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RENAL CLEARANCE STUDIES ON THE HORSE I.[1]

INULIN, ENDOGENOUS CREATININE AND UREA

By

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In studying the elimination of drugs in a given animal species an analysis of the renal excretion is of essential importance. Such analyses presuppose a knowledge of the normal renal function of the animal species concerned, a condition which has gradually been fulfilled for the large domestic animals. Clearance studies have been performed in sheep (*Shannon* 1937; *Denton et al.* 1952; *Parry & Taylor* 1955), goats (*Sperber* 1949; *Dziemian et al.* 1950; *Sperber & Sperber* 1953), pigs (*Dalgaard-Mikkelsen, Poulsen & Simesen* 1953), and cows (*Poulsen* 1956, 1957). *Ketz, Vogel, Lange & Heym* (1956) have published a work on the renal function of the horse. They calculated inulin clearance, partly on the basis of the distribution volume and elimination constant, and partly by clearance tests at rapidly falling plasma levels of inulin. At the same time they determined the endogenous creatinine clearance. As the clearance values stated by *Ketz et al.* seemed to be very low, it was found appropriate to undertake renal clearance studies in the horse at a constant plasma level of inulin, determining simultaneously the clearances of inulin, endogenous creatinine, and urea.

MATERIAL AND METHOD

The test animals used were 12 clinically healthy, non-pregnant mares, weighing from 220 to 740 kg. and ranging in age from

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1 to 20 years. The horses were sacrificed after the experiments and their kidneys and urinary tracts submitted to macro- as well as microscopic examination and found to be normal in all cases. The horses were weighed before each experiment, and this weight was used in the calculations of each experiment, thus corresponding to the conditions in clinical renal function tests.

The experiments were carried out on non-anesthetized, untrained horses placed standing in a constriction stall. Drop-infusion of inulin solution was established through a thin plastic catheter inserted in the right jugular vein (*Roberts & Dye* 1951). Blood samples were drawn from the left jugular vein through a permanent cannula which was closed with a stylet between the samplings. Urine was collected through a balloon catheter (Rüsch or Acmi no. 28, 75 ml.), filled with 150—250 ml. of air or isotonic NaCl solution. In drawing urine the bladder was washed with 100—300 ml. of isotonic NaCl solution to secure complete emptying. Variations in diuresis ranging from 1 to 160 ml./min. were obtained by water loading through administration of 10—50 liters of water by nasopharyngeal tube from 0 to 3 hours before the first period.

At low diureses the urine catheter frequently effected tenesmi. These, however, always subsided when the diuresis rose. The physiologically wide urethra of the mares would in some instances cause spillage of urine in spite of the large balloon catheter used, and in case of intense tenesmus the filled balloon might even be expelled intact. Therefore the placing of the catheter had to be under regular control to avoid invalidation of the experiments by errors of urine volume.

The periods, ranging from 10 to 46 minutes (average duration 20 minutes), started not less than 30 minutes after a constant drip of pyrogen-free inulin solution had been established. Restlessness or other reactions in relation to the inulin infusion were never observed. Dependent on the priming dose and the drip rate, the plasma inulin concentration was 150—500 μg./ml. and in the individual experiment either constant ± 10 % or slightly rising.

In calculating the clearance $\frac{U \times V}{P}$, where U is the concentration in urine, V the urine volume in ml./min., and P the plasma level, a delay time of 6 minutes was chosen arbitrarily, the same as used by *Poulsen* (1957) in experiments on cows.

Table 1.

Mare no. 1. Experiment no. 1. April 8. 1957.
Weight 233 kg.
Kidney weight 0.695 kg.
20 l. water perorally 2 hours before 1. period.
Infusion: inulin g. 25
infundibile natrii chloridi isotonicum ad ml. 1000
Priming: 250 ml. 40 min. before 1. period. Drop-infusion 5 ml./min. established 37 minutes before 1. period and continued throughout the experiment. 8 min. pause between 4. and 5. period.

