A Review on Zoonotic Dermal Infections in Humans

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Abstract:
Human skin has a major role in protecting several organs from various microbial attacks. It regulates the body’s temperature and its other normal functions. It is usually possessed by various microbes that may vary in different aspects and impacts on human dermal layer and may lead to serious infections in future. Encounter of human dermal layer to any injury or wound can be a forum for microbes to get entered and cause infection. Most of infections occur due to zoonosis which is transmission of pathogens from animals to humans. According to the type of host, zoonoses can be categorized as anthropozoonosis, zooanthroponosis, amphixenoses and euzoonoses whereas other major types of are etiological and cyclic zoonoses. Each category is further sub-categorized into various possible groups. But review highlights that domestic animals are generally the primary source for humans to get infected. So the best prevention is regular practice of personal hygiene to overcome any sort of zoonosis, however; to handle any zoonotic breakout collective efforts of international organizations, local government and of general public is required to minimize health and life loss.

Keywords: Skin, zoonosis, infections, pathogens, animals

1. INTRODUCTION
Skin shields the internal body organs by acting as a hurdle between outside surroundings and internal body parts. Not being a connective tissue, skin plays an important role in thermoregulation. It gets injured due to number of agents. The society named as “wound medicine”, acknowledge about skin injuries, ‘bruises or abrasions’ that interrupt the normal structures and functions of skin [1]. Skin performs its functions even during injured condition [2]. Human skin has large number of microorganisms on it and they belong to a varying and multiplex group of organisms. Microbes have the ability of being altered over time in order to adjust in their environment. Their form on the skin is determined by the different situations of the skin like synthetic, somatic and organic circumstances of skin [3]. Growth of microbes on skin also depends upon the dermal natural terrain like dehydrated (xerosis), humid and oily skin). Moreover, microbial growth on skin also depends upon number of skin glands and hair follicles [4]. Human dermal wounds often serve as important route of infectious agents’ transmission from animals. Several wildlife species are known for the spread of contagious maladies [5]. Another recent and devastating observation of zoonosis was epidemic of
corona virus for which edible animals were found as vectors [6]. Similarly, dermatophytes (dermal molds) also spread through zoophilic route [7]. According to "Asia Pacific strategy for emerging diseases 2010" the 60% of growing human transmittable ailments have zoonotic origin and the 70% causative agents of these ailments come from wildlife species. The word zoonosis comes from Greek word "zoon" meaning "animal" and noses meaning "sickness". World Health Organization defines zoonosis as ailments that transfer from vertebrate animals to humans and vice versa comes under the category of zoonosis [8]. The expert committee on zoonosis in 1951 defined zoonosis as: diseases and infections that are naturally transmitted between vertebrate animals and man [9]. A German physician coined the term zoonosis and explained the correspondence of humans and animals in disease transmission [10]. More appropriate terms for the transfer of zoonotic diseases are “anthropozoonosis” (transfer of disease from animals to humans) and “zooanthroponosis” (transfer of disease from humans to animals. The term, known as "amphixenoses", is used for the transfer of disease between humans and lower vertebrate animals [11]. Agents leading to the disease in host are transferred from animals to humans and are likely to known as pathogens. Disease causing pathogens are most numerous group of organisms like bacteria, viruses, sometimes unicellular and multicellular eukaryotic organisms also act as pathogens. Every group of pathogen cause contrasting sort of disease/infection in host. Virulence is designated as seriousness of disease caused by a pathogen [12]. The contact between host and pathogen may occur through exposure with contaminated food, water or through direct physical contact with animals. The contagious maladies that affect the population of any area for first time or reported to cause the infection for the first time or affect small number of people in past but is affecting a large number of people this time or spreading in a new geographical area is called as emerging infectious disease (EID) [13]. Some other transmitting mediums of infection include to touch the mouth having contaminated hands, engulf the intermediate host, touching the objects that possess microbes. Arthropods also play a major role in the transmission such as mosquitos or ticks that transmit the parasites to humans after having a contact with infected animals. Some species of parasites follow new patterns for transmission i.e. allochthonous way of transmission. For example, raccoon dog have its stem in eastern Asia but is involved in the transmission of disease in Europe. The raccoon dog is present in great number in Europe and producing summons to check out the zoonosis [14].
More than 60,000 people die due to infections from animals each year. This poses a great threat to the life of both human and animals. Moreover, it also reduces the annual yield of products obtained from animals’ i.e. eggs and milk, thereby affecting the farmers and countries in economical point of view [16]. Prevalence of 2.4 billion disease cases and 2.7 million death cases of humans in each year have been reported in the underprivileged countries around the globe. It is acknowledged that those cases were known to cause by just 13 most common and with worldwide spread zoonosis. According to experts, zoonosis affect humans in multiple ways (Figure 1), for example some infections occur in specific regions of the world after specific time period (Endemics) and affect the population of that area by causing disease case or death reports. Examples include the infections that spread through food, brucellosis, leptospirosis etc. Sometimes, there is outbreak of a parasite that affects the multiple regions of the world at same time (Epidemics). This type of infections is not very often. Some examples are rift valley fever, rabies, anthrax [8].
2. TYPES OF ZOONOSES

