

From the State Veterinary Serum Laboratory, Copenhagen, Denmark.

NECROTIZING INFECTIOUS ENTERITIS  
IN PIGLETS, CAUSED BY  
CLOSTRIDIUM PERFRINGENS TYPE C  
III. PATHOLOGICAL CHANGES\*)

By  
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Necrotizing infectious enteritis provoked by *Cl. perfringens* type C has been diagnosed with increasing frequency among piglets in Danish herds since 1963.

On a clinical basis the disease is difficult to differentiate from other enteric diseases (*Høgh 1967*).

In the small intestine, the infection gives rise to postmortem findings which, under Danish conditions, have not been observed in any other disease affecting baby pigs.

The aim of the present study is to describe the patho-anatomical and histo-pathological changes which occur in spontaneously infected pigs.

PREVIOUS INVESTIGATIONS

*Macroscopical changes*

*Field & Gibson (1955)*, in a material consisting of 8 2-3-day-old pigs, found acute haemorrhagic enteritis with necrosis and desquamation of the mucous membrane. The alterations were localized to the jejunum, while no macroscopical changes were seen in other parts of the gastro-intestinal canal or in other organs. Necrotizing enteritis without haemorrhage, together with peritonitis, exudation to the peritoneal cavity, and subepicardial haemorrhage, was seen in 2 7-10-day-old pigs.

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In a report on a Hungarian material (*Szent-Iványi & Szabó* 1956), where the mortality was greatest from the third to the sixth day after birth, it is stated that the most frequently observed postmortem finding was necrotizing enteritis with a highly thickened intestinal wall, which was often also emphysematous. Haemorrhagic enteritis with superficial necrosis of the mucous membrane, often to an extent of only a few centimetres, was observed in the peracute cases. The authors also described necrotizing enteritis where sections with and without changes occurred alternately throughout the small intestine. Besides the changes in the small intestine, where the jejunum was the site of predilection, there were often peritonitis, peritoneal and pleural hydropsy, subepicardial haemorrhage, and usually petechial haemorrhages in the kidneys.

*Barnes & Moon* (1964) found a profound haemorrhagic inflammation of the jejunum, and a fibrinous peritonitis with considerable amounts of sero-haemorrhagic fluid in the peritoneal cavity.

*Moon & Bergeland* (1965) in addition to the haemorrhagic necrotizing enteritis which generally occurred, saw necrotizing enteritis without haemorrhage in some parts of the jejunum. In certain instances such lesions were also found in the ileum, caecum and colon.

*Bergeland* (1965) reported that the macroscopic changes in the small intestine varied from acute haemorrhagic necrotizing to subchronic necrotizing enteritis. Generally the changes started abruptly 15 cm from the pylorus and ended just as suddenly most often in the middle of the jejunum. In some cases the lesions continued to the ileocaecal valve, and in other instances the caecum and colon were involved.

Dividing the small intestine into 7 equally large sections, *Smith & Jones* (1963) found, in 1 pig, the haemorrhage and necrosis localized to the second and third sections.

#### *Microscopical findings*

*Field & Gibson* reported that in the affected section of the bowel the mucosa was the seat of extensive necrosis, which in some cases also involved the muscularis mucosae. There were no definite histo-pathological changes in the liver, spleen and kidneys.

*Szent-Iványi & Szabó* found hyperaemia in the wall of the small intestine and necrosis of the epithelium in peracute cases. In subacute cases the lamina propria was also necrotic. The normal structure of the villi was blurred and the same applied to the crypts of Lieberkühn in cases where the disease had lasted for several days. The submucosa was thickened, oedematous and emphysematous, and severe stasis could be seen in the lymph and blood vessels. In subacute cases, the necrotic mucous membrane was demarcated by white blood cells and histiocytes. In the muscularis there was haemorrhage, hyperaemia in the subserosa only, except in the subacute cases, where the changes in the subserosa were similar to those in the submucosa. There was oedema, hyperaemia, haemorrhage, and emphysema in the mesenteric lymph nodes. Apart from petechial haemorrhages in the kidneys, these workers found no histo-pathological changes in other organs.

#### MATERIAL AND METHODS

The material comprised a total of 339 piglets from 125 herds of swine. For calculation of mortality rates in different age groups, only 285 animals were available, since in the rest of the cases no information was given about age.

*Macroscopical examination.* The patho-anatomical description is based on the postmortem findings in 193 pigs. The remaining 146 pigs were examined only with respect to lesions in the small intestine, and thereafter assigned to groups in accordance with the scheme adopted for classification of the autopsy findings. Examination of the spinal cord was performed on a limited number of pigs only. In 54 cases pleural and peritoneal fluids were examined for protein, cells, and bacteria.