Period		Urine pH	Diuresis ml./min.	Urine conc. μg./ml.	Plasma conc. μg./ml.	Clearance			Ratios		
No.	Min.					measured	computed per 100 kg. body weight	computed per 100 g. kidney weight	U/I	Cr/I	CrH/I
Inulin											
1	20½	7.4	35.6	1623	173	334	143	48			
2	19	7.6	33.7	1688	175	325	140	47			
3	21½	7.6	31.9	1860	184	323	138	46			
4	32½	7.7	21.2	2880	185	330	142	48			
5	46½	7.7	11.3	5802	202	325	139	47			
						Mean	140 ± 2	47 ± 1			
Urea											
1				948	213	158	68	23	0.47		
2				955	212	152	65	22	0.47		
3				951	212	143	61	21	0.43		
4				1502	215	148	64	21	0.45		
5				2488	215	131	56	19	0.40		
						Mean	63 ± 5	21 ± 2	0.44±0.03		
»Creatinine«											
1				116	13.2	314	135	45		0.94	
2				113	13.3	287	123	41		0.88	
3				118	13.8	272	117	39		0.84	
4				182	14.4	268	115	39		0.81	
5				357	14.3	282	121	41		0.87	
						Mean	122 ± 8	41 ± 3		0.87±0.05	
»Creatinine H«											
1				104	7.7	481	206	69			1.44
2				104	7.9	444	190	64			1.36
3				109	8.1	429	184	62			1.33
4				167	8.0	443	190	64			1.34
5				336	8.2	463	199	67			1.43
						Mean	194 ± 9	65 ± 3			1.38±0.05

However, with only minor variations in the plasma level, the difference between the concentration in the middle of the period and the concentration 6 minutes earlier had no influence on the reliability of the calculations.

In addition to the measured clearances, standard clearances per 100 kg. body weight and per 100 g. kidney weight were calculated in all the experiments. Computations based on surface calculations were forborne, as these seemed not to give closer accordance between the values obtained for the various test animals.

The procedure of the experiments is illustrated by the complete experimental record rendered in table 1.

ANALYTICAL METHODS

Inulin: *Brun*'s method (1946). (Designated as "I").

Endogenous creatinine: 1) Folin's method, as modified by *Thomsen* (1938) and *Poulsen* (1956, 1957). This serves to determine all Jaffé-positive substances, i. e. "true" endogenous creatinine as well as a certain amount of "pseudocreatinine". (Designated as "Creatinine" or Cr).

2) *Haugen*'s method (1953), which, unlike 1), eliminates the "pseudocreatinine", but possibly also removes part of the "true" creatinine. The analytical results seem to be attended with greater uncertainty than those of method 1). (Designated as "Creatinine H" or CrH).

Urea: *Conway* (1950). The urease preparation used is Urease, pract. grade type II Sigma. (Designated as "U").

Inulin Clearance.

In all the animal species examined so far inulin has fulfilled the requiremnets to be made on a pure filtration substance, inulin clearance being, among other things, independent of the diuresis and of the inulin concentration in plasma. To throw some light on the influence of the diuresis, 13 diuresis-variation experiments were carried out on seven mares (a total of 81 observations). Inulin clearance was found to be independent of even great variations. The smallest variations was a fall from 35 to 11 ml./min. and the greatest variation was a rise from 8 to 167 ml./min. Fig. 1 illustrates inulin clearance in relation to diuresis in three mares.

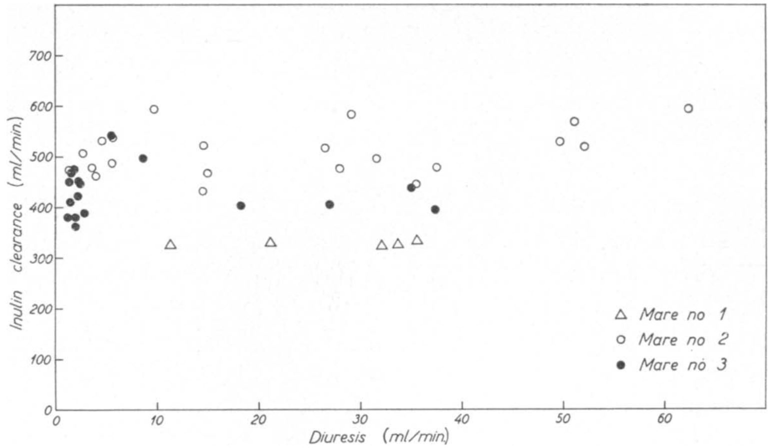

Fig. 1. Inulin clearance at various diuresis levels in 3 mares.

In the total material the plasma inulin levels ranged from 150 to 500 μg./ml. The question of whether inulin clearance is independent of changes in the plasma level has been investigated to a small extent only. No facts were found militating against the view that inulin is also a filtration substance in the horse.

