

## EFFECT OF PARTURITION ON SOW URINARY CREATININE

L. A. BATE and R. R. HACKER

*Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario  
N1G 2W1. Received 16 Apr. 1981, accepted 17 July 1981.*

BATE, L. A. AND HACKER, R. R. 1981. Effect of parturition on sow urinary creatinine. *Can. J. Anim. Sci.* **61**: 913-917.

Total urinary creatinine (UC) was measured three times a day between day 5 prepartum and day 4 postpartum in 13 Yorkshire sows. Total UC remained unchanged during days 5, 4, and 3, and decreased ( $P > 0.05$ ) during days 2 and 1 prepartum. After parturition, levels increased ( $P < 0.0001$ ), reaching peak values on day 2 and declining thereafter to approximately prepartum values. Differences in total UC did not exist between the three collection periods of the day. However, large differences ( $P < 0.01$ ) existed between animals. Correlations between litter weight (LW) and changes in UC excretion (CUCE) for days 1 and 2 postpartum were 0.746 and 0.749, respectively ( $P < 0.01$ ), while for days 3 and 4 postpartum, the correlation was only 0.349 and 0.463, respectively ( $P > 0.05$ ). Prediction equations based on LW were developed for estimating CUCE. Results indicated that if UC is to be utilized as an index for expressing concentrations of urinary metabolites, during the first 2 days following parturition, correction must be made for CUCE.

On a mesuré trois fois par jour sur 13 truies Yorkshire, entre le 5<sup>e</sup> jour avant la mise bas et le 4<sup>e</sup> jour après, la concentration totale en créatinine de l'urine (U.C.). La quantité de créatinine est restée inchangée durant les trois premiers jours puis a diminué dans les deux jours précédant la mise bas. Après la mise bas, les valeurs ont augmenté ( $P < 0.0001$ ) pour atteindre un pic au 2<sup>e</sup> jour, revenant ensuite graduellement au niveau pré-natal. Il ne s'est pas produit de différence entre les trois périodes journalières de collecte, mais de larges différences ( $P < 0,01$ ) se sont manifestées d'un animal à l'autre. Les corrélations observées entre le poids de la portée et l'évolution du taux d'excrétion de créatinine (CUCE) dans les 1<sup>er</sup> et 2<sup>e</sup> jours après la mise bas étaient respectivement de 0,746 et 0,749 ( $P < 0,01$ ), alors que pour les jours 3 et 4, les valeurs n'étaient plus que de 0,349 et 0,463 ( $P < 0,05$ ). On a élaboré des équations de prédiction du CUCE à partir du poids de la portée. Il semble que si l'excrétion de créatinine doit être utilisée comme indice des concentrations des métabolites urinaires dans les deux premiers jours qui suivent la mise bas, il faudra tenir compte des changements affectant l'excrétion.

Creatinine has commonly been used as an index compound to express the excretion rate of urinary metabolites in different species (Tillson et al. 1970; Erb et al. 1977). Adamson et al. in 1945 already used creatinine to express the concentrations of urinary vitamins.

Daily excretion of creatinine is considered to be fairly constant for individual animals (Hodgen et al. 1967; Erb et al. 1970). It is estimated that about 2% of the total creatine

and creatinine is excreted daily in the urine (Borsook and Dubnoff 1947). However, Paterson (1967) suggested that creatinine is not sufficiently constant to justify its use as an index of other metabolites in urine. Differences in creatinine excretion between animals of the same species have been reported (Folin 1905; Erb et al. 1977). These differences are attributed to variation in body composition. A high correlation has been reported between urinary creatinine and lean body mass (Van Niekerk et al. 1963b) and, even more specifically, muscle mass.

Some reports indicate changes in creatinine excretion depending on the reproductive stage of the animal (Albin and Clanton 1966; Erb et al. 1977) but no studies have been made of the effect of parturition on creatinine excretion from the sow. The purpose of this study was to determine the rate of daily total urinary creatinine (UC) excretion in sows from day 5 prepartum until day 4 postpartum, in order to establish if parturition modifies the rate of excretion.