*Microscopical examination.* Tissues from 23 piglets were examined for histo-pathological changes. Material was taken from skeletal muscle (m. long. dors.), from the thoracic and abdominal organs, and from the brain and spinal cord. The tissues were fixed in a 4% formaldehyde solution and embedded in paraffin.

*Staining methods.* The conventional methods, viz. iron haematoxylin-picric acid-acid fuchsin and haematoxylin-eosin, were used for staining of sections. In some cases, sections from the jejunum were also stained by the Gram method. Sediments from pleural and peritoneal fluids were stained by the May-Grünwald-Giemsa and Gram methods.

*Protein determination.* Total protein in pleural and peritoneal fluids was determined spectrophotometrically by Beckman spectrophotometer, model DU at 540 nm with biuret reagent, as indicated by *Gornall et al.* (1949). Amount of protein is expressed on a per-

centage basis as the average of 3 determinations on each specimen. Pig serum containing 6.6 % protein, determined by Kjeldahl's micro-method, was used as standard.

## RESULTS

### *Macroscopical changes*

The most conspicuous patho-anatomical changes were found in the small intestine. The macroscopic picture varied from that of a predominantly haemorrhagic enteritis to that of extensive necrosis without appreciable haemorrhage. On the basis of the differences observed in the jejunal changes, the material was

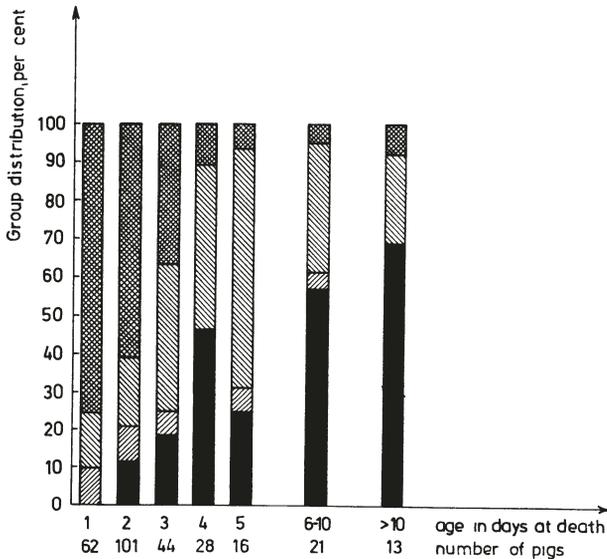


Figure 1. Percentage distribution of cases among groups and according to age.

divided into 3 groups, each representing a characteristic post-mortem picture. The frequency with which each of these groups is represented in the material is illustrated in Fig. 1, which shows the distribution of cases among the groups in relation to the age of the pigs at time of death.

### *Changes in the jejunum*

#### *Group I. Haemorrhagic necrotizing enteritis*

This postmortem picture was seen in 146 out of 339 piglets (43.1 %). Fig. 2 shows the relationship between mortality rate

