of the zoonosis monitoring. For example, MRSA was detected in herds with breeding pigs (25.9%, 2023), with fattening pigs (35.7%, 2019) but also in bulk milk samples from dairy cows (7.7%, 2019). MRSA was also detected in fattening calves (19.6%, 2010) and fattening turkeys (17.2% of conventional and 2.7% of organically farmed flocks, 2018). The pathogen is detected relatively rarely in flocks of broilers (1.9%, 2016).

Follow-up investigations in positive herds of dairy cows showed that MRSA not only occurs as a mastitis pathogen in the mammary gland, but can be detected especially in calves that are fed milk.

Detailed results of the zoonosis monitoring can be found on the Internet:

http://www.bfr.bund.de/de/a-z_index/zoonosen-4189.html (in German only)

<https://zoonotify.bfr.berlin>

https://www.bvl.bund.de/EN/Tasks/01_Food/01_tasks/02_OfficialFoodControl/06_ZoonosesMonitoring/ZoonosesMonitoring_node.html

Which factors influence the presence of MRSA in animal populations?

MRSA are usually transferred between animal populations when animals carrying the pathogen are traded and moved between herds/flocks. The presence of MRSA in animal

populations is influenced by a number of factors, such as the size of the herd/flock and the husbandry conditions. The use of antibiotics within the population also plays a role.

This was shown clearly in a study on MRSA levels in fattening pig farms. In fattening populations buying fattening pigs from external sources, the bacteria were found more frequently than in farms that fattened their own piglets to slaughter weight. In addition, the pathogens were found more frequently in larger pig and dairy herds than in small herds. The bacteria were more prevalent in herds where antibiotics had been used.

In terms of occurrence, there were differences between conventional and organic farms. In 2018, MRSA was detected in 17.2% of conventional turkey fattening flocks and in only 2.7% of organic flocks. The situation was similar for dairy cows in 2014 (9.7% conventional, 1.7% organic). In conventional broiler flocks, on the other hand, the detection rate was significantly lower than in conventional flocks (2016: 0.6% conventional, 5.4% organic). Clear differences between conventional and organic farms were also shown for pigs.

Since when has MRSA been detected in agricultural livestock?

The first MRSA findings in animals were observed in the 1970s in mastitis isolates of *S. aureus* from cattle. Until 2005, reports on MRSA in livestock only appeared sporadically. In Germany, MRSA isolates from livestock are available since 2004. It was identified as part of a retrospective investigation of *S. aureus* which was isolated during diagnostic post mortem examinations of pigs. Older isolates were not available for that study. It is not known, therefore, whether livestock-associated MRSA (LA-MRSA) was already present in Germany's pig population before 2004.

The first isolates from the poultry food chain (turkey and broiler) were made available to the BfR in the year 2008 from a voluntary monitoring programme conducted at abattoirs and retail shops. Here, too, the possibility of the pathogen being present in the population even earlier cannot be excluded.

There are detailed reports from Belgium and Germany on MRSA in dairy cattle from 2007 and 2008. MRSA in fattening calves was reported in the Netherlands in 2008. It was possible to confirm these findings for Germany as part of the zoonosis monitoring programme 2009.

MRSA was discovered relatively late in the herds because in the vast majority of cases it does not lead to illnesses.

Are the same types of MRSA detected in different livestock species?

The MRSA found in livestock are mainly assigned to the clonal complex (CC) 398. To varying extents, isolates associated with other clonal complexes are found as well. At present, this is most often the case with poultry where isolates associated with the CC9 (chicken) and the CC5 (turkey) are found. In addition, MRSA associated with the CC97 are isolated from dairy cattle.

How frequently are MRSA prevalent in livestock the cause of infections in humans?

After an adaptation of the German Protection Against Infection Act, there has been a reporting obligation for detected MRSA from blood cultures in Germany since July 2009.

According to the Robert Koch Institute, between 3,000 and 4,500 cases of human bloodstream infections with MRSA were reported annually in Germany between 2010 and 2016. In 2023, there were still 1,124 cases. The proportion of isolates of the clonal complex (CC) 398 in the bloodstream isolates submitted from hospitals to the Robert Koch Institute was 3.8% (4/105) in the period 2021/2022. The total proportion of investigated submitted clinical isolates was 3.4% (13/386). Among all MRSA submitted, the proportion of CC398 was 6.8% in 2021 and 6.4% in 2022. In regions with a high density of livestock CC398-associated MRSA accounts for a higher proportion of the detected MRSA in humans.

Can people become infected with MRSA through direct contact with livestock?

Contact with colonised animals can lead to human colonisation with MRSA. So far, this has been described most frequently after direct contact with pigs, calves and poultry. However, since there have been reports of colonisations and infections in connection with almost all types of farm animals, each of these animal species is a potential source of MRSA colonisation of humans under certain circumstances.

