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Determination of the pharmacokinetics of procaine penicillin in swine administered by intramuscular injection and with a needleless injection device

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Six pigs each received three penicillin G treatments separated by washout periods in a randomized, crossover design. Procaine penicillin G was administered intramuscularly at 44,000 IU/kg using a hypodermic needle (“needle”) or a novel, needleless air-injection system (“air”). The third treatment (“IV”) consisted of administering 44,000 IU/kg of potassium penicillin G intravenously. Order of treatment administration was randomly assigned to each pig.

Six of the needle administrations and 5 of the air administrations resulted in serum curves with two apparent maximum concentrations (C_{max}) with the times of maximum concentration (T_{max}) being very similar between pigs. One needle and one air dataset were excluded from analysis from separate pigs leaving an N of 5 for needle and air and an N of 6 for the IV method. The mean C_{max} and T_{max} for the first peak were 12.3 ± 9.3 µg/ml at 0.7 ± 0.3 hrs and 12.4 ± 11.7 µg/ml at 0.7 ± 0.3 hrs (mean ± SD) for the air and needle methods respectively. Corresponding values for the second, smaller peaks were 7.7 ± 3.0 µg/ml at 2.0 ± 0.4 hrs and 9.8 ± 9.1 µg/ml at 2.3 ± 0.4 hrs respectively. Mean area under the serum concentration curve (AUC) values were 32.6 ± 24.5, 51.7 ± 36.0, and 47.0 ± 32.5 µg-hr/ml for the air, needle, and IV methods respectively.

Mean bioavailability values were 91 ± 37% for the air treatment and 104 ± 19% for the needle

treatment. The relative bioavailability of the air method as compared to the needle method was calculated by dividing the air AUC by the needle AUC for the 4 animals that had valid comparisons, resulting in an estimate of the air method being 73.1 ± 14.9% as bioavailable as the needle method. The difference in bioavailability of the air injection and conventional needle injection methods closely approached significance (P = 0.0168 with a Bonferroni corrected significance level of 0.0167). Mean, apparent elimination half-times (T_{1/2}) were calculated as 0.36 ± 0.1 hrs for intravenous injection, 1.35 ± 0.5 hrs for air injection, and 4.09 ± 2.3 hrs for needle injection.

This exploratory study resulted in an estimate that approximately 73.1% of the drug administered by air injection was absorbed into the circulatory system during a time when the concentrations were above the level of detection as compared to conventional needle injection. The comparative conclusions of this study should be viewed as preliminary findings due to significant variation in a limited number of pigs. However, these data indicate that needleless, air injection technology is worthy of continued investigation in swine as a viable alternative to conventional hypodermic needles.

This project was funded by the National Pork Board (Project #02-136).