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NOTE

Epidemiological patterns and testing policies for bovine tuberculosis in the domestic cattle in Korea from 1961 to 2010

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Abstract

A retrospective cohort study involving various tuberculin tests was conducted to determine the trend in the extensive eradication program for bovine tuberculosis (EEPBT) in Korea from 1961 to 2010. The prevalence of bovine tuberculosis (BT) was higher when the tests were performed with either heat-concentration synthetic medium (HCSM) or purified protein derivative (PPD) tuberculin alone compared to the combination of HCSM/PPD tuberculin ($P < 0.05$). Although the current EEPBT strategies have successfully reduced the spread and threat of BT to livestock and humans, continuous surveillance is necessary to overcome the disease.

Key Words: bovine tuberculosis, extensive eradication program, Korea

Bovine tuberculosis (BT) due to *Mycobacterium bovis* is a zoonosis that may threaten human health around the world[23)]. However, the significance of the identification of *M. bovis* as a zoonotic pathogen was not initially recognized in 1882 when Robert Koch discovered tuberculosis bacillus. The real value of the bacillus causing tuberculosis as a tool in infectious disease came after years of research by veterinarians and other scientists that investigated *M. bovis* as an important zoonotic pathogen that can largely influence the public health[14,17)]. In Korea, the first official report of BT incidence was in 1913, and it was connected to two dairy cattle. Moreover, BT was confirmed using the caudal-fold-test with old tuberculin (OT), which was employed until 1960. Soon afterwards the promotion of dairy farming in Korea in 1964 was induced by the initiation of an extensive eradication program for bovine tuberculosis (EEPBT) based on a test-and-slaughter policy with compensation[1,13)]. To circumvent issues with OT sensitivity specifically false-positive readings, heat-concentration synthetic medium (HCSM) tuberculin skin testing was introduced. Retesting with purified protein derivative (PPD) tuberculin was introduced in 1974 due to the nonspecific reactivity of HCSM tuberculin at which point both HCSM and PPD were used until 1994. In Korea, BT was diagnosed using only PPD tuberculin from 1995 to 2008 because of specificity and cost-effectiveness of the test[11,18,25)].

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Both PPD and enzyme-linked immunosorbent assay (ELISA) have been used from 2009[2,22] to present. The promotion of dairy farming in Korea has been accomplished from 1964 to the early in 2000s since BT was first detected among dairy cattle through an EEPBT. However, the annual number of the infections of BT and the prevalence rate increased continuously from 1999. The detection rate of BT has been especially increasing since 2002 because of the mandatory negative certification system of BT and bovine brucellosis for cattle traded in the livestock, and the increased BT outbreak in the native and beef cattle which have never been tested nationally for BT before[1,11,18,25]. Nevertheless, despite the implementation of a strong EEPBT between 1961 and 2010, BT has still found a way to persist in Korean cattle.

The aim of this study is to compare the BT prevalence according to the various tuberculin tests for the EEPBT in Korea from 1961 to 2010, and to estimate the effectiveness for the various diagnostic policies.

Surveys and raw data for BT prevalence in Korea were obtained from the Animal, Plant and Fisheries Quarantine Inspection Agency (QIA) in the Ministry of Food, Agriculture, Forestry and Fisheries (MFAFF)[11,18]. Data on BT in domestic cattle throughout the whole country were obtained from animal infectious-diseases-data management system (AIMS) by QIA[18], and Statistical Yearbook by MFAFF (included former Ministry of Agriculture & Forestry), 1961–2010[11].

In this study, the prevalence rate (PR) of BT cases per 1,000 cattle, and the upper and lower limits of 95% confidence interval were calculated. The PR of BT in each period was compared using the Kruskal-Wallis one way analysis of variance on ranks, and multiple comparisons were performed using the Dunn's method. A P-value of 0.05 was considered statistically significant. The statistical analysis was performed with SigmaStat 3.5 for Windows (Systat Software Inc., Chicago, IL, USA).

