Risk Analysis of Infections Caused by Zoonoses of Alimentary Origin in the Selected Region of the Czech Republic

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Abstract: - The paper is aimed at risk analysis of infections caused by zoonoses of alimentary origin. The bacterial, viral, and parasitic agents were investigated. Individual risks of particular zoonoses in the Czech Republic were compared with the same indicators in the South Moravian region. The implementations of effective countermeasures were designed for unacceptable risks to mitigate them.

Key-Words: - Alimentary disease, bacterial agents, individual risk, measure, parasitic agents, risk analysis, viral agents, zoonoses.

1 Introduction
Zoonoses of alimentary origin represent a significant group of diseases. The casual agents may be bacteria, moulds and their toxins, viruses, parasites and prions. The diseases may develop through consuming contaminated food and water as well as through insufficient hygiene during food processing. Food security is currently a much debated topic covering the phases of production, processing, storage, distribution and consumption. The aim of risk analysis is to determine the critical types of zoonoses, minimize the risk of contagion with the indicated critical alimentary diseases and increase the level of population health protection. The implementation of measures is carried out in close co-operation with state administration bodies and requires public awareness.

2 Current State Analysis
Alimentary diseases are divided into food infections and poisonings depending on the character of microorganisms causing disease and the mechanisms of their effects. Alimentary intoxications are caused by microorganisms, which are transported by food or water into human alimentary tract where they reproduce and cause a disease. Toxoinfections are diseases caused by endotoxins of bacteria, which affect intestinal mucous membrane [1, 2].

The group of alimentary infections with predominantly faecal-oral way of transport is significantly affected by a “human factor” during the whole food chain. Acute diarrhoeic diseases of both bacterial and viral origins are epidemiologically significant, because they are imported from the countries with their endemic occurrence, mainly due to tourism and jobs abroad.

The group of alimentary toxoinfections represents a problem, which is difficult to solve. Anti-epidemic measures taken by doctors, vets and food producers only partially influence the tendency of their occurrence. Salmonellosis has been a problematic zoonosis for many years and recently campylobacteriosis has been occurring more and more often.

The group of alimentary poisoning from food occurs only occasionally with epidemics only in case of collective catering. Botulism is the most significant disease and its occurrence is often caused by consuming home-made vegetable and meat tins.

Salmonellosis is a frequent alimentary intoxication caused by the bacterium of Salmonella. These bacteria primarily occur in the alimentary tract of animals and people and through excrements contaminate environment and food. Poultry is a significant reservoir of etiologic agents. Risk lies in the consumption of insufficiently cooked meat and eggs [1, 3]. Rodents, wild birds and insects may also spread the disease. Interhuman transfer is extremely rare. The infectious dose is 10⁴ of bacteria. Epidemics outbreak less often in the catering facilities of closed type (school dining halls, nursery schools dining halls) than in the catering facilities of open type (street stalls, confectioneries). Infections spread mainly by sweets and finished food into which eggs are added at the end of heat treatment and not by meat products as it used to be [2].

Bacterium from the Campylobacteriaceae family causes campylobacteriosis. The risk of infection lies mainly in low hygiene during handling poultry in households and public catering facilities. Infection is transferred alimentary or directly by contact with an
infected animal. Interhuman transfer as well as epidemics’ of campylobacter are rare. The infectious dose is about $10^3$ of bacteria. Epidemiological significance increases together with the annual increase in the number of affected people [1].

*Listeria monocytogenes* is also a monitored bacteria causing alimentary disease. This microbe causes infections among people and animals. Rodents help these bacteria to sustain. They spread alimentary the most often. The occurrence of listerioses is not high, but the risk lies in high mortality, which can be up to 60% among sensitive individuals. Erysipeloid, brucellosis and tularemia belong to this group of diseases as well. Tularemia has a potential to be used as biological warfare agent [2, 3] due to its high level of dangerousness and extremely low infectious dose.

*Escherichia coli* or yersiniosis caused by *Yersinia enterocolitica* are the most significant intestinal infections caused by microorganisms triggering acute diarrhoeic diseases. The infections are mostly transported by faecal-oral way, dirty hands and contaminated food. The risk again lies in insufficiently cooked food, unwashed vegetables and contaminated water. The infectious doses are rather high, it is $10^9$ bacteria in case of *Yersinia enterocolitica* [2].