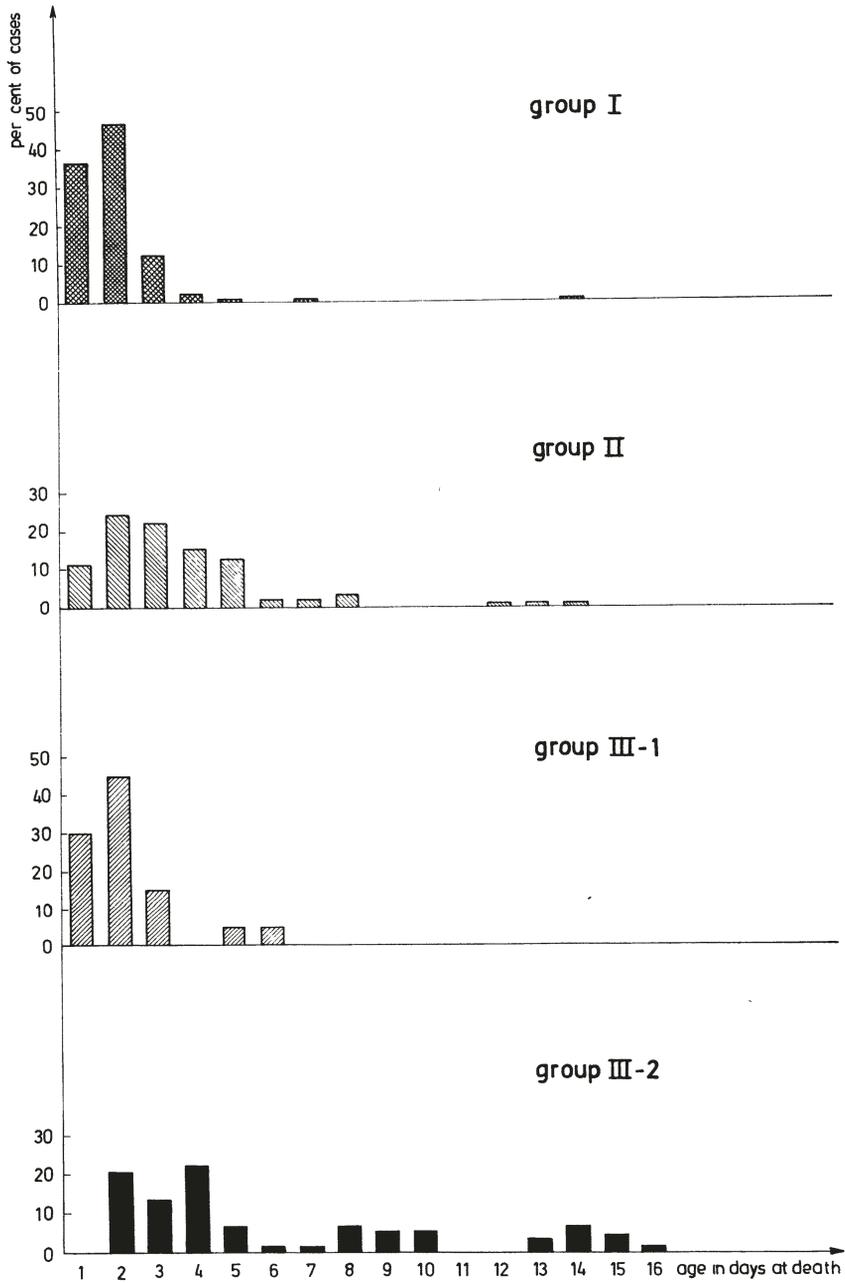


Figure 2. Percentage distribution of cases according to age within each group. Group I: 130 pigs; Group II: 77 pigs; Group III-1: 20 pigs; Group III-2: 58 pigs.

and age of pigs within each group. It will be seen that the majority of pigs with haemorrhagic necrotizing enteritis had died during the first 3 days after birth.

In all cases the changes in the jejunum were dominated by a haemorrhagic necrotizing inflammation. Viewed from the serous surface, the affected parts were diffusely red to blackish-red in colour as the result of profuse, often confluent bleedings in the intestinal wall (Fig. 3). In most cases also a pronounced lymph stasis was seen under the serous surface of the inflamed intestine. In about half the cases fine fibrinous threads were seen on the serosa of the bowel, and often there was a yellowish subserous web of fibrin in which small gas bubbles could sometimes be seen. Such subserous emphysema was observed in 25 % of the cases. The intestinal wall was slightly thickened, oedematous, friable, and unelastic. Generally the mucosa was transformed into a thin, blood-imbibed, lustreless, necrotic membrane (Fig. 11). In some cases the mucosa was swollen and heavily congested. The content of the affected part of the jejunum consisted of haemolysed blood with an admixture of fibrinous threads and casein clots.

The localization and extent of the changes varied. In 30 pigs the distance from the pylorus to the beginning of the changes and the length of the affected part of the small intestine were measured (Table 1). Except in cases with haemorrhagic necrotizing duodenitis, the changes generally began abruptly at a distance of 20 to 150 cm (average 50 cm) from the pylorus. The length of the affected stretch varied from 5 to 310 cm (average 165 cm). Orally and aborally to the inflamed stretch the jejunum was found to be atonic, its wall of normal thickness, and its mucous membrane without macroscopical changes.

#### Group II. *Necrotizing enteritis with haemorrhages in the anterior part of the small intestine*

This patho-anatomical picture was observed in 95 piglets, i. e. 28 % of all the pigs examined. It will be seen from Fig. 2 that the majority of these pigs had died during the first 5 days after birth.

The anterior part of the jejunum was the seat of necrotizing enteritis with haemorrhage in the intestinal wall. In continuation of that section there was necrotizing enteritis without haemorrhages. As a rule there was a sharp delimitation between these

Table 1. Length of affected part of the small intestine and its position in relation to the pylorus.

Group	No. of pigs		Distance from pylorus to commencement of changes (length in cm)	Stretch with necrosis of mucosa with haemorrhage in wall (length in cm)	Stretch with necrosis of mucosa without haemorrhage in wall (length in cm)
I	30	max.	150	310	0
		med.	50	165	0
		min.	20	5	0
II	23	max.	160	180	235
		med.	55	80	115
		min.	15	35	25
III-1	5	max.	90	0	280
		med.	(50)	0	(175)
		min.	20	0	70
III-2	14	max.	280	0	320
		med.	90	0	210
		min.	15	0	135

2 sections. Likewise, the beginning of the haemorrhagic section and the end of the necrotic section were sharply delimited from apparently normal parts of the small intestine.