The prevalence of BT in Korea during the period between 1961 to 2010 was shown in Table 1, in which a total of 10,775,794 domestic cattle were tested and 15,091 of them were confirmed to have BT, yielding and given a weighted prevalence rate of 1.4 (95% CI: 1.38–1.42) per 1,000 domestic cattle populations. The annual PR was high in the late 1960s when HCSM tuberculin was only used, then significantly decreased between 1974 and 1994 with HCSM and PPD tuberculin ($P < 0.05$). This was followed by another increase from 1995 to 2008 when only PPD tuberculin was used. Moreover, from 2009 to 2010, PR of BT was still occurring as 2.34 of PR when both PPD and ELISA were used.

As shown in Fig. 1, the prevalence of BT was higher when the tests were performed with HCSM or PPD tuberculin alone compared to that when using combined HCSM/PPD tuberculin or PPD/ELISA testing. When both HCSM and PPD

Table 1. Comparative observation of the prevalence of bovine tuberculosis among the domestic cattle in Korea according to different tuberculin tests used between 1961 and 2010

Period (yr)	Tuberculin	No. of tested	No. of reactors	Prevalence rate per 1,000 cattle (95% CI)
1961–1973	HCSM	169,620	497	3.11 (2.84–3.39)
1974–1994	HCSM/PPD	3,615,245	1,575	0.44 (0.41–0.46)*
1995–2008	PPD	5,600,929	9,747	1.74 (1.71–1.77)
2009–2010	PPD/ELISA	1,400,000	3,272	2.34 (2.26–2.42)
Total		**10,775,794**	**15,091**	**1.40 (1.38–1.42)**

*$P < 0.05$ vs. period of 1961–1973.
HCSM: Heat-Concentrated Synthetic Medium Tuberculin, PPD: Purified Protein Derivative Tuberculin, ELISA: Enzyme-Linked Immunosorbent Assay.

tuberculin were used, cattle were firstly diagnosed using HCSM tuberculin, and then only positive reactors were diagnosed using PPD tuberculin to prevent false positive[1]. When both PPD tuberculin and ELISA testing have been used, test results usually depended on PPD tuberculin, and the relationship between PPD and ELISA testing have been investigated[25]. The PR of BT in domestic cattle including dairy cattle seemed to differ according to the tuberculin test policies used between 1961 and 2010. According to the estimated 95% CI of PR (Table 1), we can grossly divide 3 different phases of prevalence. The first period is from 1961 to 1973, and high prevalence may be due to EEPBT based on test-and-slaughter policy with compensation[1,13]. Low prevalence occurred in the second period (1974–1994), which may be induced by change of testing policy from only HCSM to combined HCSM and PPD tuberculin. In third period (1995-up to now), BT testing policy was changed from combined HCSM and PPD tuberculin to only PPD, and prevalence of this period seems increased than previous period. It can be considered that increased prevalence may be affected by higher specificity of PPD than HCSM[6]. Reliable diagnostic method of EEPBT is very important to reduce the incidence of BT, not only in initial detection of infected animals, but also in confirming suspect cases. EEPBT campaigns in many developed countries have already led to a huge reduction in the incidence of tuberculosis in both cattle and humans[3,8], and the major weapons for controlling BT include the periodic tuberculin test of domestic cattle, the slaughter of reactors, and the sanitation of milk and dairy products. Although BT was once found worldwide, control programs have greatly reduced or nearly eliminated this disease from domesticated animals in many countries. Eradication programs are in progress in European countries, Japan, New Zealand, the United States, Mexico, and in some Central and South America countries[16,17,23]. Australia successfully eradicated BT based on a sound technical program with strong national support during a brucellosis and BT eradication