In 22 experiments, comprising 125 observations, inulin clearance was determined simultaneously with urea clearance and/or endogenous creatinine clearance. At large diureses and a fairly constant plasma level, inulin clearance was found to be determinable with an accuracy corresponding to that obtained in experiments on dogs (*Moustgaard* 1948) and cows (*Poulsen* 1957). At small diureses, which seem to be physiological for horses, the uncertainty proved to be considerably greater. This was due to the technical difficulties of completely emptying the bladder of the horse when the urine production is low.

The average inulin clearance for all 125 observations, calculated per 100 kg. body weight, was 166 ± 33 ml./min.¹). The corresponding value calculated per 100 g. kidney weight was 61 ± 14 ml./min. The values for the individual test animals are presented in table 2, where the endogenous creatinine clearances are recorded for the sake of comparison.

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¹) Here and throughout the present work, ± indicates standard deviation (cf. Acta pharmacol. et toxicol. 1955, *11*, 1).

Table 2.
Inulin and endogenous creatinine clearances per 100 kg. body weight and per 100 g. kidney weight in 12 mares.

Mare no.	Weight, kg.	Kidney Weight, kg.	Kidney wt. as % of body wt.	Number of observations	Clearances					
					Inulin		»Creatinine«		»Creatinine H.«	
					per 100 kg. body wt. ml./min.	per 100 g. kidney wt. ml./min.	per 100 kg. body wt. ml./min.	per 100 g. kidney wt. ml./min.	per 100 kg. body wt. ml./min.	per 100 g. kidney wt. ml./min.
1	233	0.695	0.3	5	140 ± 2	47 ± 1	122 ± 5	41 ± 3	194 ± 9	65 ± 3
2	346	1.071	0.3	21	147 ± 13	48 ± 4	129 ± 13	42 ± 4	187 ± 20	61 ± 7
3	223	0.587	0.3	17	192 ± 20	73 ± 7	146 ± 14	56 ± 5	231 ± 22	88 ± 8
4	742	1.759	0.3	26	171 ± 19	73 ± 7	159 ± 18	67 ± 7	207 ± 26	88 ± 12
5	423	1.240	0.3	19	180 ± 26	61 ± 9	165 ± 26	56 ± 9	231 ± 38*)	79 ± 14*)
6	331	0.963	0.3	7	228 ± 22	78 ± 8	164 ± 12	56 ± 4	247 ± 34	85 ± 12
7	254	0.593	0.2	4	171 ± 5	74 ± 2	143 ± 7	61 ± 3	—	—
8	271	0.715	0.3	3	162 ± 6	61 ± 2	120 ± 4	45 ± 2	180 ± 5	68 ± 2
9	351	1.049	0.3	7	142 ± 30	48 ± 10	148 ± 22	50 ± 11	164 ± 31	55 ± 10
10	415	1.038	0.3	5	153 ± 5	38 ± 1	141 ± 3	36 ± 1	200 ± 8	51 ± 2
11	347	0.785	0.2	7	117 ± 12	52 ± 6	110 ± 11	49 ± 5	142 ± 14	63 ± 6
12	560	1.352	0.2	4	132 ± 4	55 ± 1	—	—	144 ± 11	60 ± 5
				Total	166 ± 33	61 ± 14	146 ± 24	54 ± 11	202 ± 36	74 ± 16
					125 observations		121 observations		116 observations	

*) 14 observations

Endogenous Creatinine Clearance.

Endogenous creatinine clearance was always measured simultaneously with inulin clearance, the latter being used as standard filtration clearance. Except in two experiments, the endogenous creatinine concentrations in plasma and urine were determined both by the modified Folin's method and by Haugen's method. The results are recorded in table 2, and show that for 121 observations the "Creatinine" clearance per 100 kg. body weight was found to average 146 ± 24 ml./min., and per 100 g. kidney weight 54 ± 11 ml./min. The "Creatinine H" clearance was considerably higher, averaging, for 116 observations, 202 ± 36 ml./min. per 100 kg. body weight and 74 ± 16 ml./min. per 100 g. kidney weight.

Calculating, as illustrated in table 3, the ratio between each of the two endogenous creatinine clearances and the simultaneously determined inulin clearance, the ratio for "Creatinine" clearance was in only one case found to be 1, while in the re-

Table 3.

