Quantification of Intermediate Steps in the Renin-Angiotensin-Vasoconstrictor Feedback Loop in the Dog

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ABSTRACT

The major intermediate steps in the renin-angiotensin-vasoconstrictor feedback loop have been experimentally determined. The quantitative relationships between renal perfusion pressure, renin secretion, arterial renin activity, and systemic arterial blood pressure were determined in dogs in which the cardiovascular control loops of the central nervous system were eliminated by spinal cord destruction and decapitation. Step-decreases in renal perfusion pressure to a single kidney were introduced and maintained constant to open the feedback loop of arterial pressure. Renin activity was measured by radioimmunoassay of angiotensin I. Each decrease of 15 mm Hg in renal perfusion pressure between pressures of 100 and 50 mm Hg elevated the net secretion of renin nearly 20 ng min\(^{-1}\) g\(^{-1}\) kidney and the arterial renin activity nearly 7.0 ng ml\(^{-1}\) hour\(^{-1}\). Renin secretion and arterial renin activity decreased at perfusion pressures below 50 mm Hg. A bioassay procedure for estimating the rate of angiotensin II formation at various increments of arterial renin activity showed that an increase in renin activity of 10 ng ml\(^{-1}\) hour\(^{-1}\) resulted in an increase in the net production of angiotensin II of 5.0 ng kg\(^{-1}\) min\(^{-1}\). The results of these experiments are useful in predicting alterations in the system that follow a decrease in renal artery pressure, and they clarify interactions of the renin-angiotensin system with other homeostatic pressure-regulating systems.

KEY WORDS angiotensin II radioimmunoassay of angiotensin I blood pressure regulation renal artery constriction renin secretion decapitation

We recently presented evidence that the renin-angiotensin-vasoconstrictor feedback loop has sufficient gain and time-response characteristics to play a role in normal regulation of arterial blood pressure (1). The open-loop feedback gain was determined in dogs whose cardiovascular control loops of the central nervous system were eliminated. When both kidneys were simultaneously subjected to step-decreases in arterial perfusion pressure, the gain of the resulting pressure response was calculated to be \(-1.6\) between renal perfusion pressures of 65 and 100 mm Hg. These data indicated that the renin-angiotensin-vasoconstrictor system alone could compensate nearly 65% for an arterial blood pressure decrease. According to recent reports by other investigators the gain could be even greater because of the interaction of circulating angiotensin II with the central nervous system (2–5). Although changes in renin activity have been measured during decreased levels of renal artery perfusion pressure (1, 6–9), no attempt has been made to quantitatively correlate renin secretion rates, arterial renin activities, or the rate of angiotensin formation with changes in systemic arterial blood pressure occurring at various levels of renal artery perfusion pressure. Without these quantitative relationships a complete evaluation of the entire feedback loop is not possible.
We have therefore experimentally determined, and report in this paper, some of the major component changes in the renin-angiotensin-vasoconstrictor feedback system. An evaluation of this type necessitates the isolation of the feedback system from the other cardiovascular control loops of the central nervous system. For this reason in the experiments reported here the dogs had neurohumoral influences of the central nervous system eliminated by spinal cord destruction and decapitation. The feedback loop of arterial pressure was opened by introducing and maintaining constant decreases in renal perfusion pressure, while the changes in systemic blood pressures, renal blood flows, and arterial and renal venous renin activities were measured. Radioimmunoassay techniques for angiotensin I were used in determinations of renin activities.

Methods

**Animal Preparation.**—Nine mongrel dogs weighing between 16 and 20 kg were anesthetized with sodium pentobarbital, 30 mg/kg. The right kidney was removed through a right retroperitoneal flank incision, and the left renal artery was exposed through a similar incision on the left side. A noncannulating Carolina flow probe was placed around the renal artery, and renal blood flow was measured with a square-wave flowmeter, Carolina model 321. An adjustable screw clamp was placed immediately distal to the flow probe, and a polyethylene needle catheter for monitoring pressure was inserted into the renal artery distal to the clamp. To obtain arterial and renal venous blood samples, one catheter was inserted into one of the femoral arteries, and another was inserted into the renal vein directly through the wall close to the hilus of the kidney and held in place with a 4-0 silk purse-string suture. An additional catheter was inserted into the abdominal aorta through the other femoral artery for arterial blood pressure measurements.