The haemorrhages in the anterior part of the jejunum varied from petechiae (Fig. 4) via ecchymoses and suggillations to diffuse subserous haemorrhages (Fig. 5). In rare cases, haemorrhages were found in the whole length of the necrotic part (Fig. 6). The wall of the haemorrhagic part of the small intestine was greatly thickened and the mucosa transformed into a yellow or greyish, necrotic membrane of varying thickness; usually no haemorrhages were seen in the necrotic membrane (Fig. 12). In a very few cases the anterior haemorrhagic section was of a similar appearance as described under Group I. Emphysema in the wall of the small intestine occurred more frequently (44.2 %) and was more pronounced in Group II pigs than in Group I pigs (Figs. 4 and 6).

Viewed from the serous surface, the necrotic part of the small intestine appeared with a diffuse greyish colour (Fig. 5) or with a peculiar longitudinal striation (Fig. 4). In a few cases the streaks went circularly. The wall of this part of the intestine

was well-contracted, greatly thickened and friable. The mucous membrane was very thick, dry and wrinkled (Fig. 13). While the anterior, haemorrhagic part usually contained a considerable amount of viscous, greyish, yellowish or slightly bloodspecked mass, there was only a small quantity of dry content in the posterior necrotic part.

The extent of the lesions and their localization in relation to the pylorus, as recorded in 23 cases, can be seen from Table 1. Except for the cases with duodenitis, the haemorrhagic changes commenced at a distance of 15 to 160 cm (average 55 cm) from the pylorus. The stretch with haemorrhages varied in length from 40 to 180 cm (average 80 cm) and the necrotic stretch from 25 to 235 cm (average 115 cm).

### Group III. *Necrotizing enteritis*

Necrotizing enteritis without haemorrhages was found in 98 pigs, i.e. 28.9 % of the cases examined.

In this group distinction was made between a slight degree of necrotizing enteritis (Group III-1), which was found in 22 pigs, and severe necrotizing enteritis (Group III-2), which was found in 76 pigs.

Fig. 2 shows that pigs with a slight degree of necrotizing enteritis usually died during the first 3 days after birth. As regards animals with severe necrotizing enteritis, the highest daily mortality occurred from the second to the fourth day after birth. It will be seen, however, that 40—50 % of the pigs were 5 days old or more at death.

Group III-1. In cases with a slight degree of necrotizing enteritis, the jejunum was atonic. Viewed from the serous surface, the affected part had a greyish, yellowish, curry-like or a dirty reddish colour. In the intestinal wall which was normal in thickness or slightly thickened, the small blood vessels were heavily engorged. (Fig. 7).

In all cases, the mucous membrane had been transformed into a thin, necrotic membrane which was firmly attached to the underlying tissue (Fig. 14).

The extent of the lesions and their localization in relation to the pylorus were measured in 5 pigs (Table 1). The distance from the pylorus to the commencement of the lesions varies from 20 to 90 cm and the length of the affected stretch from 70 to 280 cm.

PLANCHE I



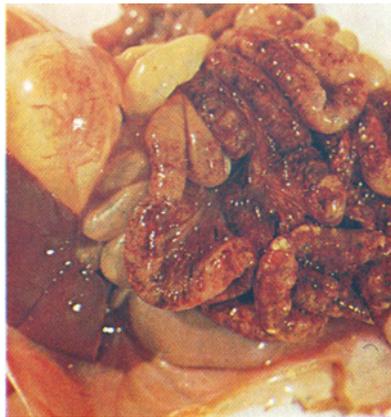
*Fig. 3.*



*Fig. 4.*



*Fig. 5.*



*Fig. 6.*

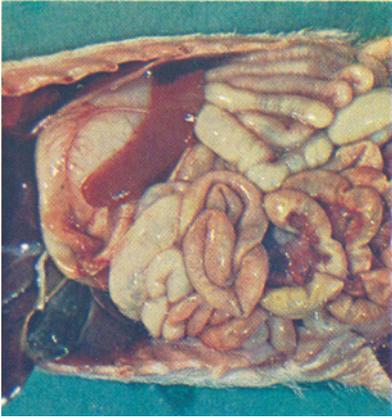
**Figure 3.** Haemorrhagic necrotizing enteritis. Severe confluent haemorrhages in the intestinal wall (Group I). Case no. 145-1/1967. Age: 2 days. (V. Chr. photo).

**Figure 4.** Necrotizing enteritis with petechial and ecchymotic haemorrhages and emphysema in the anterior part of the jejunum. In continuation hereof a greyish, necrotic section with longitudinal striation (Group II). Case no. 87/1968. Age: 2 days. (V. Chr. photo).