### MATERIALS AND METHODS

Each of 13 pregnant Yorkshire sows, parity 2 to 5, was catheterized on day 109 postbreeding by insertion of a 22 Fr. silicone elastomer-coated Foley catheter (C. R. Bard, Inc., Murray Hill, N. Y.) into the bladder. The bladder was allowed to drain completely before the catheter was connected to a plastic collection bag by means of a light polyethylene tube. Sows were housed in farrowing crates and were fed a standard diet.

An adjustment period of about 10 h was allowed before urine collection was begun. Urine was collected three times each day between 2400 and 0100 h, 0800 and 0900 h and 1600 and 1700 h. At collection time, the total volume of urine was recorded and an aliquot of 10 mL was taken. After the addition of 0.5 mL of 25%  $H_2SO_4$ , the aliquot was stored at 4°C (Van Niekerk et al. 1963a) until assayed for creatinine. Catheters were maintained through parturition and for 4 days after the onset of parturition.

The sows were weighed day 109 postbreeding and at 4 days postpartum. Piglet weights were recorded immediately after birth.

The assay procedure used to quantify UC was a modification of the method used by Hodgen et al. (1967). To 0.3 mL of urine, in a 50-mL volumetric flask, were added 10 mL saturated picric acid and 0.8 mL of 10% NaOH; the solution was mixed and incubated for 15 min, and then diluted with distilled water up to 50 mL. An aliquot of the diluted mixture was analyzed in a spectrophotometer (PYE Unicam SPC-500 uv) at 520 nm. Blanks were prepared in which the urine was replaced with distilled water. Every assay was run with a set of standards ranging from 0.0 to 1.6 mg of creatinine.

The data were analyzed as a complete randomized block design where each sow was a block and each day a treatment (Steel and Torrie 1980).

### RESULTS AND DISCUSSION

The pattern of UC in the sow during parturition is not as constant as it is during the growth period (Duggal and Eggum 1978) or during the estrous cycle or pregnancy (Erb et al. 1970). At parturition, a reduction in UC output would be expected as a consequence of the decrease in lean mass within the sow's body. In this study as pregnancy advanced sows maintained a constant level of UC until 2 days before parturition, when a 6.5% decline occurred ( $P > 0.05$ ). During days 1 and 2 postpartum, the amount of UC increased by about 29% ( $P < 0.0001$ ). By days 3 and 4 postpartum, the UC rate declined ( $P < 0.005$ ) and again approximated prepartum levels. The excretion of UC during days 3 and 4 postpartum did not differ ( $P > 0.05$ ) from that on days 5, 4, and 3 prepartum, but it was higher ( $P < 0.005$ ) than that on days 2 and 1 prepartum (Table 1).

When the values of UC excretion were expressed as  $mg\ UC \cdot kg^{-1} \cdot day^{-1}$ , the same trend was maintained, but the pre- and postpartum differences became even larger.

Pre- and postpartum weights of the sows, as well as litter weight, are presented in Table 2. The correlation between weight before and weight after parturition of sows was 0.96. No differences in total UC excretion were found between the three periods into which each day was divided. These results differ from those reported for sheep (Hodgen et al. 1967) where more creatinine was excreted from 2400 to 0600 h than from 0600 to 1200 h. There were differences ( $P < 0.01$ ) in UC excretion between sows, similar to those reported in cows by Erb et al. (1977).

The prepartum reduction in UC can be attributed to an increase in amino acid retention for producing colostrum, which has a protein content of 15–19% (Beacon and Bowland 1951; Perrin 1955), and also to the increase in extracellular fluids characteristic of late pregnancy (Guyton 1976). The large increase in UC after parturition could be related to the surge of corticosteroids, which has been measured in sows at parturition (Killian et al. 1973; Molokwu and Wagner 1973;

Table 1. Mean daily excretion of creatinine in the urine of 13 sows between day 5 prepartum and 4 postpartum

