matics (24 per cent) encountered 67 complications during and after the surgical-anesthesia event. Fifty complications were respiratory; this did not include 9 postoperative fatalities, of which 8 occurred more than 3 days after anesthesia. Serious airway obstruction manifested itself during the course of 21 anesthetics including 14 asthmatic attacks (bronchospasm). All complications were studied to uncover significant trends relating several variables with complications. *Method and Results:* The anesthetic agents were arbitrarily divided into 3 general types: (1) Conduction anesthesia: of 47 such procedures, 6 instances of intraperitoneal surgery during high spinal anesthesia resulted in 5 patients developing 9 respiratory complications (operative and postoperative). (2) General anesthesia, other than halothane: 91 asthmatics were given 8 combinations of various agents including cyclopropane. Seventeen patients (61 per cent) developed 23 complications including 9 instances of bronchospasm, 4 cases of airway obstruction and 10 postoperative sequelae. (3) Halothane anesthesia: Of 82 such anesthetics 21 patients had additional agents. This miscellaneous subgroup included 8 patients with 9 complications (2 bronchospasm). The remaining 61 asthmatics were given halothane-nitrous oxide. Six patients (10 per cent) had 6 complications, only 1 occurring during anesthesia. Two complications were respiratory and no bronchospasm was encountered. Seriousness of asthma was the second variable studied. With the use of history, physical examination and occasionally pulmonary function tests, all asthmatics were arbitrarily placed in either grade I (mild, 95 patients), grade II (moderately severe, 72 patients) or grade III (very severe, 53 patients). While grade III asthmatics encountered most complications, no significant correlation resulted between seriousness of asthma and morbidity and mortality. Thoracic, upper and lower abdominal operations were associated with far more complications (approaching 50 per cent) than surgery of the perineum, extremities, head or neck (about 12 per cent of complications). Study of duration of surgery revealed a logarithmic rather than linear relationship between increasing duration and morbidity. Surgery in the asthmatic of longer than 2 hours was associated with a 29 per cent or higher complication rate. It is probable that duration is related to site of surgery. Sex, the fifth variable studied, revealed that the male asthmatic had significantly more complicaitons (30 per cent) than females (18 per cent), including twice the incidence of postoperative death and two-and-a-half times the incidence of bronchospasm. Other variables were studied including the influence of age, physical status, smoking, preoperative medication, muscle relaxants and endotracheal intubation. Under the conditions of this study we were unable to establish any relationship between these variables and complications.

Protection by Digitalization Against the Negative Inotropic Effect of Halothane in Dogs. Alan H. Goldberg, M.D., Harriet M. Maling, Ph.D., and Thomas E. Gaffney, M.D., *National Institutes of Health, Bethesda, Maryland.* In 9 open chest dogs (9–15 kg.) comparisons were made of the depressant effects of halothane on heart contractile force (strain gauge arch) and mean arterial pressure before and after digitalization. *Method:* Following tracheal intubation facilitated by intravenous succinylcholine (5 or 10 mg.), anesthesia was produced by halothane (0.3 to 1 per cent) and oxygen under intermittent positive pressure respiration. A strain gauge arch was then sutured to the right ventricle and a catheter was inserted into a femoral artery. Halothane was administered in the following sequence: 0.2, 1, 0.2 and 2 per cent, both before and one hour after the intravenous injection of digoxin (0.1 mg./kg.) to 6 of 9 dogs. During the hour interval between the digoxin injection and the second sequence of halothane inhalation, the succinylcholine injection, used initially for tracheal intubation, and the same concentrations of halothane which had been used for the application of the strain gauge arch and the insertion of the arterial catheter, were repeated. It was then possible to consider each dog as its own control. Each halothane concentration was given for 15 minutes. With 3 dogs, the above protocol was followed exactly with the exception of the digoxin administration in order to study the inotropic and pressor effects of repeated administrations of halothane alone. *Results:* The average decreases in heart contractile force produced by 0.2, 1 and 2 per cent halothane

