Epidémiol. santé anim., 1997, 31-32

A FIELD TRIAL OF THE EFFECTIVENESS OF A FELINE *TOXOPLASMA* VACCINE IN REDUCING *TOXOPLASMA* EXPOSURE FOR SWINE

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La viande qui est la source la plus importante d'infection de l'Homme par Toxoplasma gondii aux Etats-Unis est celle de porc. Les chats, hôte final de T. gondii, excrêtent des ookystes dans les fèces, qui contaminent la nourriture, l'eau et le sol pouvant être ingérés par le porc. Dans cette étude, un vaccin toxoplasmique pour le chat, constitué de bradyzoites vivants du mutant de la souche T-263, capable de prévenir l'excrétion d'ookystes par le chat, a été utilisé. Un essai terrain a été fait dans 8 élevages de porcs de l'Illinois pour apprécier l'efficacité de ce vaccin sur la réduction de l'exposition des porcs à l'engrais à T. gondii. Chaque élevage était visité 3 fois en 1994, 3 fois en 1995 et une fois en 1996. Pendant la période vaccinale (1994-1995), les chats étaient capturés et inoculés per os avec le vaccin T-263. Du sang était prélevé sur les porcs, les chats et les souris. Les anticorps de T. gondii étaient détectés à l'aide du test modifié d'agglutination.

Un total de 179 chats (95 adultes et 84 jeunes) ont été capturés pendant la période vaccinale. Avant la vaccination, 72,6 p. cent des jeunes et 32,6 p. cent des adultes étaient dépourvus d'anticorps. Les taux de recapture pour les adultes et les jeunes chats à sérologie négative ont été respectivement de 58,1 p. cent et 45,9 p. cent. Les modifications de prévalence avant et après vaccination ont été évaluées pour toutes les fermes et toutes les espèces étudiées. Il y a eu une diminution non significative de la séroprévalence T. gondii chez les souris, les chats et les truies et une diminution significative (moyenne : -3,9 p. cent) chez les porcs à l'engrais.

La séroprévalence chez les souris pour l'ensemble des élevages a diminué de 4 p. cent en 1992-1993 à 0 p. cent en 1996. Il y avait une corrélation positive significative (rho = 1.000, p <0,0001) entre le changement de prévalence chez les jeunes chats et chez les porcs à l'engrais.

Ceci suggère que la réduction d'exposition des porcs à T. gondii était liée à l'exposition réduite des chats au parasite, indiquant que l'administration d'un vaccin toxoplasmique aux chats dans les élevages porcins peut réduire l'exposition des porcs à T. gondii.

INTRODUCTION

Toxoplasma gondii is a protozoan parasite for which cats are the definitive host; Cats shed *T. gondii* oocysts in feces. Pigs can acquire *T. gondii* infection through ingestion of feed, water and soil contaminated with oocysts, through ingestion of animal tissue(s) contaminated with the encysted form of the parasite or by transplacental transmission (Frenkel, 1990a; Dubey, et al., 1986; Dubey, 1994; Dubey & Beattie, 1988)

T. gondii infection in finishing pigs has a direct impact on public health. Transplacental transmission can cause congenital mental and physical retardation and blindness. In immunocompromised adults disease signs include encephalitis and retinochoroiditis (Dubey & Beattie, 1988; Frenkel, 1990b). In AIDS patients, *T. gondii* infection can cause death (Dubey, 1994).

Pork is considered the primary meat source of *T. gondii* infection for humans in the USA (Dubey, 1994). Humans can become infected through the consumption of raw or undercooked pork containing tissue cysts of *T. gondii* (Dubey & Beattie, 1988). *T. gondii* infection in swine is prevalent in the USA. A national serological survey of swine in the USA (in 1983-1984), found *T. gondii* seroprevalence rates of 42% in breeder pigs and 23% in market pigs (Dubey et al., 1991).

Epidemiologic field studies on swine farms in Illinois identified infection of cats and mice with *T. gondii* as risk factors for *T. gondii* infection in swine (Weigel, 1995b). Sources and reservoirs for the transmission of the parasite identified included infected rodents, and feed and soil contaminated with *T. gondii* oocysts (Dubey et al., 1995c). Since *T. gondii* transmission is dependent on oocyst shedding by cats (Dubey, 1994), it appears that the most effective strategy to reduce the risk of *T. gondii* infection in swine would be to prevent shedding of oocysts by farm cats.

A *T. gondii* vaccine for cats containing live bradyzoites from a mutant strain of *T. gondii* (T-263) has been developed (Frenkel et al., 1991; Freyre et al., 1993). Under laboratory conditions, vaccination of cats with the T-263 oral vaccine induces immunity and interrupts the sexual cycle of *T. gondii* in cats (Frenkel et al., 1991; Freyre et al., 1993). Studies of the effectiveness of the T-263 vaccine reported that a single dose protected 84% of the cats from oocyst shedding (Frenkel et al., 1991), and after 2 doses, it protected 100% of the cats (Freyre et al., 1993).