Persons who are frequently in contact with pigs and other livestock due to their job are more frequently colonised with MRSA than the general population. A study conducted in Lower Saxony showed that about 25 % of persons who had job-related contact with farm animals were colonised with MRSA. In contrast, MRSA was found in only 1.5 % of tested persons without any occupational contact with livestock. However, some of these latter persons colonised with MRSA had indirect contact with animals, e. g. through contact with household members who were occupationally exposed or who regularly visited farms.

It is likely that MRSA can be transmitted to humans both through direct contact with the animals and through inhalation of highly contaminated dust. However, despite frequent colonisation of these individuals with livestock-associated MRSA, cases of clinical skin and wound infections or respiratory tract infections are so far rarely observed.

Can people become infected with MRSA during a farm visit?

As with all zoonotic pathogens, this is possible in principle, especially if the animals are touched or the stables are entered. Studies from the north-west of Germany have shown that persons who visit farms on a regular basis in order to buy eggs or milk, for example, are more frequently colonised with livestock-associated MRSA compared to the general population. However, the risk of infection or colonisation is many times lower for this group of people than for those who are occupationally and therefore regularly exposed. A study from the Netherlands has shown that in many persons who only had occasional contact with animals, the colonisation disappeared spontaneously after a short time.

Do persons who live in the vicinity of animal farms run a higher risk of colonisation with MRSA?

MRSA are present in the air within the stables of colonized animals and are therefore also released with the exhaust air from the stables. However, in the area surrounding the stables, a strong dilution occurs, so that MRSA can only occasionally be detected in the air in the immediate vicinity of the sheds. On the ground, these bacteria can still be detected in somewhat greater distances from the sheds. A few individual articles have been published indicating that LA-MRSA is more frequent in people who live in regions with high livestock densities, but the people in these regions also have more frequent direct contact with animals. Little is known as yet about the resilience of livestock-associated MRSA in the environment. More studies are needed here.

Are livestock-associated MRSA also transmitted from person to person?

In principle, MRSA can be transmitted between humans. As far as is currently known, livestock-associated LA-MRSA is less often transmitted between humans than has been described for other MRSA (HA- and CA-MRSA) in hospitals. According to the Robert Koch Institute, no transmission of LA-MRSA in hospitals were reported in Germany in 2021 and 2022.

Are livestock-associated MRSA causing infections in hospitals?

Around 6.35% of the MRSA reported to the Robert Koch Institute in 2022 were attributable to the clonal complex (CC) 398. The proportion of MRSA involved in hospital infections attributable to the CC398 was 4.2%. According to information in the literature, the spreading tendency within hospitals appears to be lower for CC398-associated MRSA than for other types of MRSA. Nevertheless, this type of MRSA can in principle be found in most types of illness associated with *S. aureus*, i.e. in infected wounds and pneumonia as well as septicaemia.

How can livestock farms reduce the prevalence of MRSA?

The occurrence of MRSA in animal husbandry is determined by its introduction into the herds and its spread within the herd. It is to be assumed that prudent use of antibiotics can reduce the selection pressure in the direction of resistant bacteria. It is also important to check purchased animals before they are housed, to ensure thorough cleaning and disinfection between fattening cycles and to prevent the introduction of MRSA from the surroundings of the stables (e.g. from neighbouring stables). Studies in North Rhine-Westphalia (Germany) have shown that the proportion of MRSA-positive animals decreases more with straw bedding than in comparable stables without straw bedding.

How common is MRSA in food?

Based on the current state of knowledge, raw meat of all animal species may contain MRSA, although the contamination levels are often very low. As part of the zoonosis monitoring, the federal and regional authorities have tested meat of various animal species for the occurrence of MRSA. The results from recent years show that fresh meat was to some

extend contaminated with MRSA. The following detection rates were determined in the most recent analyses: Turkey meat (34.3 %, 2022), chicken meat (4.9 %, 2022), pork (13.1 %, 2015), beef (3.5 %, 2021) and veal (11.3 %, 2017).

In all tested samples, isolated MRSA are mainly attributable to the clonal complex (CC) 398. The detailed findings of these studies are available online

<https://zoonotify.bfr.berlin/>

These results are consistent with reports from the Netherlands which also described contamination of food.

Can food be a source of MRSA infection?

As MRSA can occur in food, especially raw meat, food is generally a possible source of colonisation and subsequent infection of humans. In tests in Denmark, certain types of MRSA belonging to the livestock-associated clonal complex CC398 were detected in individual human infections. These MRSA in humans showed similarities and had specific common characteristics with the MRSA isolated from poultry meat. This does not necessarily mean, however, that the human infection is actually attributable to poultry meat as the source of infection. There is currently no epidemiological evidence of any kind for this.