Ratio Cr/I and CrH/I in 12 mares.

Mare no.	Obs.	Cr/I	CrH/I
1	5	0.87 ± 0.05	1.38 ± 0.05
2	21	0.88 ± 0.06	1.27 ± 0.08
3	17	0.77 ± 0.10	1.21 ± 0.09
4	26	0.93 ± 0.08	1.21 ± 0.13
5	19	0.92 ± 0.08	1.30 ± 0.23*)
6	7	0.72 ± 0.03	1.08 ± 0.10
7	4	0.84 ± 0.02	——
8	3	0.75 ± 0.02	1.11 ± 0.02
9	7	1.04 ± 0.06	1.16 ± 0.09
10	5	0.92 ± 0.04	1.31 ± 0.09
11	7	0.94 ± 0.04	1.22 ± 0.07
12	4	——	1.09 ± 0.07
Total		0.88 ± 0.11 (121 obs.)	1.23 ± 0.13 (116 obs.)

*) 14 observations

maining it was about 0.9. The ratio "Creatinine H" clearance/inulin clearance, on the other hand, was always higher than 1, averaging 1.2. This difference is referable to the analytical methods employed. By the modified Folin's method plasma levels ranging from 11.3 to 16.3 μg./ml. (average 13.2 ± 1.1) were found, values which accord fairly closely with the conditions in man (*Popper, Mandel & Mayer* 1937), rabbits (*Grant* 1953), and cows (*Poulsen* 1957). Whereas by Haugen's method, a 30 per cent lower plasma level was seen (8.8 ± 1.4 μg./ml.), because this method does not include "pseudocreatinine", such as glucose, acetone, and pyruvic acid. In urine analyses, on the other hand, the creatinine concentrations found by Haugen's method were no more than 5 per cent lower than the concentrations measured simultaneously by Folin's method. In accordance with *Taggart* (1950), *Smith* (1951), and *Poulsen* (1957) it is consequently supposed that the filtered pseudocreatinines are reabsorbed by the tubules, whereas "true" endogenous creatinine to a certain extent (20 per cent) is excreted by active tubular secretion. Thus, clearance determinations by means of the modified Folin's method give values which are a little lower than the filtration clearance. Haugen's method, however, by which the "pseudocreatinines" are eliminated in plasma and urine, will give clearance values somewhat exceeding the filtration clearance.

As there is a fair accordance between inulin clearance and “Creatinine” clearance (Folin), it seems justifiable to use the latter in the clinical routine to indicate filtration clearance in horses, in which the plasma “Creatinine” has been found not to exceed about 16 μg./ml. This shows that the pseudocreatinine concentration is not abnormally elevated. The advantage of using this clearance is the simple analytical method in connection with the fact that it is unnecessary to infuse foreign test substances.

Urea Clearance.

Previous investigations have shown that urea clearance, which always is lower than a simultaneously measured filtration clearance, at low diureses is proportional to the square of the diuresis up to a certain limit, the augmentation limit (*Austin, Stillman & van Slyke* 1921; *Effersøe* 1951). At diureses above this limit, urea clearance is almost constant, rising only slightly with increasing diuresis, and to be regarded as maximum clearance. In studying the urea clearance, the chief aim has been to fix the augmentation limit through experiments with greatly varying diureses.

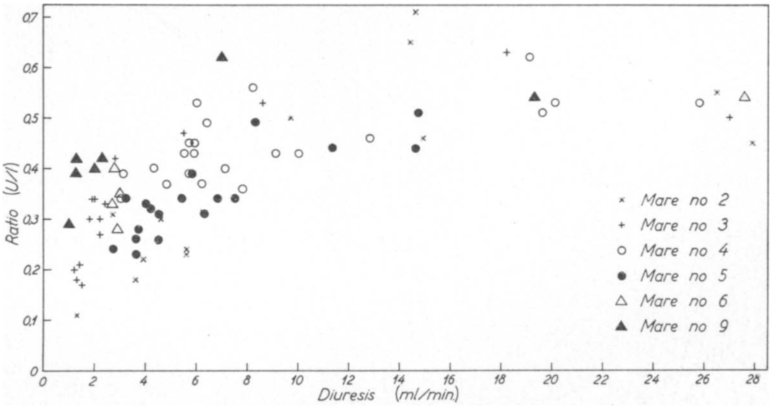
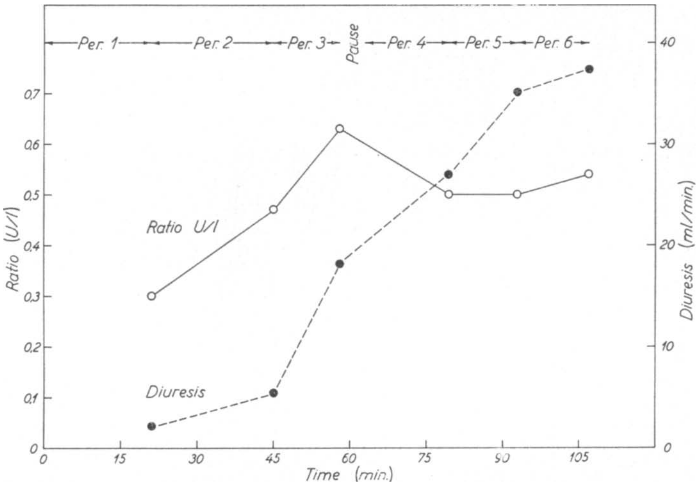