A 3 year field intervention trial was conducted to determine the effectiveness of the T-263 *Toxoplasma* vaccine in reducing oocyst shedding by cats on swine farms and thereby reducing *T. gondii* exposure in swine. The

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hypothesis to be tested was that vaccination of cats decreases the prevalence of *T. gondii* in sows, finishing pigs, mice and previously unvaccinated cats.

METHODS

Eight swine farms were selected from the 47 Illinois farms that participated in the 1992-1993 epidemiologic investigations of risk factors, sources and reservoirs for the transmission of *T. gondii* on swine (Weigel et al.,, 1995b; Dubey et al., 1995c). Criteria used to include a farm in this study were: 1) seroprevalence of in finishing pigs greater than 2 % , 2) cats had access to the housing facilities of finishing pigs, 3) at least 2 seropositive cats were trapped, 4) Of the selected farms, 4 had finishing pigs raised in total confinement and 4 farms had finishing pigs raised outdoors. Farm owners or managers were contacted to request their participation on this 3 year vaccine trial.

For each participating farm, baseline prevalence prior to vaccination was obtained from the 1992/93 field investigations. The outcome of interest was the change in prevalence from the baseline period to the post vaccination period of 1996. Each farm was visited a total of 7 times over the 3 year period of the field trial, 3 visits in 1994, 3 in 1995, and one in 1996. The 2 years of intervention involving cat vaccination were 1994 and 1995. The evaluation year, without cat vaccination, was 1996. During 1994 and 1995, the 3 visits per year were distributed as follows one in the spring and two in the summer.

During the intervention period, each of the 6 visits involved an overnight live trapping for mice and cats, both inside and outside swine facilities. On each visit, blood samples were obtained for all mice and cats trapped, and from 30 finishing pigs over 70 kg. On visit 1 and 6, blood samples from 30 sows were also collected. The treatment assigned to all participating farms was a feline *T. gondii* vaccine, administered orally at a dose of 0.5 ml to all the cats at least 8 weeks old. Cats were released at the capture site and recaptured animals were re-vaccinated up to 3 times. The evaluation period of 1996 consisted of a single visit of 2 nights of live trapping for mice and cats. Blood samples from cats, mice, 90 finishing pigs and 30 sows were collected. Trapping and animal processing protocols for cats and mice followed the procedures of our previous field study (Dubey et al., 1995c).

Serum samples collected from mice, cats and swine were forwarded to the Parasitology Biology and Epidemiology Laboratory of the USDA Agricultural Research Service in Beltsville, Maryland. The samples were evaluated for the presence of antibodies to *T. gondii* using the modified agglutination test (MAT) (Desmonts & Remington, 1980). Sera showing a positive response at a 1:25 dilution were considered seropositive. The change in seroprevalence from baseline pre-vaccination period to the endpoint evaluation period was evaluated for sows, finishing pigs, mice and adult and juvenile cats. Only the serological data from unique unvaccinated cats (i.e., first capture) were used in the analysis. The comparisons were made using a Wilcoxon Paired sample test (matched-paired Signed Ranks Test) (Siegel, 1956). An alpha level of 0.05 for a 1-tailed probability was chosen for statistical significance.

RESULTS

A total of 179 different cats (95 adults and 84 juvenile) were trapped during the vaccination period. Recapture rates for all unique cats was 48.6% (n=87) and for adult and juvenile cats, 53.7% (n=51) and 42.9%, (n=36) respectively. Prior to vaccination, 51.4% (n=92) of all cats captured were seronegative the first time they were caught: 72.6% (n=61) for juvenile cats and 32.6% (n=31) for adult cats. Recapture rates for first time caught seronegative cats were 58.1% (n=18) for adult and 45.9% (n=28) for juvenile cats.

One farm was lost to follow up in 1996 and one changed its farrow to finish production system to just finishing. Thus, evaluation of change in prevalence is based on 6 farms for sows and 7 farms for finishing pigs and mice. Only farms where cats were caught both in the pre-vaccination and the post-vaccination period were included in the statistical analysis. Every negative sign represents a decrease in the prevalence for that farm (Table I.).

Table I
Change in seroprevalence, from the baseline pre-vaccination to post-vaccination period, for all farms and for all species tested.

	Change in prevalence (%) 1992/93 to 1996				
FARM	**Sows**	**Finishing**	**Mice**	**Adult feline**	**Juvenile feline**
1	____	____	____	____	____
2	-16.67	0.02	-6.67	____	50.0
3	____	-5.59	-14.29	____	____
4	2.18	-1.09	0.00	____	0.00
5	-22.08	-2.20	0.00	-50.0	____
6	6.63	-0.02	0.00	0.00	____
7	-3.60	-14.4	-11.11	0.00	-84.62
8	-3.33	-4.48	0.00	0.00	-50.0
Sign rank*	non significant	< 0.05	non significant	= 0.05	non significant

Sign rank*: 1-tailed p value for Wilcoxon Paired Sample Test (Match-Paired Signed-Ranks Test)