**Figure 5.** Necrotizing enteritis with suggilations and diffuse haemorrhage in the wall of the anterior part of jejunum, followed by a greyish, necrotic part without haemorrhage. Note the distended but apparently normal duodenum and the haemorrhage in the wall of the stomach (Group II). Case no. 22/1968. Age: 3 days. (V. Chr. photo).

**Figure 6.** Necrotizing enteritis with petechiae, suggilations and emphysema in the whole length of the necrotic part. The duodenum is distended but apparently normal (Group II). Case no. 221/1967. Age: 3 days. (B. N. photo).

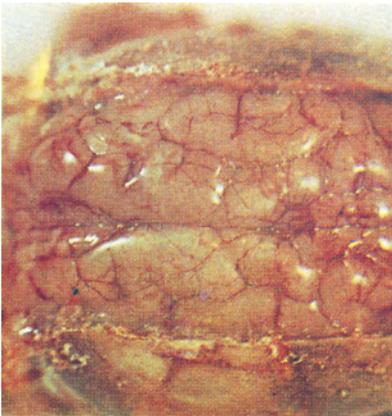
## PLANCHE II



*Fig. 7.*



*Fig. 8.*



*Fig. 9.*



*Fig. 10.*

**Figure 7.** Necrotizing enteritis without haemorrhages. The necrotic part of jejunum is curry-like in colour. Note the engorged mesenteric vessels and the whitish, apparently normal duodenum (Group III-1). Case no. 106/1968. Age: 3 days. (V. Chr. photo).

**Figure 8.** Severe necrotizing enteritis without haemorrhages. Note the engorged mesenteric vessels and the enlarged lymph nodes (Group III-2). Case no. 145-7/1967. Age: 10 days. (V. Chr. photo).

**Figure 9.** Hyperaemia and petechiae in the cerebral meninges. Case no. P 65/1967. Age: 3 days. (V. Chr. photo).

**Figure 10.** Spinal cord with surrounding yellowish-red mucoid mass. Case no. P 65/1967. Age: 3 days. (V. Chr. photo).

PLANCHE III



*Fig. 11.*



*Fig. 12.*



*Fig. 13.*



*Fig. 14.*



Figure 11. Jejunum with blood-imbibed, necrotic mucous membrane (Group I). Case no. 145-1/1968. Age: 1 day. (V. Chr. photo).

Figure 12. Necrotic mucous membrane of the anterior haemorrhagic part of the jejunum (Group II). Case no. 127-1/1968. Age: 2 days. (V. Chr. photo).

Figure 13. Necrotic mucous membrane of the posterior, purely necrotic part of the jejunum. Note its wrinkled appearance (Group II). Case no. 55-7/1968. Age: 5 days. (V. Chr. photo).

Figure 14. Necrotic mucous membrane of jejunum (Group III-1). Case no. 210/1968. Age: 2 days. (V. Chr. photo).

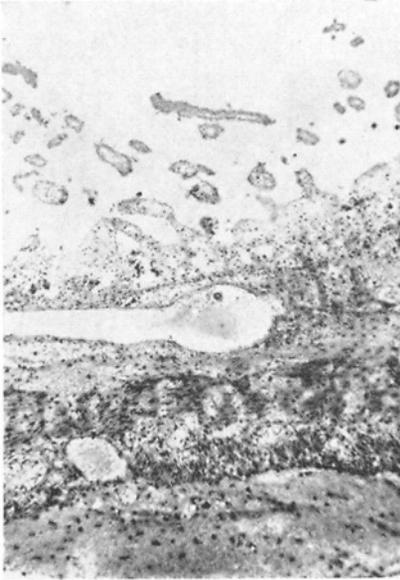
**Figure 15.** Jejunum. Denuded necrotic villi in the lumen. Heavy engorgement of blood vessels and profuse haemorrhages in all layers of the intestinal wall. Case no. 145-1/1967. Age: 2 days. Haem.-Eos. 60:1. (A. M. photo).

**Figure 16.** Jejunum. Necrotic mucous membrane demarcated by a distinct cellular infiltration. Heavy engorgement of blood vessels and oedema and haemorrhage in the submucosa. Increased cell content in the submucosa. Case no. 146-1/1967. Age: 2 days. Haem.-Eos. 60:1. (A. M. photo).