Multiple ways are used to classify zoonosis but most commonly three ways to categorize are: on the basis of type of host, etiological agents and life cycle of pathogens [11].

2.1 Host based zoonosis

Categorizing the zoonosis on the basis of host is a slight older method of classification which is as follows:

2.1.1. Anthropozoonosis

Infections that transfer from animals to humans come under the category of anthropozoonosis includes:

2.1.2. Zooanthroponosis

Maladies that are transmitted from humans to animals are called zooanthroponosis e.g., tuberculosis is transferred to domesticated cats or monkeys.

2.1.3. Amphizoonoses

The diseases that can follow both ways i.e. from humans to animals or from animals to humans are known as amphizoonoses for example staphylococcal infections.

2.1.4. Euzoonoses

There are many diseases for which parasite need humans to complete its life cycle. Such diseases are termed as euzoonoses for example Taenia solium, Taenia saginata [16].

2.2 Etiological zoonosis

According to Koch's postulates, to group the organisms as aetiological agent, it must have properties including: organisms must have the property to be isolated and cultivated in the laboratory, the agent must be present in all affected organisms but not in non-affected organisms, agents should cause infections when inoculated into fine host and antibodies must be produced in the host.

Among the etiological zoonosis, bacterial zoonosis accounts for 42%, viral for 22%, parasitic for 29%, mycotic for 5% and prions for 2%. Zoonosis is also caused by DNA and RNA viruses. RNA viruses’ related zoonosis is more common than DNA viruses’ related zoonosis [17].

2.2.1. Bacterial zoonosis

2.2.1.1. Corynebacterium species

These parasites cause disease in hedgehogs. Parasite was collected from the alveolar tissue of dead animal and regarded as cause of death. There are chances of transmit of parasite from infected hedgehogs to humans [18].

2.2.1.2. Leptospira species

It generally causes leptospirosis due to shedding of pathogenic Leptospira spp. by infected cats and eventually transmits disease in humans [19].

2.2.1.3. Coxiella burnetti
This class includes gram negative bacteria. They are found inside the host cell and are obligate parasites. *Coxiella burnetti* is known for Q fever. The pathogen transfer from domesticated or critter animals to humans. The route of transmission is generally physical contact with affected animals or products released from affected animals [20].

2.2.1.4. Methicillin resistant *Staphylococcus aureus* (MRSA)

It causes hospital related maladies in humans. MRSA infections may spread from domestic animals like cattle, birds and pigs. These infections include food poisoning, localized purulent infection, botryomycosis, pyogenic endocarditis, pneumonia, otitis media, osteomyelitis, and pyogenic infections of the skin and soft tissues [21].

2.2.1.5. *Mycobacterium* species

They cause many type of malfunctioning in humans and animals. Paratuberculosis is caused by *Mycobacterium avium* in ruminants. It is the causative agent of Crohn's disease in humans [22].