Fig. 2. Ratio Ureacl./Inulincl. at various diuresis levels.

The ratio between urea clearance and inulin clearance in relation to diuresis is shown in fig. 2 as conducted on six of the experimental mares. By water loading, the diuresis was raised from 1 to 28 ml. of urine per minute. This ratio is seen to be about 0.2 at low diuresis, while a maximum value of about 0.5

Fig. 3. Ratio U/I compared with corresponding diuresis. Mare no. 3, experiment no. 3.



Period no.	Diuresis ml./min.	Inulincl. found ml./min.	Ureacl. found ml./min.	U/I
1	2.2	422	127	0.30
2	5.5	540	256	0.47
3	18.2	403	253	0,63
4	27.0	404	203	0.50
5	35.1	438	220	0.50
6	37.3	394	212	0.54

was reached within the range of 6—10 ml./min. Thus, maximum will always be obtained at diuresis exceeding 10 ml./min. In the cases of the remaining six test animals observations were made only at diureses over 28 ml./min., and the ratio in all cases was about 0.5. It is seen in fig. 2 that some of the observations gave ratios essentially higher than 0.5. These excessively high values ("Exaltation", *Shannon* 1936) were obtained in that period of the experiment in which the most abrupt rise in diuresis took place. This recurring observation is illustrated in fig. 3, where the ratio U/I is seen to have exceeded temporarily the "maximum" value in the third period of the experiment, during which the diuresis was elevated from 5.5 to 18.2 ml./min. As seen in the chart, equilibrium is attained in the following periods, which therefore show the true maximum ratio. *Effersøe* (1951) who has made similar observations in rabbit experiments, believes the cause to be that during the clearance period concerned, the high concentration of urea in the walls of the tubules depresses the reabsorbtion of urea from the lumen. This is not very far from the urea excretion theory of the counter-current school, elaborately treated by *Schmidt-Nielsen* (1958). This theory involves an active transport of urea building up a maximum concentration of urea in the tip of the papilla. This active mechanism is supposed to be graded according to urine flow. Accordingly, the "exaltation phenomenon" is explained as a washing out of urea from the papilla tissue by the suddenly rising flow of urine.

In experiments on six mares (29 observations) with diureses exceeding 10 ml./min. urea clearance was found to average 76 ± 20 ml./min. per 100 kg. body weight and 30 ± 9 ml./min. per 100 g. kidney weight. The ratio urea clearance/inulin clearance was calculated at 0.50 ± 0.06, indicating an extensive back-diffusion. The plasma urea, based on 120 observations, averaged 251 ± 61 μg./ml. (140—410 μg./ml.). If one desires to calculate the maximum urea clearance on the basis of experiments at low diureses, the present material seems to justify fixation of the augmentation limit at a diuresis of 10 ml./min. Paralleling *Møller, McIntosh & van Slyke* (1928), *Hilden* (1946), *Effersøe* (1951), and *Poulsen* (1957), one can consequently convert the found clearance to maximum clearance by multiplying with the factor $\frac{\sqrt{10}}{\sqrt{\text{diuresis}}}$. However, as the uncertainty of clearance determination in horses is greatest at low diureses, owing to incomplete emptying of the bladder, it is most expedient to make the experiments at diureses exceeding 10 ml./min., thereby obtaining maximum clearance directly.

