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Short Communication

Etiologic and epidemiologic analysis of bacterial infectious upper respiratory disease in Thoroughbred horses at the Seoul Race Park

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Infectious upper respiratory disease (IURD) of Thoroughbred racehorses has been a frequent problem (29.6% of incidence) at the Seoul Race Park (Korea). Risk factors for IURD include the season with a high transfer rate (summer and fall), the stabling period (≤ 3 months), and age (2 to 3 years old), suggesting that the movement and new environment may have depressed the immune system of the horses and decreased their ability to respond properly to pathogens. The bacterial strains (n = 98) isolated from IURD horses included *Pseudomonas* spp., *Escherichia coli*, *Staphylococcus* spp., *Streptococcus equi* subsp. *equi* and *zooepidemicus*.

Keywords: infectious upper respiratory disease, risk factors, *Streptococcus equi* subsp. *equi*, *Streptococcus equi* subsp. *zooepidemicus*, Thoroughbred racehorses

Infectious upper respiratory disease (IURD) is a common and frequently recurrent problem for racehorses in training. It is considerably more common in young racehorses and clinical signs usually include coughing, visible increases in tracheal mucus, and poor racing performance. This is an acute clinical disease that can be caused by several respiratory viruses and bacteria including equine influenza virus, equine herpesvirus-1 and -4, equine arteritis virus, *Streptococcus equi* subsp. *equi*, and *S. equi* subsp. *zooepidemicus* [8]. At the Seoul Race Park, where the largest horse population in Korea is located, there has only been one influenza epidemic in 1973 and an equine herpesvirus in 1979, and no additional viral respiratory outbreaks have occurred since that time.

Data were collected from January 2001 to December 2005 by the Korea Racing Authority Equine Registration and Health Management System (Table 1). With the Analyse-it program (Analyse-it Software, UK), the χ^2 and one-tailed p values from the Mantel-Haenszel χ^2 test and the two-tailed probability from the Fisher Exact test were used to analyze significant differences in IURD incidence with different risk factors (season, age, and stabling period). The Park had yearly IURD epizootics with a 29.6% average incidence rate from 2001 to 2005. This was significantly higher than the 1.5% IURD incidence rate per quarter in non-racetrack horse populations in the USA

Table 1. Statistics related to infectious upper respiratory disease (IURD) at the Seoul Race Park

	2001	2002	2003	2004	2005
No. of all resident horses (A)	2060	2118	2077	2114	2264
No. of newcomer horses (B)	616	731	638	680	748
No. of horses returned to the Park again (C)	26	41	66	139	283
No. of existing resident horses (D)	1421	1353	1379	1315	1273
Population turnover rate (B/A × 100, 32.1% on average)	29.9	34.5	30.7	32.2	33.0
No. of total IURD horses (E)	582	621	637	635	670
No. of IURD horses (F) from (B)	303	369	353	379	326
No. of IURD horses from (C)	6	11	18	42	80
No. of IURD horses (G) from (D)	273	241	266	214	264
Incidence rate of IURD (E/A × 100, 29.6% on average)	28.3	29.3	30.7	30.0	29.6
Incidence rate of IURD in newcomer (F/B × 100, 50.9% on average)	49.2	50.5	55.3	55.7	43.6
Incidence rate of IURD in already existed horses (G/ D × 100, 18.7% on average)	19.2	17.8	19.3	16.3	20.7
No. of IURD treatments (H)	5161	5674	5678	4755	4701
Average no. of treatments per IURD horse (H/E, 8.3 on average)	8.9	9.1	8.9	7.5	7.0

The difference between the sum of A, B, C, and D is derived from the return of newcomer horses within 1 year.

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reported at the annual convention of the American Association of Equine Practitioners. The difference between the incidence of IURD in our study and the USA might be caused by the dense population and high turnover rate at the Park (Table 1).

A number of risk factors for IURD occurrence were identified in this study including the frequent stabling seasons, the stabling period, and age of the horses. There was frequent movement of horses in and out of the Park in the spring, summer, and fall and the least amount of movement in winter (Fig. 1A, $p < 0.05$). The IURD incidence rate (Fig. 1B) was significantly higher in the summer and fall ($p < 0.05$). The main populations of newly stabled horses and IURD patients were 2 to 3 years old. The incidence rate of IURD in the 2 and 3 years old group (Table 2) was significantly higher than in other age groups ($p < 0.05$). The IURD incidence rate in horses stabled for less than 3 months (Table 2) was significantly higher than that for horses stabled for other periods of time ($p < 0.05$).

