Escherichia Coli: An Infectious or a Factorial Pathogen?

Proceeding

Escherichia coli (rus. кишечная палочка [kishechnaya palocha] - "intestinal rod") is a well-known and widely studied ubiquitous Gram-negative, facultative anaerobic, non-sporeforming rod-shaped bacterium, isolated in 1885 by a German-Austrian pediatrician from the feces of healthy individuals and originally named Bacterium (bacillus) coli communis.

As natural inhabitants of the lower intestine of warm-blooded organisms, most of more than 700 known E.coli serotypes behave like harmless commensals, but some (EHEC, ETEC, EIEC, EaggEC, EPEC and DAEC) can cause serious illness in humans (e.g., O104:H4, O121, O104:H21, O157:H7 etc.) including bloody diarrhea, stomach cramps, vomiting and occasionally fever. The bacteria can also cause pneumonia, neonatal meningitis, hemolytic-uremic syndrome, peritonitis, mastitis, septicaemia, and there is evidence of their involvement in cancer. Strains of E. coli that cause disease outside the intestinal tract of any species share common characteristics and are called Extraintestinal pathogenic E. coli (ExPEC). Research into ExPEC has shown that its potential transmission from food animal sources is likely to be implicated in human infections and that chickens, together with beef and pork, are a major reservoir. Nowadays the most dangerous are so called ESBL E.coli, which produce an enzyme called extended-spectrum beta lactamase (ESBL). The Infectious Diseases Society of America (IDSA) included ESBL E.coli into the group of multi-resistant “ESKAPE bacteria” (“Bad Bugs – No Drugs”), which includes Enterococcus faecium (VRE), Staphylococcus aureus (MRSA), Klebsiella pneumoniae (ESBL), Acinetobacter baumanii, Pseudomonas aeruginosa, and Enterobacter species.

The occurrence of ESBL E. coli in chicken meat increases worldwide. According to the Technical University of Denmark (2012) in Danish chicken meat it increased from 8.6% in 2010 to 44% in 2011 while the occurrence in imported chicken meat was 50% in 2010 and 48% in 2011. Colibacillosis was first described in chickens in 1894. Since then, there have been numerous reports on colibacillosis in poultry and considerable research on the disease has been completed. Many investigators doubt that E. coli is a primary pathogen. Others are convinced that certain serotypes are primary pathogens and their opinion seems to prevail. When in mammals it is mostly a primary enteric or urinary tract disease, colibacillosis in poultry is typically a localized or systemic infection occurring secondarily when host defenses have been impaired or overwhelmed by virulent E. coli strains - avian pathogenic Escherichia coli (APEC). Most APEC are ExPEC and share characteristics with mammalian ExPEC. The O (somatic) antigen serotypes most commonly associated with disease outbreaks in poultry are 01, 02, 035, and 078. The K (capsular) antigens most commonly associated with virulence are K1, K80, K88, K99. In the intestinal tract of normal poultry, nonpathogenic serotypes far outnumber pathogenic serotypes, with 10-15% of intestinal coliforms being potential pathogens.

Birds are continuously exposed to the bacteria through contaminated feces, water, dust, and environment. Poultry colibacillosis has many “faces”: colisepticemia, coligranulomatosis (Hjarre’s disease), ophthalmitis and yolk sac infection, aerosacculitis (chronic respiratory disease, CRD), swollen-head syndrome (SHS), panophthalmitis, conjunctivitis, pericarditis, pneumonia, perihepatitis, splenitis, salpingitis, “egg peritonitis” (in layers, breeders), cellulitis, osteomyelitis/arthritis/tenosynovitis, femoral head necrosis (FHN), food pad dermatitis (FPD), enteritis etc. However, lesions alone do not allow concluding about E. coli infection, because other opportunistic bacteria (Aerobacter, Proteus, Klebsiella, Pseudomonas, Salmonella, Bacillus, Staphylococcus, enteric Streptococcus, Clostridia, ORT, MG, MS, MM, Pasteurella, Bordetella, etc.) can behave similarly to E. coli as secondary infections.

Among the conditions, predisposing to the development of Ecoli infection in poultry there are numerous external and internal factors, such as:

I. Bad biosecurity and poor hygiene: Old, multiage farms, improper house cleaning and disinfection, poor control of vectors (rodents, synanthropic birds, insects), litter quality etc.

II. Incubation: Dirty, cracked, exploded eggs, overheated/dehydrated underdeveloped day old chickens with open navels - an easy target for any enterobacteria and other pathogens from the surrounding.

III. Management disturbances: High stocking density, low feeding/drinking space, high growth speed, weighing, selection, beak trimming, fasting, thirst, onset of lay, catching, transportation, spiking, trauma etc.