DISCUSSION

The only clearance studies about the horse available in literature are those mentioned in the introduction by *Ketz, Vogel, Lange & Heym* (1956), who found an inulin clearance of 69.4 ± 11.1 ml./min. per square meter of body surface, and studies on one horse by *Poulsen* (1957), who found the inulin clearance to be 1.4 ml./min. per kg. body weight. As the clearance values stated by *Ketz et al.* were calculated per square meter, a comparison of their results with the present studies implies a conversion, which naturally introduces a certain error. *Ketz* and his collaborators employed Meeh-Rubner's formula: Body surface = $k \times \sqrt[3]{G^2}$, where G is the weight in grams and k has been set at 9.5 by the authors (cf. *Seuffert & Hertel* 1924—25). By calculation, according to this formula, using the same k value and a "standard horse" of 500 kg, a body surface of 6 sq.m. is found. By converting, on the basis of this "standard horse", the average clearance of the present material to clearance per square meter, the following values are found: inulin 138 ml./min. (*Ketz et al.* 69.4 ± 11.1), "Creatinine" 122, and "Creatinine H" 168 ml./min. (*Ketz et al.* 70.6 ± 18.7, analyzed according to *Popper, Mandel & Mayer*). Thus, the values obtained in the present study for both inulin and endogenous creatinine clearances are about twice as high as those found by *Ketz et al.* Perhaps the difference in inulin clearance is accounted for by the fact that *Ketz* and his collaborators worked under conditions of a rapidly falling plasma inulin concentration, which normally results in too low clearance values (*Brun, Hilden & Raaschou* 1949). As for the creatinine clearance, the explanation must be the unusually high plasma level (2.6 ± 1.2 mg.%) found by *Ketz et al.* compared with the plasma level of "Creatinine" found in the present investigation (13.2 ± 1.1 μg./ml. — average of 121 observations).

Table 4 presents the filtration clearances of different domestic animals and man, in the order of size of the animal species. It seems to show that filtration clearance is inversely proportional

Table 4.
Filtration clearance in some domestic animals and man.

Animal species	Clearance	Clearance pr. kg. body weight	Author
Dog	inulin	2.9	*Moustgaard* (1948)
Goat	exogenous creatinine	2.2	*Dziemian* et al. (1950)
Sheep (1 specimen)	inulin	2.0	*Shannon* (1937)
Man	inulin	2.1	*Smith* (1951)
Cow	inulin	1.8	*Poulsen* (1956)
Horse (1 specimen)	inulin	1.4	*Poulsen* (1956)
Horse	inulin	0.8[1]	*Ketz* et al. (1956)
Horse	inulin	1.7	*Knudsen* (1959)

[1] Computed, see text.

to the size of the animal species. *Ketz et al.*'s inulin clearance has been converted into clearance per kilogram for a horse weighing 500 kg. and having a surface of 6 sq.m. The resulting value differs appreciably from the remaining values in the table.

Some of the experiences gained from the investigation as reported here may possibly be of importance to the clinician. The normal diuresis in the horse seems to be 1—8 ml./min., dependent on the size of the animal. It cannot be increased by first letting the horse become thirsty and thereafter letting it drink, as the thirst regulation seems to be so sensitive that the animal does not ingest any excess of water. The urine is cloudy and rather viscous within this range, but from about 10 ml./min. it grows clearer and thinner. The stated uncertainty for clearance determinations at low diureses seems to be caused by faulty bladder evacuation. So far it has proved impossible to correct this. This error is of no significance for the calculation of ratios, as it figures in both the numerator and the denominator, but in clearance studies aiming at procuring exact figures for filtration and urea clearances the most reliable procedure will be that of making all the determinations at high diuresis levels, which are most easily obtained by administering 20 to 35 liters of water to the animal by nasopharyngeal tube 2 hours before the experiment. The diuresis will then, unless the animal is dehydrated, remain above the augmentation limit for about 3 hours. In this way the tenesmi which the catheter may bring about in mares whose bladder is not distended by urine, may be avoided. Finally, as in several other animal species, it seems justified to employ "Creatinine" clearance in the horse to indicate filtration clearance in clinical studies, where the plasma "creatinine" concentration, determined by the modified Folin's method, does not exceed 15 μg./ml.