Hepatitis A from *Picornaviridae* family represents diseases of viral origin. Viral diseases transported by food show several differences when compared with bacterial alimentary diseases. The infection does not affect alimentary tract, but it gets directly to liver where it attacks parenchymatic cells and reproduces there. The virus neither reproduces in food nor changes food sensorial properties, which makes its identification more difficult. The zoonotic transport is unlikely due to specific properties of viruses. The risk lies in faecal-oral transport. Transport is possible through the vectors such as insects and water. The resistance of virus is rather high as it is not destroyed by common pasteurizing temperatures and it maintains its virulence in frozen food for at least 1,5 year. The alimentary risk assessment is more complicated when compared with bacteria due to long incubation time (30 days in average) as well as long and difficult proof of causal agent [1, 2].

The frequency of diseases caused by parasites is not high, but the effects on human organism are serious. *Toxoplasma gondii* is a causal agent of toxoplasmosis and the disease outbreaks mainly among people with decreased immunity. The causal agent belongs to coccidia, the life cycle of which requires several hosts. Felines are the final hosts and infectious oocysts grow in their intestines and are excreted into environment. People and other warm-blooded animals may become carriers. The risk of infection arises from consuming raw or undercooked meat containing tissue cysts, rarely also from contact with an infected animal or congenital transport from mother with an acute form of disease [1, 2, 4].

Teniases are parasitic diseases caused by *Taenia solium* or *Taenia saginata*. Adult specimen live as parasites mainly on a small intestine and can cause serious diseases of people and animals. People are sources of infection and animals are carriers that, after eating eggs of Taenia, let them grow in their muscles. The risk of infection arises from consuming raw or undercooked meat containing cysticerci. Faecal-oral transport is also possible in case of low level of personal hygiene [1, 2, 4].

### 3 Used Methods

The outcomes of analyses carried out by accredited microbiological laboratories at regional hygienic centres and the State Medical Institute have been used in the paper. Causal agents have been identified through direct methods including cultivation, microscopic detection, direct immunofluorescence, Enzyme Linked ImmunoSorbent Assay (ELISA), and Polymerase Chain Reaction (PCR). Indirect methods have been used for detecting formed antibodies. The ELISA method and indirect immunofluorescence have been used for the detection of antibodies. Microscopic detection, immunofluorescence, ELISA and PC have been used for rapid diagnostics.

The occurrence of selected zoonoses in a region and in the Czech Republic has been found out through the EPIDAT programme. The EPIDAT programme is used by a hygienic service for obligatory reporting, evidence and analysing the occurrence of infectious diseases in compliance with corresponding legal amendment [6, 7] and international regulations binding for the WHO member countries.

Brainstorming has been used for determining the levels of impact of individual infections [8].

### 4 Outcomes and Discussion

The individual risks of diseases caused by selected zoonoses of alimentary origin have been calculated on the basis of data acquired from the EPIDAT programme [5] and the Czech Statistical Office [9]. The values of individual risks for the assessed zoonoses from 2003 to 2008 are shown in Table 1.

The individual risks of infections caused by diseases of bacterial, parasitic and viral origins have been studied. The infections of bacterial origin have been chosen for their pathogenity, speed of spreading and high frequency of occurrence. The parasitic infections have been chosen because of their difficult life cycle and unclear detection.
infections caused by bacterial intestinal infections including yersiniosis and diseases include campylobacteriosis, salmonellosis, Hepatitis A has been monitored due to its epidemic occurrence. The values of individual risks of the alimentary origin have been carried out for the inhabitants of South Moravia region. The data from the regional hygienic centre and the Czech Statistical Office have been used for the analysis. The values of individual risks for the assessed diseases are shown in Table 2. It results from the comparison of data in Table 1 and Table 2 that the current individual risk of infections caused by zoonoses in the South Moravia region is comparable with the risk situation on the territory of all country. The situation in the region is more favourable in most cases (listeriosis, erysipeloid, tularemia, other bacterial intestinal infections, hepatitis A, toxoplasmosis and teniasis), however it is exceptionally rather worse in case of salmonellosis and campylobacteriosis). The highest levels of individual risks have been recorded for salmonelloses, campylobacterioses and other bacterial intestinal infections. Yersinia enterocolitica and Escherichia coli have been separately