The spinal cord was destroyed by injecting 10 ml of 80% ethanol into the lumbar spinal canal. Cessation of respiration and failure to elicit a carotid sinus reflex when the carotid arteries were tied prior to decapitation confirmed the success of cord destruction. Artificial ventilation was then instituted, and the blood pressure was maintained at 100 mm Hg by intravenous infusion of norepinephrine. By crushing the neck with a large steel vise the head was rapidly removed distal to the vise without bleeding, since the vise could be completely closed in 12 seconds with a 2-ton hydraulic truck jack.

A stabilization period of 1 hour followed decapitation and preceded any experimental manipulation. During this time the norepinephrine infusion was adjusted so that the arterial pressure remained at 100 mm Hg; the infusion rates required for the dogs in these experiments ranged from 0.05 to 0.4 μg kg⁻¹ min⁻¹. Generally after 20–40 minutes the arterial pressure stabilized and remained stable for several hours without further adjustment in the norepinephrine infusion rate. In no experiment was the rate of infusion altered during data collection. There were no signs of animal deterioration during manipulations in any experiment from which data are reported.

To estimate the rate of angiotensin II formation at various levels of arterial renin activity, six additional dogs were prepared by spinal destruction and decapitation, and their arterial pressure was stabilized at 100 mm Hg with infusion of norepinephrine. Interaction with the dog’s own renin-angiotensin system was prevented by total nephrectomy 1 hour preceding the angiotensin (Hypertensin, Ciba) infusion. The steady-state arterial pressure obtained at each intravenous angiotensin infusion rate was used to construct a dose-response curve. The arterial renin activities which resulted in an equivalent rise in mean arterial blood pressure in the nine animals previously described were then correlated with the dose-response curves to estimate the amount of angiotensin II formation that could be expected with various arterial renin activities. This was therefore a bioassay technique for determining the rate of angiotensin II formation. (See Results for details.)

**Experimental Protocol.**—Control samples of arterial and renal venous blood were taken to determine renin activities at the end of the 1-hour stabilization period after decapitation. Step-decreases of about 15 mm Hg in renal artery perfusion pressure were then introduced, and the response of aortic blood pressure was recorded. The renal artery clamp was adjusted to maintain a constant renal perfusion pressure during the period of occlusion. The systemic arterial blood pressure rose to a new plateau level in about 20 minutes at which time arterial and renal venous blood samples were simultaneously withdrawn. Immediately after each blood sample was taken, a zero-flow base line for the renal artery flowmeter was obtained by occluding the renal artery for less than 5 seconds. The renal artery perfusion pressure was then set 15 mm Hg below the preceding level. Inputs of 80–85 mm Hg, 65–70 mm Hg, and 50–55 mm Hg (and 35–40 mm Hg in three
experiments) were used in all experiments. The control perfusion pressure was 100 mm Hg. The results of these experiments were used only if postocclusion systemic blood pressure returned to the control value, indicating no change in vascular tone or blood volume during the period of manipulation.

Renin Analysis.—Renin activity was determined by radioimmunoassay of angiotensin I according to the technique described by Haber et al. (10). All blood samples (3 ml) were drawn directly into ice-cold Vacutainer tubes containing 6 mg of sodium EDTA. The tubes were immediately put on ice and centrifuged for 30 minutes at 4°C to obtain 1 ml of plasma for analysis. EDTA, dimercaprol, and 8-hydroxyquinoline were added to inhibit converting enzyme and angiotensinases while angiotensin I was formed during a 3-hour plasma incubation period at 37°C. Possible nonspecific effects of plasma or cross-reactions with renin substrate and angiotensin I were determined by processing a control unincubated plasma tube for each sample at 4°C. In addition, duplicate samples were processed for all standards and all plasma assays. A standard curve was prepared with each group of samples from which the angiotensin I present in plasma samples was determined.1 A Nuclear-Chicago Corporation 130 B solid-crystal scintillation counter was used to determine radioactivity. Renin secretion rates were calculated by multiplying the difference between venous and arterial renin activity by the renal plasma flow per gram of kidney. Renin activities are reported as angiotensin I formed during incubation per milliliter of plasma per hour.