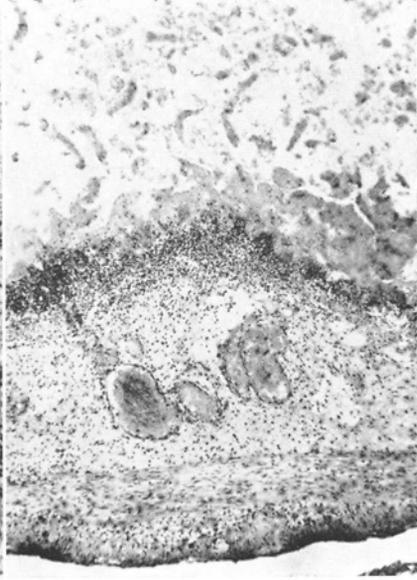
**Figure 17.** Jejunum. Superficial necrosis of the mucous membrane. The contours of the crypts of Lieberkühn are visible. No distinct demarcation zone. Case no. P 65/1967. Age: 3 days. Haem.-Eos. 60:1. (A. M. photo).

**Figure 18.** Jejunum. In the propria a distinct demarcation zone is seen, under which the crypts of Lieberkühn are still visible in some areas. In the submucosa there appears to be an increased cell content. Case no. 118/1965. Age: 10 days. Haem.-Eos. 60:1. (A. M. photo).