Sows had a decrease in seroprevalence in 4/6 farms and finishing pigs in 6/7 farms. Seroprevalence in mice for all farms decreased from 4% in 1992/93 to 0% in 1996. For adult cats there was a decrease in one farm and no change in the others. In juvenile cats, there was a decrease in 2/4 farms. These 2 farms had the highest

populations of cats on a farm. There was no change in one farm and an increase in the other. Although mice, cats and sows showed indications of decrease in seroprevalence to *T. gondii*, the results were not statistically significant. However, there was a significant decrease in seroprevalence (mean =- 3.9%) for finishing pigs. In addition, there was a significant positive correlation (rho =1.000 p< 0.0001) between the change in prevalence in juvenile cats and the change in prevalence in finishing pigs.

DISCUSSION / CONCLUSION

Intervention strategies for the reduction of the risk of transmission of *T. gondii* to swine have not been investigated previously. The only significant change in prevalence was in finishing pigs, which is the most important swine group evaluated, since these are the pigs raised mostly for human consumption. It is possible that the reduced exposure of pigs to *T. gondii* was related to the reduced exposure of cats to the parasite. Sows live longer (without replacement) on the farm and they are exposed for a longer time to the environment contaminated by the parasite. Thus, it is more difficult to evaluate their change in seroprevalence over a 3 year period.

In a real field situation, this vaccine, although efficacious in decreasing environmental contamination of *T. gondii* by cats, could be ineffective in reducing the risk of transmission to swine. This vaccine could be ineffective due to the dispersed environmental contamination of the parasite on swine farms, the long survival of contaminating oocysts on the soil, and travel distances of farm cats. In addition, a low compliance with cat vaccination, due to the difficulties of the administration of the vaccine, would contribute to the ineffectiveness of the vaccination strategy. However, the results of this study do indicate that administration of a *Toxoplasma* vaccine to cats on swine farms can reduce the exposure of pigs to *T. gondii*, suggesting that the cycle of reproduction and transmission of enzootic *Toxoplasma* in swine farms could be interrupted by vaccinating cats. Thus, a vaccine that can be administered easily to all cats on a swine farm is desired.

A reduction in *T. gondii* seroprevalence on swine farms could have an impact on food safety for **pork producers. Thus, the swine industry could provide a healthier product for human consumption by marketing pork without contamination with the encysted form of the parasite, which would decrease the risk of human infection with *T. gondii*.**

REFERENCES

Desmonts G. Remington JS., 1980. Direct agglutination test for diagnosis of *Toxoplasma* infection: method for increasing sensitivity and specificity. J Clin Microbiol 11, 562-568.

Dubey JP., Beattie C., 1988. *Toxoplasmosis* of Animals and Man, Boca Raton, Fla: CRC Press, Inc, 1-220.

Dubey JP., 1994. *Toxoplasmosis. J Am Vet Med Assoc* 205(11), 1593-1598.

Dubey JP., Leighty JC., Beal VC., Anderson WR., Andrews CD., Thulliez P., 1991. National seroprevalence of *Toxoplasma gondii* in pigs. *J Parasitol* 77(4), 517-521.

Dubey JP., Weigel RM., Siegel AM., Thulliez P., Kitron UD., Mitchell MA., Mannelli AM., Mateus-Pinilla NE., Shen, SK., Kwok, OCH and Todd, KS., 1995c. Sources and reservoirs of *Toxoplasma gondii* infection on 47 swine farms in Illinois. *J Parasitol*, 81(5), 723-729.

Dubey, JP., Murrell, KD., Hanbury, RD., Anderson, WR., Doby, PB., Miler, HO., 1986 Epidemiologic findings on a swine farm with enzootic *Toxoplasmosis. J Am Vet Med Assoc* 189(1), 55-56.

Frenkel JK., 1990a. Transmission of *Toxoplasmosis* and the role of immunity in limiting transmission and illness. *J Am Vet Med Assoc* 196(2), 233-240.

Frenkel JK., 1990b. *Toxoplasmosis* in human beings. *J Am Vet Med Assoc* 196(2), 240-248.

Frenkel JK., Pfefferkorn ER., Smith, DD., Fishback JL., 1991. Prospective vaccine prepared from a new mutant of *Toxoplasma gondii* for use in cats. Am J Vet Res 52(5), 759-763.

Freyre A., Choromanski L., Fishback JL., Popiel I., 1993. Immunization of cats with tissue cysts, bradyzoites, and tachyzoites of the T-263 strain of *Toxoplasma gondii. J Parasitol* 79 (5), 716-719.

Siegel S., 1956. Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, Book Company, Inc, 75-83.

Weigel RM., Dubey JP., Siegel AM., Kitron UD., Mannelli AM., Mitchell MA., Mateus-Pinilla NE., Thulliez P., Shen K., Kwok O., and Todd KS., 1995b. Risk factors for transmission of *Toxoplasma gondii* on swine farms in Illinois. *J Parasitol*, 81(5), 736-741.