IV. Psychological: Hierarchy, competition, fear, aggression, feather pecking, cannibalism etc.

V. Environmental: Physical (temperature, humidity, draught, dust, light, noise) and chemical (CO₂, NH₃, CO).

VI. Nutrition: Raw materials/feed quality and contamination, starvation, overfeeding, nutrients/minerals/vitamins excess/deficiencies, poor feed structure, weed seeds, (mycotoxins, poisoning, etc.
VII. Water quality: High bacterial count, high pH, low ORP, biofilm, Iron, pesticides etc.

VIII. Subclinical intestinal/respiratory infections/invasions: coccidiosis, disbacteriosis, helminthes, MG/MS/MM, ORT etc.

IX. Vaccine reactions: some strains of IB, ND, ILT, TRT viruses can produce tissue reactions of the respiratory organs and mucous membranes, which may develop into a chronic respiratory disease. Live vaccines may have even more generalized detrimental effects depending on the flock’s health status, the vaccine strain, the application method (rolling infections), interactions with other vaccines, environmental stress and combinations of these points.

X. Immunosuppressive field/circulating viruses: Infectious Bursal Disease Virus (IBDV), Marek’s Disease (MD), Chicken Anemia Virus (CAV), turkey Hemorrhagic Enteritis Virus (HEV) – by damaging lymphocytes or their precursor cells, they can trigger chronic respiratory disease.

XI. Respiratory field/circulating viruses: Low pathogenic Avian Influenza (LPAI), Newcastle Disease (NCD), Infectious Laringotracheitis (ILT), Infectious Bronchitis Virus (IBV), Avian Metapneumovirus (Turkey Rinoentreheitis) – by damaging the respiratory tract clia they open a passage for numerous bacteria.

XII. Unjustified usage of broad-spectrum antibiotics (cephalosporins, fluoroquinolones etc.): without having a preliminary sensitivity test done; incorrect doses and duration of antibiotic administration (h/day, consecutive days); combination of several BSA on one farm.

XIII. Hormonal responses to stress: Corticosterone is the main hormone associated with stress in chickens. Its concentration in plasma rises under stressful conditions. Changes in corticosterone have secondary effects on other hormone systems, such as the conversion of noradrenaline into adrenaline or the production of thyroid hormones. Elevated corticosterone levels in response to stress, irrespective to its nature, transform major metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe metabolic processes of the organism into a catabolic rout with an irreversible effect, ending up with a severe
b) **Prevention** assumes strict biosecurity rules: hatchery, barns, vehicles, equipment thorough disinfection, hatching eggs quality control (dirty, cracked, exploded), incubation process control (egg shell temperature, "hatch window"), water, feed sanitation (disinfectants, organic acids, pelletizing), monitoring and prevention of immunosuppressive viral infections, mycoplasma, salmonella, mycotoxins, stocking density control, environmental stress management, competitive exclusion (pre/probiotics), immunostimulants. The existing commercial (killed) vaccines have not gained popularity. Some farms tried autovaccines based on local APEC serotypes.

c) **There are a few vaccines available in Russia:** killed associated AVIVAC «Salmo-Coli-Pastovac» (E.coli + S. Enteritidis C5-AT + P. multocida) VNIVIP; killed (Stavropol), killed (VNIVIP, St. Petersburg, experimental), killed associated E. coli + Pasteurella (VNIVIP), killed for ducks 078, Live E.coli «Г-5» (Saratov, experimental).

d) **Targets for future:** The major improvements can be achieved by changing the old farms to “all in – all out” system, better understanding and controlling the environmental stress factors, using reliable laboratory diagnostics, antibiotics sensitivity test, more selective antibiotics application focused on narrow-spectrum drugs, application of new generation vaccines against APEC /ESBL E.coli.

**References**

1. Bergeron CR, Prussing C, Boerlin P, Daignault D, Lucie Dutil, et al. (2012) Chicken as Reservoir for Extraintestinal Pathogenic Escherichia coli in Humans, Canada. Emerging Infectious Disease Journal. 18(3): 415-421.
2. Демиховская Е.В. Беседы с микробиологом. Журнал «Болезни и антибиотики» 2 (05) 2011
3. Boucher HW, Talbot GH, Bradley JS, Edwards JE, Gilbert D, et al. (2009) Bad Bugs, No Drugs: No ESKAPE! An Update from the Infectious Diseases Society of America. Clin Infect Dis 8(1): 1-12.
4. Gross WB (1978) Colibacillosis. In: Hofstad MS (Ed.), Diseases of poultry (8th edn) Iowa State University Press, Ames, Iowa, USA, pp. 270.