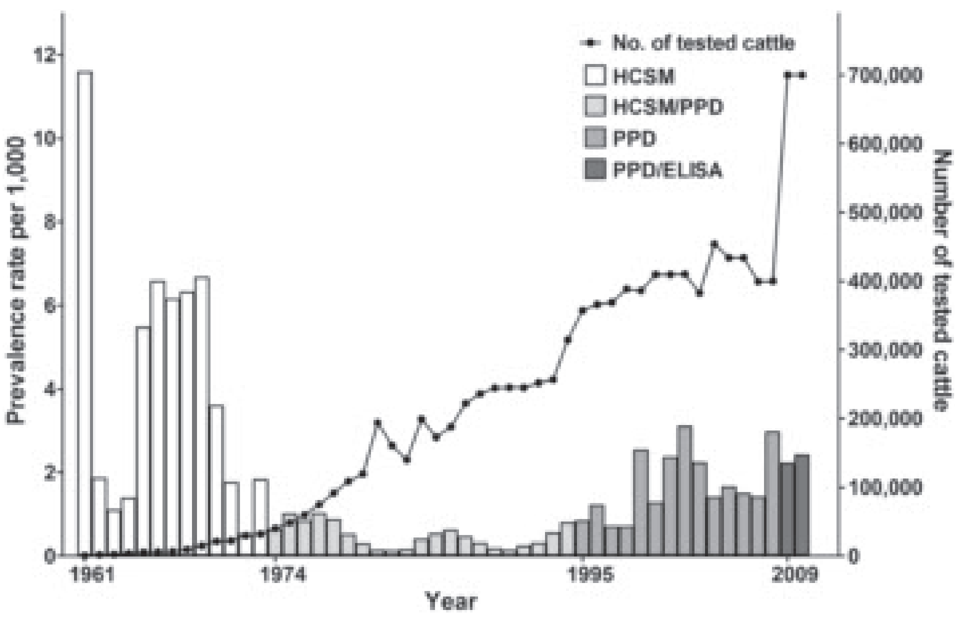

Fig. 1. The prevalence rate of bovine tuberculosis (BT) and number of tested animals under the extensive eradication programs for BT in Korea from 1961 to 2010. Heat-concentration synthetic medium (HCSM) tuberculin skin testing has been used at 1960s (□). The HCSM and retesting with purified protein derivative (PPD) tuberculin was introduced in 1974, and both HCSM and PPD were used till 1994 (□). Only PPD tuberculin has been used for BT diagnosis in Korea from 1995 to 2008 (□). Both PPD and enzyme-linked immunosorbent assay (ELISA) have been used from 2009 (■).

campaign lasting more than 25 years[19]. In the cases of Japan, BT control was legislated in 1901[24], and domestic cattle were checked using, but not limited to, OT test, and positive reaction with BT had to be slaughtered in 1903. This policy led to a decline in the prevalence of BT among dairy cattle in 1969 when the testing included the use of both HCSM and PPD tuberculin. More recently, prevalence further declined to about nearly zero, including false reactors with non-visible lesions, thereby indicating almost perfect eradication of BT in Japan[5,9,15,19–21,24].

Although intradermal test using tuberculin such as HCSM or PPD is most common BT diagnostic method and Office International des Epizooties (OIE) have admitted only tuberculin skin test based on delayed type hypersensitivity, intradermal test has disadvantages such as the need for holding animals for 72 hours, and limitations regarding both sensitivity and specificity[10,12]. There are definitive diagnosis methods such as culture or PCR, but those methods require tissue samples that could only be obtained post-mortem[7]. According to recent reports[4,10], interferon-gamma assay have been suggested as effective noninvasive confirmatory test. Additionally, extensive monitoring for prevalence should be required after 2009 because ELISA testing has been tried with PPD and included animals for EEPBT have been extended from only dairy cattle to native cattle[25].

In conclusion, although concentrated efforts were tried to eradicate BT in Korea during half a century, this disease is still occurring in some livestock. However, currently used EEPBT strategies have successfully controlled BT spread. Continued vigilance must be maintained to keep control over BT even though the threat may be minimal to livestock and humans. In addition, the development of rapid and accurate diagnostic methods is urgently needed, along with the identification of the transmission factors through well-designed epidemiological studies in veterinary medicine to general public health in Korea.

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