Item	Days								
	-5	-4	-3	-2	-1†	1	2	3	4
g UC·sow <sup>-1</sup> ·day <sup>-1</sup>	15.79 <sup>ab</sup>	15.58 <sup>ab</sup>	15.85 <sup>ab</sup>	14.32 <sup>b</sup>	14.33 <sup>b</sup>	18.48 <sup>c</sup>	18.99 <sup>c</sup>	16.81 <sup>a</sup>	16.37 <sup>a</sup>
SD	4.04	4.00	4.71	4.47	3.32	5.44	4.53	4.73	3.82
mg UC·kg <sup>-1</sup> ·day <sup>-1</sup> ‡	51.31 <sup>ab</sup>	51.54 <sup>ab</sup>	52.62 <sup>ab</sup>	49.00 <sup>b</sup>	47.85 <sup>b</sup>	69.08 <sup>c</sup>	71.15 <sup>c</sup>	65.62 <sup>a</sup>	61.00 <sup>a</sup>
SD	9.56	8.22	11.47	8.63	8.40	17.71	13.44	13.56	12.89

†Time of parturition.

‡The weight used to estimate UC·kg<sup>-1</sup>·day<sup>-1</sup> before parturition was the sow weight at 109 days postbreeding, while the weight at 4 days postpartum was used to estimate the postpartum values.

a-c Means with the same letters do not differ ( $P > 0.05$ ). Means with different letters differ ( $P < 0.005$ ).

Table 2. Average sow and litter weight†

Item	Time	Weight (kg)	SD
Sow	109‡	298.4	43.6
Litter	0§	16.1	2.4
Sow	4	265.3	37.5

†Thirteen sows and litters are represented.

‡Day 109 postbreeding.

§At birth.

||Postpartum.

Baldwin and Stabendfelt 1975). Glucocorticoids greatly enhance protein catabolism in muscle (Guyton 1976). The return to a constant pattern of UC is reflected in the decrease of UC found during days 3 and 4 postpartum in this study, and it could well be associated with the decrease in glucocorticoid levels 2 days after parturition (Killian et al. 1973).

In view of the findings presented herein, it becomes necessary to know the pattern of UC excretion by the sow after parturition when creatinine is to be used as an index for expressing the excretion of another metabolite in urine, especially in the case of hormone-related metabolites, which fluctuate markedly around parturition.

If the UC index is to be used, it is of paramount importance to have a practical and simple way of estimating the change in UC occurring in sows as a consequence of parturition. Litter weight (LW) could be used as a simple parameter with which to estimate this change. In the present study, the correlations between LW and changes in UC excretion (CUC) for the first and second days postpartum were 0.746 and 0.749, respectively ( $P < 0.01$ ). The regression equations for predicting the CUC for these 2 days were  $Y = -18.046 + 1.377X$  and  $Y = -8.975 + 0.846X$ , respectively (Table 3), when  $X$  was expressed as kilograms and  $Y$  as grams of UC per sow per day. After the second day postpartum, the UC excreted declined at a rate which was not constant for all sows, making it difficult to establish a meaningful prediction equation using LW as a parameter. The correlations between LW and CUC for days 3 and 4 postpartum were

Table 3. Regression equations for predicting change in urinary creatinine excretion on the basis of litter weight and its correlation coefficient for 4 days postpartum in sows

Day	<i>r</i>	Regression equation
1	0.7463**	$Y = -18.046 + 1.377X$
2	0.7494**	$Y = -8.975 + 0.846X$
3	0.3487NS	
4	0.4634NS	

\*\**P* < 0.01; NS, not significant.

only 0.349 and 0.463, respectively (*P* > 0.05; Table 3).

Change in the weight if the sow could be another, and probably more precise, parameter with which to estimate CUCE; however, it can not be used of weight measurements are taken at different times before parturition, as in this experiment. It would be preferable to estimate CUCE on the basis of the change in sow weight from immediately before to immediately after parturition. This estimate would include the weight loss due to the placenta and it would also minimize the error involved in weighing individual piglets.

For the concentrations of a metabolite to be expressed accurately on the basis of the UC index, a correction must be made to adjust for the changes in UC excretion after parturition. Metabolite concentration otherwise published will represent a gross underestimation of the true values.

