

Ketamine hydrochloride as a General Anesthetic for Domestic Fowl Chicks: Quantal Response

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Abstract:

Ketamine hydrochloride was tested as a general anesthetic administered as a single intramuscular injection at doses of 1, 2, 6.7, 11.4, 20 or 22.2 mg/ bird to 2-day-old male Hisex White domestic fowl chicks weighing 30.75 g on average. In another trial, the drug was given to 6-day-old chicks of the same breed, weighing 37.7 g, at doses of 0.5, 1, 2, 5, 8.6 or 12 mg/bird. Quantal response to treatment was expressed mathematically using probit analysis with LD50 = 3.71 mg/bird (120.7 mg/kg) for 2-day-old chicks compared with 3.75 mg/bird (99.5 mg/kg) for the older group. A dose as high as 51 mg/kg produced no mortality in 2-day-old chicks compared with a dose of 37.2 mg/kg in older birds. There is no significant difference between birds of the two age groups regarding the response to the drug as judged by the LD50 and regressive doses lower than this level. The rationale behind testing ketamine in domestic fowl chicks was discussed.

Key Words: Ketamine, Anesthesia, Hisex White, Chicks.

Introduction:

The domestic fowl (*Gallus domesticus*), as a species, is considered a unique experimental model in immunological research where selective surgical ablation of the bursa of Fabricius in newly hatched chicks combined with sublethal whole – body x-irradiation has been shown to be effective in suppression of antibody-forming capacity without affecting cell- mediated immune responses (Cooper *et al.* 1966). This surgical approach, however, as compared with other methods for suppression of bursal functions , for instance *in ovo* hormonal bursectomy, extirpation of the bursa during embryonic life (Elowni, 1985) or gene targeting (Schusser *et al.* 2013), .is an economically and a technically feasible method leading to loss of antibody-forming capacity. The procedure, however, requires an effective and a short-acting anesthetic to enable operation in such young birds. Ketamine is a cyclohexanone derivative with analgesic and anesthetic properties in both mammalian and avian species. The drug is given either intramuscularly or intravenously. Several investigators have recommended ketamine hydrochloride as a suitable injectable general anesthetic agent in a wide range of avian species (Kittle, 1971; Mandelker, 1972; Boever and Wright, 1975; Paul-Murphy and Fialkowski, 2001; Flecknell, 2009). The drug has a wide margin of safety in most of these species (Sinn, 1994; Anon, 2001). Despite the popular use of this drug in veterinary practice, studies on its effects on young or small bird species are apparently lacking. The objective of the present study was to assess the primary response of domestic fowl chicks to Ketamine treatment following intramuscular injection.

Materials and Methods:

Birds: Sixty male, clinically healthy 2-day-old domestic fowl chicks of the Hisex White breed of 28–35 g body weight, average 30.75 g, were allocated randomly to 6 groups each comprising 10 birds. In a second trial, another batch of sixty 6-day-old birds of the same breed, body weight 35.7 - 40.6 g, average 37.7 g, were equally divided into 6 groups before treatment.

Treatment: Ketamine HCl 10%, serially diluted in sterile normal saline, was given to birds as a 0.2 ml fixed volume injected in the pectoral muscle with extra fine needles. The 2-day-old birds received doses of 1, 2, 6.7, 11.4, 20 or 22.2 mg/ bird. The older birds were given doses of 0.5, 1, 2, 5, 8.6 or 12 mg/bird by a similar procedure.

Response: Using probit analysis (Randhawa, 2009), quantal response to the drug was assessed in terms of the median lethal dose (qualified as LD50 i.m.) and the highest dose that produce 0% mortality.

Results:

Treatment of 2-day-old birds with different drug doses resulted in progressive effects expressed by the formula $y = 0.9146x + 1.6073$ where "y" is mortality percent transformed to probits and "x" is the dose in mg/bird (Figure 1;).