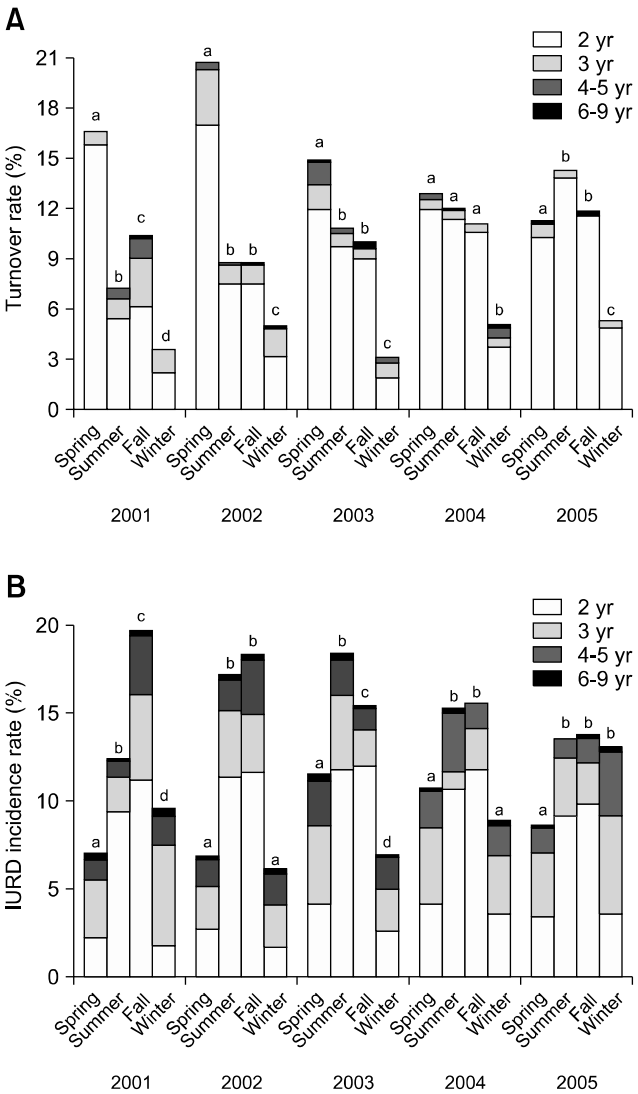

Fig. 1. Comparison of seasonal population turnover rates (A) and seasonal incidence rates of infectious upper respiratory disease (IURD) (B) at the Seoul Race Park (2001～2005). (A-B) [a-d]Letters indicate statistical differences ($p < 0.01$). The main populations of newly stabled horses (A) as well as IURD patients (B) were 2 and 3 years old (yr).

Bacterial identification and confirmation were performed using nasal swap specimeans with the API 20 Strep (bioMérieux, France). *In vitro* antimicrobial susceptibility testing was conducted using the disk-diffusion testing method with Sensi-disc test discs (Becton, Dickinson and Company, USA) in accordance with the guidelines of the Clinical and Laboratory Standards Institute (CLSI) [3,4]. *S. equi* subsp. *equi* ATCC 33398, *S. equi* subsp. *zooepidemicus* ATCC 43079, and *Staphylococcus aureus* 25923 were used as quality control organisms. The zone diameters were determined using criteria defined by the CLSI and Food and Drug Administration, and other protocols from France and the USA [5,7]. The most commonly isolated organisms were *Pseudomonas* spp. (16.3%), *Escherichia coli* (14.3%), *S. equi* (10.2%) [*S. equi* subsp. *equi* (5.1%), and *S. equi* subsp. *zooepidemicus* (5.1%)], *Enterobacter cloacae* (9.2%), and *Staphylococcus* spp. (8.2%) among the aerobic bacterial isolates (n = 98). The bacterial isolates most commonly identified in this study are consistent with previous reports, but notable differences existed in their isolation frequency [1,2,6]. Results from a study of acute respiratory disease in horses in Ontario, Canada suggested that the most frequently isolated bacteria were α-hemolytic streptococci, coagulase-negative staphylococci, *Actinobacillus equuli*, and *S. equi* subsp. *zooepidemicus* [2]. Another study of foals with

Table 2. Comparison of incidence rates of IURD according to age and stabling periods at the Seoul Race Park