Results

A record from a representative experiment (Fig. 1) illustrates the changes in (1) renal artery flow, (2) arterial renin activity, (3) renal venous renin activity, and (4) mean aortic blood pressure caused by setting the renal artery perfusion pressure at four different levels (100, 80-85, 65-70, and 50-55 mm Hg). Blood samples for renin analysis were withdrawn after the step-decrease in renal perfusion pressure had been maintained constant for 20 minutes. Progressive increases in both venous and arterial renin activities attended each step-decrease in renal artery pressure to levels of 50-55 mm Hg. Renin values determined 30 minutes after release of the occlusion showed that the activities had nearly returned to control values. The renal blood flow remained constant between renal artery pressures of 100 and 80 mm Hg, below which a steady decrease was observed. The aortic

![A typical record showing the effects of setting renal artery perfusion pressure at different pressure levels. A brief total occlusion of the renal artery to check the flowmeter base line is indicated by sharp downward deflections in the renal artery pressure and flow tracings.](image-url)
blood pressure reached a maximum of 140 mm Hg at a renal artery pressure of 50–55 mm Hg. Elevations in aortic blood pressure accompanied increased levels of arterial renin activity at each level of decreased renal perfusion pressure, with the maximum arterial renin activity corresponding to the maximum rise in aortic pressure at a renal perfusion pressure of 50–55 mm Hg.

**Average Changes in Arterial Blood Pressure during Constriction of the Renal Artery.**—Figure 2 shows the relationship between renal artery perfusion pressure and the average resulting mean aortic blood pressure for nine dogs. The aortic pressures represent the maximum plateau level reached 20 minutes after the step-decrease in renal perfusion pressure. Between renal perfusion pressures of 100 and 65 mm Hg, constriction of a single renal artery resulted in an average aortic blood pressure rise equal to 100% of the renal artery pressure drop. The systemic blood pressure reached its highest mean value of 140.8 ± 4.5 (SE) mm Hg at renal perfusion pressures of 50–55 mm Hg; below this level the rise in systemic blood pressure was equal to only about 30% of the decrease in renal artery pressure. The mean control arterial pressure set at 100.6 ± 1.0 (SE) mm Hg returned to a pressure of 100.0 ± 1.6 (SE) mm Hg in an average of 30 minutes after release of the renal artery constriction.

**Renal Plasma Flow and Arterial and Venous Renin Activities during Reduced Renal Artery Pressure.**—Figure 3 shows the average arterial and renal venous renin activities and also the renal plasma flows obtained at five different levels of renal artery perfusion pressure. The results for nine dogs showed nearly a 250% increase in the arterial renin activity (9.7 ± 2.3 to 33.5 ± 6.5 ng ml⁻¹ hour⁻¹) and nearly a 600% increase in renal venous renin activity (27.1 ± 8.4 to 180.4 ± 34.9 ng ml⁻¹ hour⁻¹) as the renal perfusion pressures were decreased from 100 to 50–55 mm Hg. The arterial renin activities generally declined at renal perfusion pressures less than 50 mm Hg; such pressures, as indicated in the next paragraph, are...
associated with low renal blood flows. The venous renin activity increased to high levels, over 600 ng ml\(^{-1}\) hour\(^{-1}\), at perfusion pressures of 35–40 mm Hg. A paired-variance statistical analysis of the data between each level of renal perfusion pressure showed the increases in arterial and venous renin activity to be statistically significant \((P < 0.05)\) at each pressure level down to renal perfusion pressures of 50–55 mm Hg. After release of the renal artery constriction the arterial renin activity returned to 13.8 ± 4.3 ng ml\(^{-1}\) hour\(^{-1}\) and the venous renin activity to 26.2 ± 6.2 ng ml\(^{-1}\) hour\(^{-1}\) within 30 minutes; neither value differed statistically from the control values.

Figure 3 also shows that the average renal plasma flow decreased to 69% of the control value when renal artery pressure was decreased from 100 to 65 mm Hg but that it dropped to nearly 40% of the control value at perfusion pressures of 50–55 mm Hg. In three of nine experiments the renal perfusion pressures were lowered to 35–40 mm Hg, which resulted in renal plasma flows of only 15% of the control value. The arterial renin activity generally declined, presumably because of low delivery of renin to the blood stream, at these low levels of renal plasma flow.

**Calculated Renin Secretion Rates at Different Renal Artery Perfusion Pressures.**—Renin secretion rates were calculated by multiplying the difference between the venous and arterial renin activities by the renal plasma flow per gram of left kidney. The average weight of the left kidneys was 57.1 ± 3.1 g.