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SUMMARY

Endogenous creatinine and urea clearances have been studied in 12 mares simultaneously with inulin clearance at a constant plasma level of inulin. The following values were found, calculated per 100 kg. body weight: Inulin clearance 166 ± 33 ml./min. (125 observations), endogenous "Creatinine" clearance (Folin's method) 146 ± 24 ml./

min. (121 observations), endogenous "Creatinine H" clearance (Haugen's method) 202 ± 36 ml./min. (116 observations), and maximum urea clearance 70 ± 20 ml./min. (29 observations). Calculated per 100 g. kidney weight the following clearance values were determined from the same observations: Inulin 61 ± 14 ml./min., endogenous "Creatinine" 54 ± 11 ml./min., endogenous "Creatinine H" 74 ± 16 ml./min., and urea 30 ± 9 ml./min.

The ratio "Creatinine" clearance/inulin clearance was found to be 0.88 ± 0.11 in 121 observations, while "Creatinine H" clearance/inulin clearance was 1.23 ± 0.13 in 116 observations, and urea clearance/inulin clearance 0.50 ± 0.06 in 29 observations.

Maximum urea clearance is obtained at diureses of 5—10 ml./min. The augmentation limit can therefore be fixed at 10 ml./min.

ZUSAMMENFASSUNG

Studien über die renale Clearance beim Pferd. I. Inulin, endogenes Kreatinin und Harnstoff.

Die endogene Kreatininclearance und Harnstoffclearance wurden an 12 Stuten gleichzeitig mit der Inulinclearance bei konstantem Plasmaspiegel von Inulin studiert. Folgende Werte wurden gefunden, auf 100 kg Körpergewicht berechnet: Inulinclearance 166 ± 33 ml/Min. (125 Beobachtungen), endogene „Kreatinin"-Clearance (Folins Methode) 146 ± 24 ml/Min. (121 Beobacbtungen), endogene „Kreatinin H"-Clearance (Haugens Methode) 202 ± 36 ml/Min. (116 Beobachtungen) und maximale Harnstoffclearance 70 ± 20 ml/Min. (29 Beobachtungen). Auf 100 g Nierengewicht bezogen, wurden die folgenden Clearancewerte aus denselben Beobachtungen errechnet: Inulin 61 ± 14 ml/Min., endogenes „Kreatinin" 54 ± 11 ml/Min., endogenes „Kreatinin H" 74 ± 16 ml/Min. und Harnstoff 30 ± 9 ml/Min.

Das Verhältnis „Kreatinin"-Clearance/Inulinclearance betrug in 121 Beobachtungen 0.88 ± 0.11, während „Kreatinin H"-Clearance/Inulinclearance sich in 116 Beobachtungen auf 1.23 ± 0.13 und Harnstoffclearance/Inulinclearance sich in 29 Beobachtungen auf 0.50 ± 0.06 beliefen.

Die maximale Harnstoffclearance wurde bei Diuresen von 5—10 ml/Min. erreicht. Die „augmentation limit" (Steigerungsgrenze) lässt sich deshalb auf 10 ml/Min. festlegen.

RESUMÉ

Renale clearanceundersøgelser på hest. I. Inulin, endogen kreatinin og urinstof.

Endogen kreatinin- og urinstofclearance er undersøgt på 12 hopper simultant med inulinclearance ved konstant inulinplasmakoncentration. Der fandtes følgende værdier beregnet per 100 kg legemsvægt:

inulinclearance 166 ± 33 ml/min. (125 obs.), endogen „Kreatinin"-clearance (Folins metode) 146 ± 24 ml/min. (121 obs.), endogen „Kreatinin H"clearance (Haugens metode) 202 ± 36 ml/min. (116 obs.) og urinstofmaximalclearance 70 ± 20 ml/min. (29 obs.), mens clearances beregnet per 100 g nyrevægt for de samme observationer er: inulin 61 ± 14 ml/min., endogen „Kreatinin" 54 ± 11 ml/min., endogen „Kreatinin H" 74 ± 16 ml/min. og urinstof 30 ± 9 ml/min.

Ratio „Kreatinin"cl./inulincl. er fundet til 0,88 ± 0,11 i 121 observationer, mens „Kreatinin H"cl./inulincl. er 1,23 ± 0,13 i 116 obs. og urinstofcl./inulincl. 0,50 ± 0,06 i 29 obs.

Maximal urinstofclearance opnås ved diureser på 5—10 ml/min., augmentation limit kan derfor sættes til 10 ml/min.

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