<table>
<thead>
<tr>
<th>Type of disease</th>
<th>Individual risk R_i [person^{-1}.year^{-1}]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
</tr>
<tr>
<td>campylobacteriosis</td>
<td>1.96x10^{-3}</td>
</tr>
<tr>
<td>salmonellosis</td>
<td>2.64x10^{-3}</td>
</tr>
<tr>
<td>listeriosis</td>
<td>1.18x10^{-6}</td>
</tr>
<tr>
<td>erysipeloid</td>
<td>8.82x10^{-7}</td>
</tr>
<tr>
<td>tularemia</td>
<td>5.88x10^{-6}</td>
</tr>
<tr>
<td>brucellosis</td>
<td>0.00</td>
</tr>
<tr>
<td>other intestinal infections</td>
<td>2.31x10^{-4}</td>
</tr>
<tr>
<td>hepatitis A</td>
<td>1.12x10^{-5}</td>
</tr>
<tr>
<td>toxoplasmosis</td>
<td>4.46x10^{-5}</td>
</tr>
<tr>
<td>teniasis</td>
<td>9.80x10^{-7}</td>
</tr>
</tbody>
</table>

Hepatitis A has been monitored due to its epidemic occurrence and dangerousness. The monitored bacterial diseases include campylobacteriosis, salmonellosis, listeriosis, erysipeloid, tularemia, brucellosis, and other bacterial intestinal infections including yersiniosis and infections caused by Escherichia coli. The parasitic diseases include toxoplasmosis and teniasis, viral diseases include hepatitis A.

Similar risk analysis resulting from the zoonoses of alimentary origin has been carried out for the inhabitants of South Moravia region. The data from the regional hygienic centre and the Czech Statistical Office have been used for the analysis. The values of individual risks for the assessed diseases are shown in Table 2.
monitored in the South Moravia region. The levels of their risks exceed the referential level $R_t = 10^{-4}$ [person$^{-1}$ year$^{-1}$] published in the U.S. EPA database [11] both in the region and the whole country and are therefore unacceptable. However, it is necessary to realize that in relation to other intestinal infections the sum of risks does not significantly exceed the referential value. As it seems from the regional monitoring the highest number of infections is caused by Yersinias. It is clear that a maximum attention has to be paid to the prevention of transfer of salmonella and campylobacteria, similarly as in the armed forces [12].

Mortality has been monitored and possible impacts of diseases assessed in order to increase the informative value of individual risks. It has been found out that most deaths have been recorded among the citizens over 70 years old and rarely among children up to three years and citizens from 50 to 70 years old. Deaths have not been recorded in other age categories during the monitoring period. The impacts of disease C have been determined with the use of brainstorming and assessed in the interval $C \in (1; 10)$ $\land$ $C \in N$, where N is a symbol for the set of all natural numbers. The final individual risk $R_{IC}$ [person$^{-1}$ year$^{-1}$] has been calculated according to the equation (1):

$$R_{IC} = R_t \cdot C$$  \hspace{1cm} (1)

The corresponding data with the final risk $R_{IC}$ for 2007 (data on mortality in 2008 were not known at the time of data processing) are shown in Table 3. It is clear from the table that the conclusions derived from the individual risk $R_t$ of individual diseases are analogical even after including the weight of impact and thus derived from the final risk $R_{IC}$. The reason is that the probability of occurrence of campylobacterioses, salmonelloses and other intestinal infections is often different by more than one level when compared with other diseases and that there is approximately the same impact of the above mentioned critical infections.

As far as the risk development of diseases caused by the assessed alimentary diseases is concerned it may be stated that during the monitoring period it either fluctuates in a relatively narrow interval (listeriosis, tularemia, other intestinal infections, toxoplasmosis, teniasis) or after an initial increase it decreases to the values analogical or lower than at the beginning of monitoring (salmonellosis, campylobacteriosis), as it is shown in Figures 1 to 3.

An exception is the increased incidence of hepatitis A in case of which the risk of infection in 2008 increased more than 5 times in the region and by even more than one level in the Czech Republic. We assume that reason is the reduced immunity of population due to a long term minimal incidence of the disease resulting in the increased sensitivity of the generation, which has not been affected by the disease so far. At the same time tourism was on the increase, especially in Prague, where the situation was the most critical.