The calculated secretion rates of renin at different renal artery perfusion pressures are shown in Figure 4. The rate of renin secretion progressively increased in all experiments up to a maximum of 245% of the control value at renal artery pressures of 50–55 mm Hg (19 ± 5.1 to 64 ± 12.4 ng ml\(^{-1}\) min\(^{-1}\) per gram of kidney). Secretion decreased at perfusion pressures lower than 50 mm Hg, which were associated with severe depression of renal blood flow. This effect was actually greater than is indicated in Figure 4, since at renal perfusion pressures of 35–40 mm Hg the renal blood flow in two other experiments decreased below the limits of sensitivity of the flow probe; therefore, the renal occlusion was released, and blood samples were not taken.

**Relationship between Net Secretion and Arterial Renin Activity.**—Figure 5 shows the relationship between the rate of renin secretion and arterial renin activities. The coefficient of correlation, 0.77, which is highly significant \((P < 0.001)\), was calculated using the control values for the nine animals and the renin values measured at the various step-decreases in renal perfusion pressure. The calculated regression equation for these values is \(Y = 0.66 X -3.12\), by the method of averages \((11)\).

**Effects of Arterial Renin Activity on Mean Arterial Blood Pressure.**—Figure 6 shows the relationship between the changes in arterial renin activity and mean aortic blood pressure. These data were obtained by extrapolating the arterial blood pressure for each experiment to each of the indicated arterial renin activities above the control value. A correlation coefficient of \(r = 0.67\) was obtained for all the data.
Regression of net renin secretion (ng ml⁻¹ min⁻¹ per gram of kidney) and arterial renin activity.

points, which was highly significant (P < 0.001).
The data in Figure 6 represents changes in arterial renin activity from the control value so that the bioassay of angiotensin II formation could be more readily determined, as is indicated in the next section.

Bioassay of the Rate of Angiotensin II Formation.—Six dogs were prepared by spinal cord destruction, decapitation, and bilateral nephrectomy to determine arterial pressure dose-response curves for angiotensin II infusions. The bilateral nephrectomy prevented feedback interaction of angiotensin on renin release by the kidneys (12-14). Figure 7 is the average dose-response curve obtained and relates the rate of infusion of angiotensin II (ng kg⁻¹ min⁻¹) to the steady-state mean arterial blood pressure at each level of infusion. About 10 minutes were required to reach a satisfactory steady-state pressure level.

The estimated net rate of angiotensin II formation at the various arterial levels of renin activity was obtained by plotting the arterial renin activities associated with the indicated arterial pressure changes in Figure 6 against the angiotensin II infusion rates needed to obtain a corresponding level of arterial blood pressure. The relationship is plotted in Figure 8. This bioassay procedure permitted an estimate of the rate of formation of angiotensin II at various increments of arterial renin activity. For example, an increase of 10 ng ml⁻¹ hour⁻¹ in renin activity resulted in an increase in the net production of 5.0 ng kg⁻¹ min⁻¹ of angiotensin II.

Discussion

The experiments presented in this paper represent an effort to quantify the major interrelationships of the various components
of the renin-angiotensin-vasoconstrictor feedback loop. The concept that decreased renal perfusion pressure causes the release of renin with subsequent activation of angiotensin II is widely accepted, and the results of these experiments are in full agreement with this idea. However, when our previous studies indicated that this vasoconstrictor system was active in the normal minute-by-minute regulation of blood pressure, a more rigorous analysis of the feedback loop became desirable. Radioimmunoassay techniques for analysis of renin activity permitted use of small samples and more rapid analysis, and therefore a tool to measure the changes occurring within the feedback loop became available. Use of small samples in the areflexic preparation is especially important since we found that rapid removal of only 10.0 ml of blood could lower the mean arterial blood pressure as much as 5 mm Hg.

The data presented in this paper show that, within the limits imposed by the experimental conditions, quantitative values for most of the major elements of the renin-angiotensin-vasoconstrictor feedback system have been determined. On the basis of the unified data it is possible to predict alterations in the system attending a decrease in renal artery pressure. For example, if the renal artery pressure is lowered to 65–70 mm Hg, the net renin secretion may be expected to increase from 19 to nearly 61 ng ml⁻¹ min⁻¹ per gram of kidney (Fig. 4). This increase in renin secretion results in an elevation of renal venous renin concentration from 25 to nearly 115 ng ml⁻¹ hour⁻¹ and a rise in the arterial activity from 9 to 31 ng ml⁻¹ hour⁻¹ (Fig. 3). The elevation of nearly 22 ng ml⁻¹ hour⁻¹ in arterial renin activity is in turn related to a rise of about 35 mm Hg in mean aortic pressure (Fig. 7).