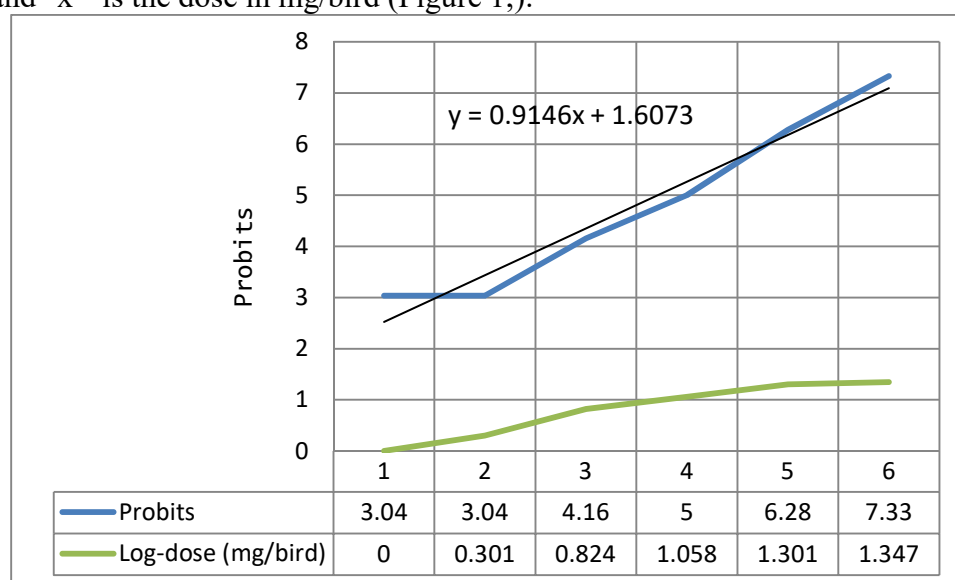


Figure 1 Effect of Ketamine hydrochloride intramuscular injection on 2-day-old domestic fowl chicks: Quantal log-dose response relationship.

The LD50 was 3.71 mg/bird (120.7 mg/kg bwt.). Using the formula, a dose as high as 1.57 mg/bird (51 mg/kg) is predicted to produce no mortality. Figure (2) shows drug lethality below the LD50.

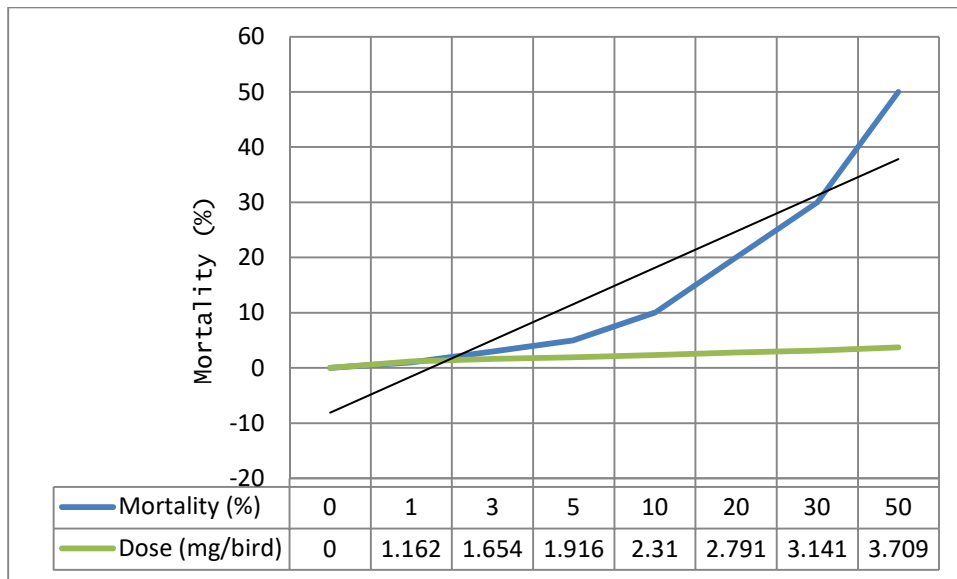


Figure 2 Lethality of Ketamine hydrochloride to 2-day-old domestic fowl chicks: Predicted range of effects (0 - 50% mortality) was calculated using the formula y (probits) = $0.9146x + 1.6073$ (Figure 1). Actual mortality figures were presented for clarity. The effect of treatment on 6-day-old birds was expressed by the formula $y = 0.8326x + 1.866$ (Figure 3) with LD50 = 3.75 mg/bird (99.5 mg/kg).