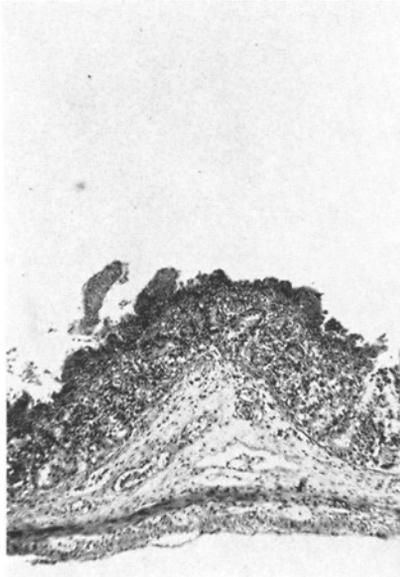
PLANCHE IV



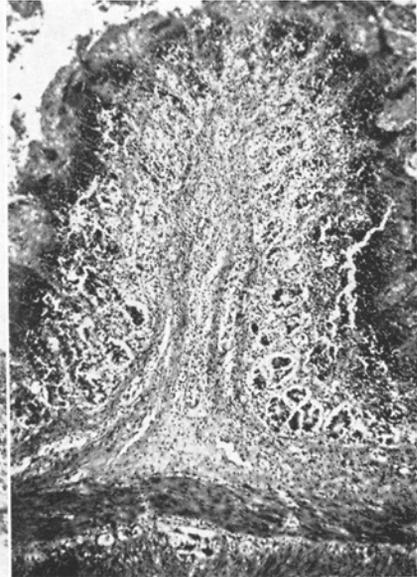
*Fig. 15.*



*Fig. 16.*



*Fig. 17.*

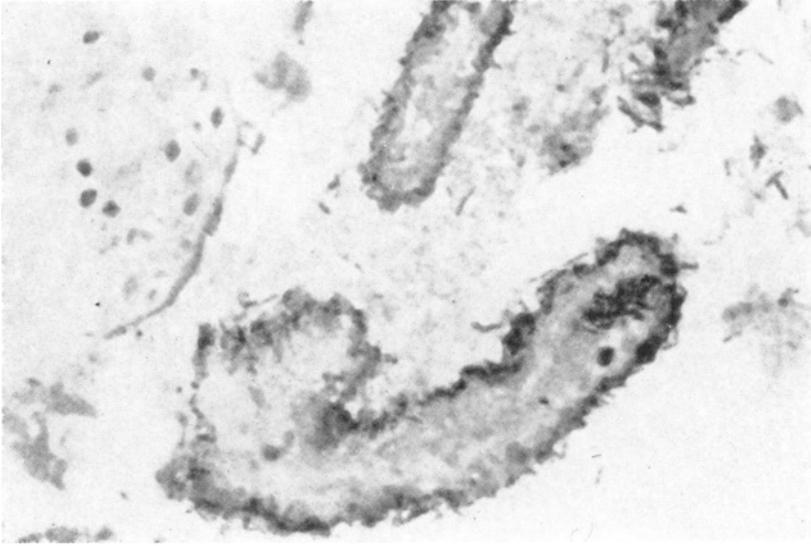


*Fig. 18.*

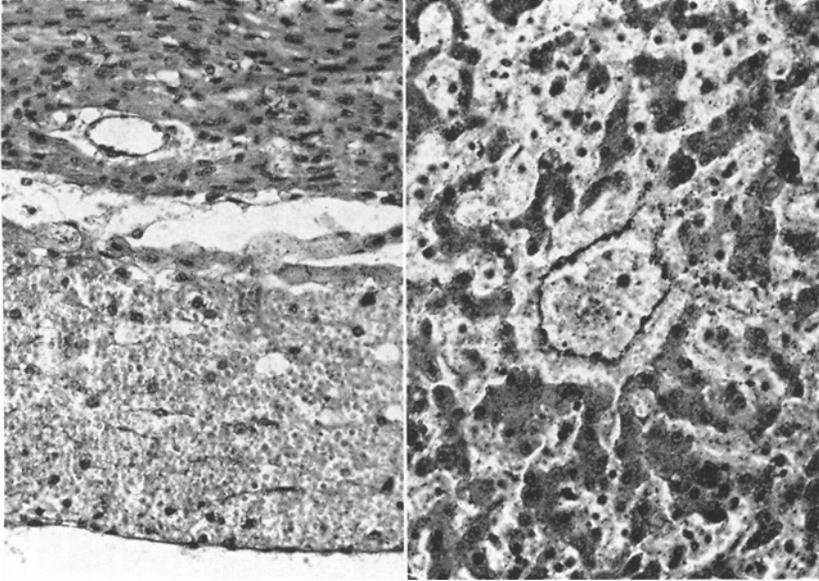
Figure 19. Sloughed-off necrotic villi surrounded by a rim of Gram-positive rods. Case no. 14/1965. Gram-stained 100:1 (J.M. photo).

Figure 20. Haemorrhages in the superficial layers of the myocardium. Case no. 145-2/1967. Haem.-Eos. 250:1. (A. M. photo).

Figure 21. Liver. Severe stasis with haemorrhage into the spaces of Disse and slight cyanotic atrophy. Case no. P 68/1967. Age: 3 days. Haem.-Eos. 250:1. (A. M. photo).



*Fig. 19.*



*Fig. 20.*

*Fig. 21.*



Group III-2. In cases with severe necrotizing enteritis the changes in the jejunum largely resembled those found in the posterior necrotic section of the bowel of the pigs with post-mortem findings corresponding to Group II (Fig. 8).

In 32.6 % of the cases the jejunum was atonic and distended, and its colour, viewed from the serous surface, was a diffuse greyish yellow. In 44.2 % the affected part of the jejunum was well-contracted and longitudinally striated. In the remaining cases the anterior part of the jejunum was distended and congested, and often diffusely reddish in colour, while the posterior part presented the picture associated with longitudinal striation. In all cases the intestinal wall was strongly thickened, inelastic and friable. The mucous membrane was necrotic and dry, and in sections with longitudinal striation also very wrinkled (cf. Fig. 13). In about 8 % of the pigs there was an extensive emphysema in the wall of jejunum.

The content of the jejunum varied from a copious, greyish or yellowish mass in the atonic and distended part of the bowel, to a very sparse and dry mass in the well-contracted, longitudinally striated part. In a few cases the jejunum had a greyish-black, foul content.

From Table 1 it will be seen that in 14 pigs the distance from the pylorus to the commencement of the changes varied from 15 to 280 cm (average 90 cm) and the length of the necrotic section of the bowel from 135 to 320 cm (average 210 cm).

*Changes in other parts of the gastrointestinal canal, and in the mesentery and mesenteric lymph nodes (Table 2)*

*Stomach.* Generally the stomach was filled or even distended with normal, well-coagulated milk. In 31 pigs (16.1 %) the stomach was empty or nearly empty. About half of these cases were in Group III-2.

Catarrhal gastritis with hyperaemia of the mucous membrane was found in some pigs. Only in one case were areas of necrosis found in the mucosa. Haemorrhagic gastritis with petechial or diffuse haemorrhages in the wall of the stomach, occasionally with oedema and emphysema, was seen in 22 pigs (11.4 %). As a rule the haemorrhagic gastritis had caused a black discoloration of the surface of the coagulated milk. More rarely the contents of the stomach were thin, brownish and poorly coagulated. With

a few exceptions, gastritis was seen only in pigs of Groups I and II.

*Duodenum.* Generally the postmortem examination revealed no abnormalities in the duodenum, but in some cases there was a large accumulation of a thin yellowish or greyish content in this part of the small intestine, which would then be distended and congested, and, when viewed from the serous surface, often show a curry-like or dirty reddish discoloration. In a few instances the duodenum was distended with gas and without solid content. Haemorrhagic necrotizing duodenitis was found in 12 pigs (6.2 %) and necrotizing duodenitis without haemorrhages in 4 animals (2.1 %). The haemorrhagic duodenitis was seen only in pigs of Groups I and II.

*Ileum.* In the majority of cases the ileum was without demonstrable changes. Ileitis was found in 39 pigs (20.2 %). With the exception of the few cases designated alternating enteritis, the ileitis found was a continuation of the changes in the posterior part of the jejunum. In 15 pigs the ileitis was accompanied by typhlitis and colitis, and in 7 cases by either typhlitis or colitis. In the remaining 17 cases the changes ended at the ileo-coecal valve. The frequency with which ileitis occurred varied from 13.8 % in Group I and 19.0 % in Group II to 37.2 % in Group III-2.