The correlation of arterial renin activity and the rate of angiotensin II formation by the bioassay procedure (Fig. 8) indicates that the elevation of arterial renin activity in this example would result in an increase in angiotensin formation of nearly 10 ng kg⁻¹ min⁻¹ above control levels. It is possible that the bioassay procedure used in this manner did not take into account substances in renal tissue that could stimulate or inhibit the peripheral vascular action of angiotensin II, as has been suggested by some investigators (15).

Briefly, then, lowering the renal artery pressure from 100 to 65–70 mm Hg resulted in a nearly 200% increase in the net rate of renin secretion and a nearly 200% increase in arterial renin activity. In turn, the net rate of angiotensin II formation increased proportionately, and the mean aortic blood pressure increased 35 mm Hg above the control blood pressure of 100 mm Hg.

Some variables measured in our areflexic animals were measured in dogs with intact nervous systems in other laboratories. However, these values were never related to peripheral blood pressure responses. The renin values reported by Fojas and Schmid (9) for dogs with intact nervous systems at three levels of reduced renal artery pressure generally agreed with our results. They also observed that the maximum net release of renin occurred at renal artery pressures of about 50 mm Hg. The somewhat higher levels of renin activity obtained in our experiments could have resulted from the 20-minute period of occlusion at each level rather than the 12-minute period used by the other investigators. Since, as we previously reported, 20 minutes were required for the aortic pressure to reach a maximum plateau value after constriction of the renal artery, it seems reasonable that the
same time was also required for the arterial renin concentration to reach a plateau (1). Imbs et al. (16) reported that renin secretion fell at renal perfusion pressures below 50 mm Hg in normal intact dogs; our results were in agreement.

For a number of reasons the control arterial renin activities in our experiments were higher than those generally reported for intact unanesthetized dogs. Laparotomy, which was performed prior to spinal cord destruction, has been shown to elevate plasma renin activity reflexly (17). Brief periods of renal ischemia during the surgical preparation of the renal artery would further elevate control levels of renin activity. The small amounts of heparinized saline used to flush the arterial and venous catheters (5 USP units/ml) could also cause a slight elevation in renin activity (18). Finally, norepinephrine has been shown to increase renin secretion when infused into the renal artery of the dog (19, 20). Although intravenous norepinephrine infusions were maintained constant during the periods of data collection, these low rates of infusion possibly resulted in a slightly higher control level of arterial renin activity.

**Pressure Response of the System.**—Correlation of renal perfusion pressure and systemic blood pressure response (Fig. 2) showed that the arterial blood pressure continued to rise until renal perfusion pressure was lowered below 50–55 mm Hg. As we have previously reported, when the renal artery pressure was decreased from 100 mm Hg to 50–55 mm Hg in one step, the systemic pressure rise at this perfusion pressure was only about two-thirds the pressure elevation obtained at 65–70 mm Hg (1). In the experiments reported here the renal perfusion pressure was lowered to 50–55 mm Hg in step-decreases of 15 mm Hg, and about 40 minutes were required to reach the low perfusion pressure. Since under these conditions the systemic arterial blood pressure continued to rise at renal artery pressures of 50–55 mm Hg, certain adjustments apparently permitted the system to respond to the lower pressure when renal perfusion pressure was lowered over a prolonged period.

**Mechanism for Blood Pressure Elevation.**—This research and our earlier work showed that the arterial pressure elevations in short-term experiments were caused by the increased rate of renin release resulting in increased levels of angiotensin II, which by its direct vasoconstrictor effect elevated the arterial blood pressure. A number of findings support this conclusion.

First, previous research indicated that the rise in mean aortic blood pressure during renal artery constriction in the areflexic dog was due to increased total peripheral resistance rather than to increased cardiac output; this evidence supported the direct peripheral vasoconstrictor concept (1). Second, that the increased total peripheral resistance was indeed a result of the action of angiotensin was indicated by the immediate return of the aortic pressure to control levels when a specific antibody for angiotensin II was injected at the height of the arterial pressure response. Finally, the data presented here demonstrate a significant correlation between arterial renin activity and mean aortic blood pressure.