2.2.1.6. *Salmonella* species

They are the members of family Enterobacteriaceae. They are gram negative, facultative, rod shaped and anaerobic organisms in nature. The most common infection in humans and animals caused by salmonella species is “Enteritidis” caused by *Salmonella enterica* [23].

2.2.2 Mycotic zoonosis

2.2.1.1. *Candida albicans*

It causes Candidiasis in humans. The disease is transmitted through domestic pets in human [24].

2.2.1.2. *Microsporum* species

*Microsporum* is well known Dermatophyte genus. Members of the genus cause a number of dermal issues in humans. The species *M. canis* and *M. gypseum*, of this genus cause dermatophytosis in humans around the globe on exposure of infected cats usually [25].

2.3 Cyclic zoonosis

Depending upon maintenance cycles, zoonosis is grouped into following four classes:

2.3.1. Cyclozoonoses

The pathogens that come under the category of cyclozoonoses require multiple in human vertebrate hosts to complete life cycle. Vertebrate acts as an intermediate host. This is the rare type of zoonosis. The examples include human taeniasis, hydatid cyst disease and pentastomid infections [16].

2.3.2. Direct zoonosis

It is also known as orthozoonosis. Direct contact of humans with infected animals may cause to spread this type. This contact can occur through fomites, bites or via vectors. For example avian influenza - a viral infection spreads from animals to humans through fomites. Rabies - the most horrible viral disease transmit through
bites by infected organisms i.e. fox, raccoon, rabid dog and cat etc. Virus penetrates into body of human through saliva during bite [26]. Dengue fever spread through vectors. Generally arthropods are taken as most common organisms that act as vectors. But any other organism that can transmit disease to humans is vector [27].

3.2.3. Metazoonosis

These types of infections are also termed as pherozoonosis. In this type, the vectors need vertebrate and invertebrate hosts to complete their life cycle. It usually uses invertebrate host to divide and accomplish its incubation period. Then it is transmitted to vertebrate host where it accomplishes its remaining life cycle and also causes disease. Plague, schistosomiasis, encephalitis and arbovirus are some well-known examples of metazoonosis [28].

3.2.4. Saprozoonosis

WHO committee on zoonosis defines saprozoonosis as the diseases that spread through the causative agents that require a vertebrate host and a non-animal host (food, soil, plant and organic matter) for development are termed as saprozoonosis. Examples include mycotic diseases (histoplasmosis and aspergillosis) and bacterial infections (legionellosis) [16].

4. INFLUENCE OF ZOONOSIS ENVIRONMENT

Ecosystem also affect the spread of infections in which causative agent circulate. On the basis of ecosystem the zoonotic diseases are classified into following terms:

4.1. Synanotropic zoonosis

In this type of zoonosis the causative agent completes its cycle only in domestic animals. Disease spread from domestic animals to humans via conjunctiva or skin. Examples of synanotropic zoonosis are ringworm, listeriosis, and bovine tuberculosis.

4.2. Exoanthropic zoonosis

The parasite completes its life cycle in animals that are out of domestication i.e. feral. Transmission occurs through vectors that feed on human blood i.e. mostly arthropods. Examples include arboviruses and tick borne encephalitis [16].

5. ZOONOSIS OF DOMESTIC ANIMALS

Domestic animals have a prime role in spread of disease in humans. They are the carriers of pathogens and deliver the disease to humans also from wild animals. Domestic animals are the source of 60% of infections occurring in humans. The causative agents of diseases follow different pathways to enter into the body of humans. They may enter through swallowing, breathing, biting or close association with infected animals. Different types of domestic animals like goats, cats, sheep and horses (Table 1) the transmission of diseases to humans [29].
### Table 1. Infections that transfer from domestic animals to humans