Years		2001	2002	2003	2004	2005
Age	2 yr	51.8^{a}	54.5^{a}	61.4^{a}	56.9^{a}	43.6^{a}
	3 yr	36.1^{b}	26.4^{b}	29.1^{b}	30.3^{b}	34.3^{b}
	4～5 yr	13.1^{c}	16.8^{c}	13.8^{c}	12.4^{c}	17.7^{c}
	6～7 yr	8.0^{c}	10.1^{c}	11.5^{c}	5.8^{c}	8.1^{c}
	8～9 yr	2.2^{c}	3.6^{c}	18.2^{c}	8.3^{c}	0.0^{c}
Stabling period	P ≤ 3 mo	47.4^{a}	45.0^{a}	44.5^{a}	48.1^{a}	46.9^{a}
	3 < P ≤ 6 mo	19.1^{b}	19.8^{b}	21.0^{b}	20.8^{b}	18.1^{b}
	6 mo < P ≤ 1 yr	10.0^{b}	12.3^{b}	14.0^{b}	15.7^{b}	10.3^{b}

[a-c]Superscripts indicate statistical differences ($p < 0.01$). The differences among age groups were significant for IURD incidence rates only in the 2- to 3-year-old group. The differences among stabling periods were significant for IURD incidence rates only when the stabling period was less than 3 months.

upper respiratory tract infections in Poland reported that coagulase-negative staphylococci and *Acinetobacter* sp. were the dominant identified species [1]. A German study of respiratory symptoms in horses found that *S. equi* subsp. *zooepidemicus* and *S. equi* subsp. *equi* were the dominant species [6]. A possible explanation of these differences in the frequency of major bacterial species isolated from cases of IURD may be due to differences in geography and stabling environments. Antimicrobial susceptibility of bacterial isolates is summarized in Table 3, suggesting that the current initial (trimethoprim/sulfamethoxazole, oxytetracyclin, penicillin, or amoxicillin/clavulanate), secondary (amikacin and gentamicin nebulization), and tertiary antibiotic (ceftiofur) treatments for IURD were effective.

In conclusion, this study revealed that host factors have a critical role in the development of IURD. Further analysis is required to determine the viral contribution to IURD and the detailed relationships between risk factors and IURD incidence rates at the Seoul Race Park in Korea. Regulatory veterinarians should target and segregate horses with the greatest IURD risks and design more effective preventative measure, such as implementing specific respiratory pathogen-free certification systems prior to the Park arrival, and removing infected horses.

Table 3. Antimicrobial susceptibility results (%) for bacterial isolates collected from horses with IURD (2001 ~ 2005)

Isolates	Antibiotics*							
	AN	AMC	Cef	GM	N	T	P	SXT
All isolates								
Sensitive	57.4	59.8	85.0	58.6	81.8	57.3	84.8	75.0
Resistant	41.0	35.1	7.5	39.2	13.6	40.8	15.2	16.7
Intermediate	1.6	5.2	7.5	2.2	4.5	1.9	0	8.3
Pseudomonas spp. isolates (non-*aeruginosa*)								
Sensitive	47.1	100	100	44.4	100	0	0	100
Resistant	52.9	0	0	50.0	0	100	0	0
Intermediate	0	0	0	5.6	0	0	0	0
Pseudomonas aeruginosa isolates								
Sensitive	29.4	0	0	23.5	0	0	0	0
Resistant	70.6	0	0	76.5	0	0	0	0
Intermediate	0	0	0	0	0	0	0	0
Streptococcus equi subsp. *equi* isolates								
Sensitive	0	100	100	100	0	100	100	0
Resistant	0	0	0	0	0	0	0	0
Intermediate	0	0	0	0	0	0	0	0
Streptococcus equi subsp. *zooepidemicus* isolates								
Sensitive	33.3	87.5	87.5	100	75.0	78.6	92.9	60.0
Resistant	66.7	0	0	0	25.0	21.4	7.1	20.0
Intermediate	0	12.5	12.5	0	0	0	0	20.0
Staphylococcus spp. isolates								
Sensitive	62.5	62.5	75.0	77.8	66.7	75.0	66.7	66.7
Resistant	25.0	12.5	16.7	22.2	33.3	25.0	33.3	33.3
Intermediate	12.5	25.0	8.3	0.0	0.0	0.0	0.0	0.0

*AN: Amikacin, AMC: Amoxicillin/Clavulanate, Cef: Ceftiofur, GM: Gentamicin, N: Neomycin, T: Oxytetracycline, P: Penicillin, SXT: Trimethoprim/Sulfamethoxazole.

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