Examination of the data revealed a poor correlation between the rise in arterial blood pressure or arterial renin activity and the infusion rates of norepinephrine. A previous publication from this laboratory also showed that the open-loop feedback gain of the system was not influenced by the rates of norepinephrine infusion (0 to 0.8 μg kg⁻¹ min⁻¹) required to stabilize arterial pressure at 100 mm Hg before and during constriction of the renal artery (1).

**Open-Loop Gain.**—The feedback loop of the vasoconstrictor system was opened by holding the decreased perfusion pressure to the kidney at a constant level while recording aortic blood pressures and renin changes. In accordance with the principles of linear control systems the open-loop feedback gain of the system was calculated by dividing the increase in aortic blood pressure above the control level by the pressure drop from the control level in the renal artery. A feedback gain of −0.92 to −0.99 was obtained between renal perfusion pressures of 100 and 50 mm Hg.
RENIN-ANGIOTENSIN FEEDBACK SYSTEM

Hg; the same gain was found for single artery occlusions in our previous studies (1) but extended to a slightly lower range of renal perfusion pressure. Gains of this magnitude indicated that a single kidney, operating through the renin-angiotensin-vasoconstrictor loop, was capable of a 50% return of a blood pressure decrease toward normal. Simultaneous constriction of both renal arteries resulted in a gain of nearly 1.6 at the same renal perfusion pressures (1).

Stability of Decapitated Preparation.—It is important that the preparation be well stabilized throughout the experimental period. Data were used only from dogs that exhibited satisfactory stability over the 90-minute period of data collection. Various observations were used as indicators of the degree of stability. First, a typical pattern of arterial blood pressure generally followed decapitation. An initial period of instability occurred in all animals for 20–40 minutes after decapitation, during which time the norepinephrine infusion rate was intermittently adjusted to maintain the mean arterial blood pressures above 100 mm Hg. Arterial pressures were not permitted to fall below 100 mm Hg to avoid activation of the renin-angiotensin system during the 1-hour stabilization period. Thereafter, the arterial blood pressure became stabilized in about two-thirds of the animals and could be maintained at 100 mm Hg for several hours without further adjustments in the infusion rate of norepinephrine. No refractoriness to norepinephrine developed during the experimental period of several hours, although the more stable preparations required smaller infusion rates of norepinephrine.

A second indicator of stability was the return of the mean arterial blood pressure to control values after the release of the renal artery occlusion. The blood volume was probably not significantly changed during the experiment; the amount of saline solution infused with norepinephrine was 0.2–1.0 ml/min and corresponded closely to the urinary output measured in four decapitated dogs. It thus seems safe to assume that the return of the arterial blood pressure to control values after experimental manipulations indicated negligible changes in blood volume or baseline levels of vascular tone during the experimental period. The removal of 3 ml of blood for each renin determination at 20-minute intervals for the five periods of collection appeared to have little effect on mean arterial blood pressure, although rapid removal of the total volume (30 ml) decreased pressure.

Identical dog preparations have often been maintained in our laboratory for up to 36 hours with little deterioration during the first 12 hours after decapitation. Deterioration is indicated by the need for increasingly larger amounts of catecholamines and blood volume expanders to maintain normal arterial pressures. The arterial pressure becomes less stable, and the animal finally appears to succumb to respiratory failure. Observations of preparations for long periods give us confidence in the stability during short-term procedures such as were performed for these renin studies.

Physiological Significance of Experiments.—These experiments and our previous research (1) demonstrated that the kidney could respond to decreased perfusion pressures by rapidly releasing renin in amounts sufficient to contribute to the short-term regulation of arterial blood pressure. It was necessary to eliminate the cardiovascular control loops of the central nervous system to quantify the feedback loop of the system, but we recently obtained evidence that the peripheral vasculature of the decapitated dog responded in a manner similar to that of the intact dog (21). The pressure response to intravenous angiotension II infusions was nearly the same in the decapitated dog preparation as in unanesthetized sino-aortic baroreceptor denervated dogs.

Quantitative values for some major components of the system have been measured or derived. These data, when used in combination with other well-known features of the system, should permit us to better understand and predict changes within the system and

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explain its interactions with other homeostatic pressure-regulating systems.

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