The implementation of the following counterepidemic measures may be recommended in relation to the unacceptable individual risk of infections caused by campylobacteriosis and salmonellosis:

a) sensorial check upon the purchase of food;
b) adequate heat treatment of food (minimum of 10 minutes at 72 °C);
c) to consume food immediately after preparation;
d) to store food in temperatures over 60°C, or below 10 °C;

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Table 3 Individual risks of diseases caused by selected zoonoses of alimentary origin in the Czech Republic (CZ) and the South Moravia (SM) Region in 2007 while considering the impact of diseases

<table>
<thead>
<tr>
<th>Type of disease</th>
<th>Level of impact</th>
<th>Mortality [person]</th>
<th>$R_t$ [person$^{-1}$ year$^{-1}$]</th>
<th>$R_{IC}$ [person$^{-1}$ year$^{-1}$]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CZ</td>
<td>SM Region</td>
<td>CZ</td>
</tr>
<tr>
<td>campylobacterioses</td>
<td>4</td>
<td>X</td>
<td>X</td>
<td>2.35x10$^{-3}$</td>
</tr>
<tr>
<td>salmonellosis</td>
<td>4</td>
<td>1</td>
<td>10</td>
<td>1.76x10$^{-3}$</td>
</tr>
<tr>
<td>listeriosis</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>4.94x10$^{-6}$</td>
</tr>
<tr>
<td>erysipeloïd</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>4.84x10$^{-7}$</td>
</tr>
<tr>
<td>tularemia</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>5.23x10$^{-6}$</td>
</tr>
<tr>
<td>brucellosis</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>other intestinal infections</td>
<td>5</td>
<td>3</td>
<td>16</td>
<td>2.74x10$^{-4}$</td>
</tr>
<tr>
<td>hepatitis A</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1.24x10$^{-5}$</td>
</tr>
<tr>
<td>toxoplasmosis</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>2.24x10$^{-5}$</td>
</tr>
<tr>
<td>teniasis</td>
<td>3</td>
<td>X</td>
<td>X</td>
<td>9.69x10$^{-7}$</td>
</tr>
</tbody>
</table>

X - data not available
c) to reheat cooked food thoroughly before consumption;
f) to avoid the contact of raw and cooked food;
g) to maintain sufficient personal hygiene during the preparation of food;
h) to maintain the hygiene of working environment and tools during the preparation of food;
i) to protect food against insects, rodents and other animals;
j) to use drinking water;

The above mentioned preventive measures are of key importance especially in summer season, which has all favourable conditions for the reproduction of causal agents of intestinal infections.

![Fig. 1 The development of individual risk $R_I$ of infection caused by campylobacteriosis in the region and the Czech Republic](image1.png)

![Fig. 2 The development of individual risk $R_I$ of infection caused by salmonellosis in the region and the Czech Republic](image2.png)

5 Conclusion

The individual risk $R_I$ of infections caused by selected bacterial, viral and parasitic zoonoses of alimentary origin has been assessed in the South Moravia region and then compared with the country average. Unacceptable risk has been recorded in case of salmonellosis, campylobacteriosis and other bacterial intestinal infections, where the risk values exceed the referential value $R_I = 10^{-4}$ [person$^{-1}$ year$^{-1}$] published by the U.S. EPA. It is worth mentioning that the detection of infections, which is carried out by epidemiological-hygienic service, remains on a qualitatively very high level in the Czech Republic.

The risk situation in the region corresponds with exceptions with the situation in the whole Czech Republic. The situation in the region is less favourable in case of critical infections, but on the contrary it is more favourable in case of low frequency diseases. Similar outcomes have been obtained also after incorporating the impacts of individual infections.

The development of risk situation did not change a lot from 2003 to 2008 and it slightly improves both in the Czech Republic and the region. Significantly increased risk of infection caused by hepatitis A was monitored in 2008 together with the increasing campylobacteriosis salmonellosis infections risk ratio. The outcomes have shown that attention has to be paid mainly to the area of preventing the transport of campylobacteria, partially salmonella and lately mainly hepatitis A. Specific measures have been proposed to deal with the above mentioned infections.

**References:**