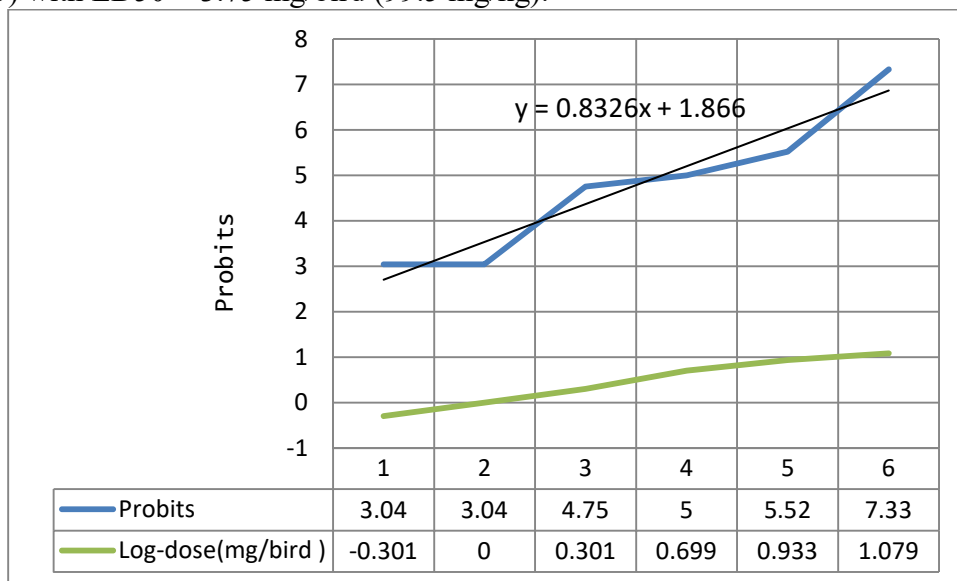


Figure 3 Effect of Ketamine hydrochloride intramuscular injection on 6-day-old domestic fowl chicks: Quantal log-dose response relationship. A calculated dose of 1.4 mg/bird (37.2 mg/kg) is expected to produce no mortality in these older birds. Figure (4) shows drug lethality below the LD50.

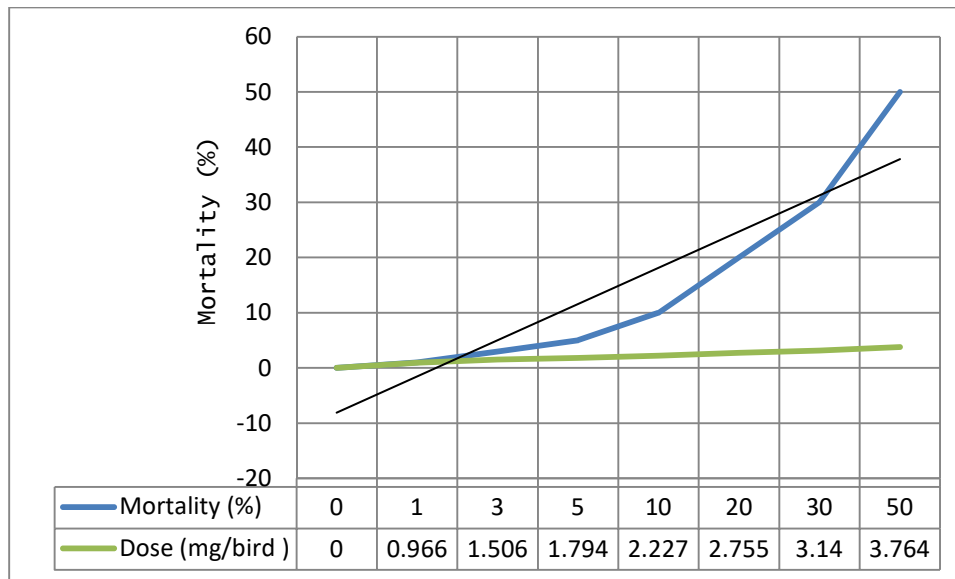


Figure 4 Lethality of Ketamine hydrochloride to 6-day-old domestic fowl chicks: Predicted range of effects (0 - 50% mortality) was calculated using the formula y (probits) = $0.8326x + 1.866$ (Figure 3). Actual mortality figures were presented for clarity.

Comparisons of responses between birds of the two age groups in terms of doses that produce 50% and lower mortalities (30, 20, 10, 5, 3, 1, 0 % ; Figures 2 & 4) showed no statistical difference between the groups ($n_1 = n_2 = 8$; $T > 49$; $P > 0.05$, Wilcoxon Two-Sample Rank Test).

Discussion:

In the present study, ketamine was assessed as a potential candidate for application as a general anesthetic for domestic fowl chicks. The drug has been recommended as a suitable injectable general anesthetic agent in a wide range of avian species and is commonly used at dose ranges of 5-75 mg/kg (Sinn, 1994). The results indicate that following intramuscular injection, the drug is well tolerated by domestic fowl chicks and doses as high as 51 mg/kg, or 37.2 mg/kg, produced no mortality when given to 2- or 6-day-old birds, respectively. Despite such notable safety, several authors attributed undesirable effects to Ketamine treatment in birds (Maiti *et al*, 2006; Durrani *et al*, 2014). The drug has therefore been recommended to be used in combination with other injectable agents to reduce or eliminate such undesirable effects (Maiti *et al*, 2006; Durrani *et al*, 2014). Birds of the two age groups responded equally to the drug as judged by the LD50 and doses lower than this level. These findings may lead further to critical evaluation of performance of ketamine as a general anesthetic for domestic fowl chicks and perhaps other small bird species.

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