in 6 dogs were 33, 73 and 80 per cent prior to digitalization, and 25, 53 and 65 per cent after digitalization. There was significantly less depression of myocardial contractile force produced by 1 per cent halothane ($P < 0.001$) and 2 per cent halothane ($P < 0.01$) after the administration of digoxin. No protective effect of digitalization was found at 0.2 per cent halothane. The average decreases in mean arterial pressure produced by these same concentrations of halothane were 44, 74 and 87 per cent before digitalization and 43, 63 and 73 per cent after digitalization. Digitalization exerted a significant protective effect at 1 and 2 per cent halothane ($P < 0.02$), but not a 0.2 per cent. The average heart rate, which was decreased both by halothane and digoxin, was 93 at 2 per cent halothane before digoxin, and 80 at 2 per cent halothane after digoxin. In the 3 dogs which received no digoxin, the second administration of 1 and 2 per cent halothane produced as much or more depression of heart contractile force and mean arterial pressure as the first administration, thereby eliminating any question of halothane tachyphylaxis. *Comment:* These findings demonstrate that the negative inotropic and hypotensive effects of halothane in the dog are lessened by the prior administration of digoxin. Furthermore, this protection occurs at clinically useful halothane concentrations. These observations support the principle of the prophylactic preoperative use of cardiac glycosides.

Cyclopropane and Digitalis Synergism with Epinephrine. J. S. GRAVENSTEIN, M.D., and TORSTEN W. ANDERSEN, *Division of Anesthesia, College of Medicine, University of Florida, Gainesville, Florida.* Cyclopropane anesthesia is associated with an increase of blood norepinephrine and an increase in peripheral vascular resistance. Cardiac glycosides may also increase peripheral vascular resistance (Ross, J., Jr., and others: J. Clin. Invest. 39: 930, 1960) and apparently do so without liberating catecholamines. Cyclopropane is capable of enhancing the response of the nictictating membrane to epinephrine (Gravenstein, J. S., and others: J. Pharmacol. Exp. Ther. *129:* 428, 1960). Such a synergism may contribute to the vascular effects of cyclopropane. A similar mechanism might explain the vascular effect of the glycosides. We therefore postulated that the glycosides increase peripheral resistance by enhancing the vasopressor effect of catecholamines. This hypothesis was tested by exposing vascular smooth muscle to epinephrine with and without a cardiac glycoside or cyclopropane 40 per cent. *Method:* Rabbit aorta was helically cut into strips which were attached to a strain gauge, placed under 1 Gm. of tension and suspended in a bath containing 30 ml. of aerated Locke solution, kept at 34.5° C. According to a strictly timed schedule, different doses of epinephrine were added to the bath with washings between doses. All strips served as their own control, being exposed at one period to epinephrine alone in different concentrations, and at a different period to epinephrine in identical dosages, but after a glycoside or cyclopropane had been added to the stock solution and the bath. The order of drug administration was alternated so as to cancel out effects due to time or drug sequence. *Results:* Cyclopropane 40 per cent, ouabaine 200 μg./l. or less and desacetyllanatoside C (Cedilanid-D) 200 μg./l. or less had no effect on the strips in the absence of epinephrine. However, cyclopropane 40 per cent in oxygen or ouabaine 200 μg./l. enhanced the response to 0.1, 0.3, 1 and 3 μg. epinephrine per 30 ml. bath significantly (P values for differences between epinephrine alone minus epinephrine-cyclopropane or epinephrine-ouabaine combinations were < 0.01 for epinephrine 0.1, 0.3 and 1 μg./30 ml. and < 0.05 for 3μg./30 ml.). The effects of larger doses of epinephrine were not enhanced. Ouabaine 60 μg. was equally effective (P for 0.1, 0.3, 1 and $3 < .01$). Desacetyl-lanatoside C 200 μg. gave similar highly significant enhancement of the epinephrine effect. Twenty μg./l. of either glycoside were ineffective. *Comment:* In this experiment and in the dosages chosen, cyclopropane and cardiac glycosides were indistinguishable in their synergistic effect on the response of rabbit aorta to epinephrine. This does not imply that these agents act on smooth muscle through identical mechanisms. The synergism is probably nonspecific. In limited numbers of experi-