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Causative agent</th>
<th>Animals</th>
<th>Route of transmission</th>
<th>Symptoms</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthrax</td>
<td>Bacillus anthracis</td>
<td>Cattle and goat</td>
<td>Direct contact with animals or their products</td>
<td>Pneumonitis, malignant pustules, gastroenteritis</td>
<td>[30]</td>
</tr>
<tr>
<td>Bovine tuberculosis</td>
<td>Mycobacterium bovis, M. tuberculosis, M. caprae</td>
<td>Domestic animals</td>
<td>Contaminated milk, aerosols of animals</td>
<td>Cough, fever, weight loss, night sweats</td>
<td>[31]</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>Brucella melitensis, B. abortus, B. suis, B. canis</td>
<td>Sheep, cattle, dogs</td>
<td>Infected milk products, aerosols, contact with infected animal secretions</td>
<td>Pneumonia, muscle and joint pain, fever, meningitis, night sweats</td>
<td>[32]</td>
</tr>
<tr>
<td>Rabies</td>
<td>Rhabidoviridae - Rabies virus</td>
<td>Cats, jackals, bats, foxes, dogs</td>
<td>Through bite of infected animals</td>
<td>Bewilderment, solicitude, excitation, hallucinations, hydrophobia</td>
<td>[33]</td>
</tr>
<tr>
<td>Ecthyma contagious (Orf zoonosis)</td>
<td>Parapoxvirus</td>
<td>Sheep, goats or fomites</td>
<td>Through open wounds and bruises of host on exposure of lesions of infected animals</td>
<td>Dermal lesions and nodules especially on fingers, hands and forearms</td>
<td>[34]</td>
</tr>
</tbody>
</table>

### 6. BIOSAFETY AND TREATMENT OF ZOONOSES

Zoonosis accounts a major threat to human health. Most of the human diseases have zoonotic origin. Nearly 75% of human diseases are zoonotic in nature [35]. In zoonosis, there is transfer of pathogen from animal to humans but environment is also considered important factor in the spread of disease. Therefore, in order to control zoonosis many factors are taken under consideration [36].

- The most important step to control zoonosis is surveillance. It is needed at every stage of zoonosis i.e. premature stage of disease, level of disease in humans and animals and the areas of disease spread. Surveillance provides a schematic way to check out the plan of action to overcome the spread, to lessen the ill effects of disease and to reduce the death rate of humans and animals. Zoonosis is of both types i.e., endemic and pandemic, so surveillance is needed at territorial, federal and global level [37].

- The basic management to deal with diseases involves the treatment of afflicted organisms, proper vaccination of organisms that are not affected with infections, holding the vulnerable animals in captivity and proper tests for vulnerable individuals. In order to avoid the spread of infection a proper sanitizing system is established for both animals and humans. Individual shielding apparatus for eyes, skin and other exposed parts during handling the affected organisms is also needed to
minimize the chances of exposure. To stun the severity of infections that are appearing at any geographical region for the first time, there is a need of joint and incorporative efforts [38].

- Some disease spread after biting of affected arthropods and are called arboreal diseases. So, to cease the growth of these infections, there is a need to check the growth of the responsible vectors along with the endemic surveillance [39].

The strategies that are made to overwhelm the population of pathogens need some kind of sponsorship which is not accessible in emergent countries. That's why there is a necessity of monetary support for such countries from economically grown nations. Some legislative organizations like World Health Organization, European Union, US department of Agriculture etc. and non-legislative organizations like Welcome Trust can be appealed for monetary support even for any zoonotic epidemic in, if occurs in developing countries [40].

7. CONCLUSION

Human skin is one of the largest organs in whole body. It gives a shield to other organs. It usually protects us from different microbial infections. For this purpose, the skin as itself, must be also protected. It is possessed by different microbes. If it get injured or get any bruises of cuts, it is readily available for microbial infections. Mainly, human skin get infected by means of zoonosis. Zoonosis has prime importance in human dermal infections. Zoonosis is differentiated into different types depending on their type of host, etiological agents and life cycle of pathogens. Domestic animals are the main source of disease spread. Our hands, palms and feet are more exposed to microbes and in response to touch, it may leads to some kind of serious skin infection or disease. Hands must be washed properly in order to prevent the infectious agents. Preventive measures of personal hygiene must be adapted to overcome any sort of zoonosis.

References