Based on the current state of knowledge, raw meat of all animal species may contain MRSA, although the contamination levels are often very low. In individual cases, for example in the thawing water of chicken meat, the MRSA-count may be higher. Provided that the rules of kitchen hygiene are observed, the risk of an infection or colonisation with MRSA via food is low.

Can consumers tell whether a food is contaminated with MRSA?

No, contamination of foods with MRSA can only be detected through laboratory analyses.

Are organically produced foods free of MRSA?

MRSA can be detected in organically produced food as well, as animals from organic farms can also be colonised with the bacteria. Therefore, the same level of hygiene is required when handling meat from organic livestock farming as with conventionally produced meat. However, the incidence of MRSA in organically produced meat is usually significantly lower. For example, comparative studies in 2018 showed that turkey meat from organic farming had a significantly lower incidence of MRSA (11.0%) than meat from conventional farming (42.7%). Similar differences were also determined in 2018 for bulk tank milk in dairy herds (1.7 vs. 9.7 %).

What can consumers do to protect themselves from MRSA in foods and livestock?

The normal hygiene recommendations for handling food and animals apply when it comes to protection against MRSA colonisation: after contact with animals as well as after preparing raw animal foods, consumers should wash their hands thoroughly with soap and water. Furthermore, efforts should be made to avoid any direct contact between the mouth

and animals or raw animal foods. These hygiene measures also provide protection against other pathogens such as *Salmonella*, *Campylobacter* and Shiga toxin-producing *Escherichia coli* (STEC).

The BfR has summarised further tips on how consumers can protect themselves from food-borne infections in the following FAQ:

https://www.bfr.bund.de/en/foodborne_infections_in_private_households_identifying_sources_and_avoiding_risks-194152.html

Is MRSA widespread in Germany compared to other countries?

Data on MRSA infections in humans are collected and published throughout Europe in the “European Antimicrobial Resistance Surveillance System” (EARS Net) and the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network. The programmes are coordinated by the European Centre for Disease Prevention and Control (ECDC) and the European Regional Office of the World Health Organization (WHO). The data from Germany is transmitted to ECDC by the Robert Koch Institute. According to the report, there has been a decreasing trend in the proportion of MRSA isolates among *S. aureus* isolates in invasive infections in hospitals in Germany since 2017 (2017: 9.1%; 2018: 7.7%; 2019: 6.7%; 2020: 5.5%; 2021: 4.9%).

Similar to the figures from Germany, the proportion of MRSA among *S. aureus* isolates found in hospitals was less than 5% in eleven of 44 European countries in 2021. In Southern and Eastern Europe in particular, the proportion of MRSA among all *S. aureus* infections was significantly higher in 2021 and sometimes exceeded 25%.

In what areas does the BfR conduct research on MRSA?

The BfR, together with the federal states, is investigating the occurrence of MRSA along various food chains, starting in livestock populations through the slaughterhouse to the food itself. In the National Reference Laboratory for coagulase positive staphylococci including *S. aureus*, located at the BfR, the bacteria isolated in the laboratories of the federal states are then analysed to establish in more detail their characteristics and affinities, and strains of MRSA from different sources are compared.

In recent years, the German government and the European Union have funded research projects on the occurrence and spread of MRSA. In these studies, universities and healthcare research institutions have worked closely with veterinary and food control authorities. The BfR was involved in many of these projects.

As part of national and international research projects, in collaboration with cooperation partners, the BfR develops methods for detecting and typing of MRSA. The BfR studies how MRSA is spread between animal populations and along the food chain and how certain MRSA-types with critical pathogen properties and antibiotic resistance behave.

What are the competent authorities doing to combat MRSA in animal populations?

Due to reports on MRSA in animals, especially in livestock and animal foods, veterinary and food control authorities in Germany regularly investigate the prevalence of MRSA in animals

and foods. For example, as part of the zoonosis monitoring programme, the federal and state authorities undertake extensive studies on the prevalence of MRSA in livestock populations, at slaughterhouses and in foods. These annual studies provide also important data on the properties of the MRSA types involved. The BfR updates its risk assessment on the basis of emerging data if necessary and makes it available to the federal and state authorities as well as to the public.

What are public health authorities doing to combat MRSA in hospitals?

The former Commission for Hospital Hygiene and Infection Prevention (KRINKO) already published recommendations in 2008 indicating that persons with occupational exposition to livestock should be tested for MRSA when admitted to hospital. The committee for biological job safety has authored an opinion on occupational contamination with MRSA.

Due to an amendment of the Infection Protection Act, it became compulsory in July 2009 to report detected MRSA from human blood cultures.

The point of contact for more information on the subject of “MRSA in hospitals” is the Robert Koch Institute:

https://www.rki.de/EN/Home/homepage_node.html

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the Federal Ministry of Food and Agriculture (BMEL) in Germany. The BfR advises the Federal Government and the States ('Laender') on questions of food, chemicals and product safety. The BfR conducts independent research on topics that are closely linked to its assessment tasks.

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