#### ACKNOWLEDGMENT

This study was supported by Agriculture Canada, the Ontario Pork Producers Marketing Board and the Ontario Ministry of Agriculture and Food. The technical assistance of Janice Hoover and Albert Lun is gratefully acknowledged.

ADAMSON, J. D., JOLIFFE, N., KRUSE, H. D., LOWRY, O. H., MOORE, P. E., PLATT, B. S., SEBREEL, W. H., TICE, J. W., TISDALL, F. F., WILDER, R. M. and ZAMECNIK, P. C. 1945. Medical survey of nutrition in Newfoundland. *Can. Med. Assoc. J.* **52**: 227-239.

ALBIN, R. C. and CLANTON, D. C. 1966. Factors contributing to the variation in urinary creatinine and creatinine-nitrogen ratios in beef

cattle. *J. Anim. Sci.* **25**: 107-112.

BALDWIN, D. M. and STABENFELDT, G. H. 1975. Endocrine changes in the pig during late pregnancy, parturition and lactation. *Biol. Reprod.* **12**: 508-515.

BEACON, S. E. and BOWLAND, J. P. 1951. The essential amino acids (except tryptophan) content of colostrum and milk in the sow. *J. Nutr.* **45**: 419-429.

BORSOOK, H. and DUBNOFF, J. W. 1947. The hydrolysis of phosphocreatine and the origin of urinary creatinine. *J. Biol. Chem.* **168**: 493-509.

DUGGAL, S. K. and EGGUM, B. O. 1978. Urinary creatinine and creatine excretion in pigs in relation to body weight and nitrogen balance. *J. Sci. Food Agric.* **29**: 683-688.

ERB, R. E., SURVE, A. H., RANDEL, R. D. and GARVERICK, H. A. 1977. Urinary creatinine as an index of urinary excretion of estrogen in cows prepartum and postpartum. *J. Dairy Sci.* **60**: 1057-1063.

ERB, R. E., TILLSON, S. A., HODGEN, G. D. and PLOTKA, E. D. 1970. Urinary creatinine as an index compound for estimating rate of excretion of steroids in the domestic sow. *J. Anim. Sci.* **30**: 79-85.

FOLIN, O. 1905. Laws governing the chemical composition of urine. *Amer. J. Physiol.* **13**: 66-115.

GUYTON, A. C. 1976. Textbook of medical physiology, W.B. Saunders Company, Toronto.

HODGEN, G. D., ERB, R. E. and PLOTKA, E. D. 1967. Estimating creatinine excretion in sheep. *J. Anim. Sci.* **26**: 586-589.

KILLIAN, D. B., GARVERIC, H. A. and DAY, B. N. 1973. Peripheral plasma progesterone and corticoid levels at parturition in the sow. *J. Anim. Sci.* **37**: 1371-1375.

MOLOKWU, E. C. I. and WAGNER, W. C. 1973. Endocrine physiology of the puerperal sow. *J. Anim. Sci.* **36**: 1158-1163.

PATERSON, N. 1967. Relative constancy of 24-hours urine volume and 24-hours creatinine output. *Clin. Chim. Acta* **18**: 57-58.

PERRIN, D. R. 1955. The chemical composition of the colostrum and milk of the sow. *J. Dairy Res.* **22**: 103-107.

STEEL, R. G. D. and TORRIE, J. H. 1980. Principles and procedures of statistics. McGraw-Hill Book Co. New York.

TILLSON, S. A., ERB, R. E. and NISWENDER, G. D. 1970. Comparison of luteinizing hormone and progesterone in blood and metabolites of progesterone in urine of domestic sows during the

- estrous cycle and early pregnancy. *J. Anim. Sci.* **30**: 795-805.
- VAN NIEKERK, B. D. H., BENSADOUN, A., PALADINES, O. L. and REID, J. T. 1963a. A study of some of the conditions affecting the rate of excretion and stability of creatinine in sheep urine. *J. Nutr.* **79**: 373-380.
- VAN NIEKERK, B. D. H., REID, J. T., BENSADOUN, A. and PALADINES, O. L. 1963b. Urinary creatinine as an index of body composition. *J. Nutr.* **79**: 463-473.