*Coecum and colon.* Typhlitis, accompanied in 11 cases by emphysema, and in 3 cases by severe oedema in the wall of the coecum, was demonstrated in 50 pigs (25.9 %). Colitis, also accompanied in some cases by emphysema and oedema, occurred in 49 pigs.

It will be seen from Table 2 that typhlitis and colitis were found much more frequently among the pigs in Groups I and II than among the Group III animals. Typhlitis and colitis occurred together in 35 pigs and separately in 15 and 14 cases, respectively.

Typhlitis and colitis occurring in Group I pigs were mostly of the type with both necrosis and haemorrhages. Only in 2 such pigs was a purely necrotizing typhlitis and colitis observed. On the other hand, apart from a single case of haemorrhagic necrotizing typhlitis in a Group II pig, lesions of the coecum and colon in pigs of Groups II and III were of the necrotic type. In addition, subserous petechiae in the coecum and colon walls were seen in a number of cases. Subserous petechiae without necrosis of the mucous membrane were observed in the large intestine in a few cases.

Table 2. Patho-anatomical changes in gastrointestinal canal, mesentery and mesenteric lymph nodes.

Group		I	II	III-1	III-2	Total	%
No. of pigs examined		80	58	12	43	193	100
Organ	Change						
<b>Stomach</b>							
	Distended with food	75	49	9	29	162	83.9
	Empty or nearly empty	5	9	3	14	31	16.1
	Discoloured contents	7	11	0	4	22	11.4
	Thin contents	5	11	0	3	19	9.8
	Catarrhal gastritis	3	2	0	1	6	3.1
	Haemorrhagic gastritis	13	7	1	1	22	11.4
	Necrotizing gastritis	0	1	0	0	1	0.5
	Engorgement of blood vessels in wall	7	3	1	1	12	6.2
	Oedema in wall	3	1	0	0	4	2.1
	Emphysema in wall	2	2	0	0	4	2.1
<b>Duodenum</b>							
	Distended with food	24	19	0	10	53	27.5
	Distended with air	0	6	2	3	11	5.7
	Haemorrhagic necrotizing duodenitis	7	5	0	0	12	6.2
	Necrotizing duodenitis without haemorrhage	2	0	0	2	4	2.1
	Engorgement of blood vessels in wall	23	6	2	7	38	19.7
	Emphysema in wall	0	1	0	0	1	0.5
<b>Ileum</b>							
	Haemorrhagic necrotizing ileitis	11	0	0	0	11	5.7
	Necrotizing ileitis	0	11	1	16	28	14.7
	Emphysema in wall	2	0	0	0	2	1.0
<b>Coecum</b>							
	Haemorrhagic necrotizing typhlitis	23	4	0	0	27	14.0
	Necrotizing typhlitis	3	12	0	8	23	11.9
	Subserous petechiae	2	2	0	0	4	2.1
	Oedema in wall	3	0	0	0	3	1.6
	Emphysema in wall	9	2	0	0	11	5.7
<b>Colon</b>							
	Haemorrhagic necrotizing colitis	18	0	0	0	18	9.3
	Necrotizing colitis	2	21	1	7	31	16.1
	Subserous petechiae	3	4	0	0	7	3.6
	Oedema in wall	3	0	0	0	3	1.6
	Emphysema in wall	5	4	0	0	9	4.7
<b>Mesentery</b>							
	Stasis in mesenteric vessels	74	56	10	38	178	92.2
	Oedema	37	22	0	12	71	36.8
	Emphysema	21	24	0	1	46	23.8
	Subserous petechiae	0	4	0	0	4	2.1
	Oedema in mesocolon	11	3	0	0	14	7.3
<b>Mesenteric lymph nodes</b>							
	Swollen and oedematous	59	47	6	33	145	75.1
	Hyperaemia	30	23	5	19	77	39.9
	Haemorrhage	32	20	0	3	55	28.5
	Emphysema	14	14	0	2	30	15.5

*Mesentery and mesenteric lymph nodes.* Stasis in the mesenteric vessels was seen in 178 pigs, and about one-third of these (178) also had oedema in the mesentery. In 46 animals (23.8 %) the stasis was accompanied by emphysema, and in 4 cases petechiae were seen in the mesentery. The pigs with emphysema in the mesentery also had emphysema in the wall of the small intestine. In addition to changes in the colon already mentioned, 14 pigs had a slightly haemorrhagic oedema between the coils of the colon spiral.

The mesenteric lymph nodes draining the diseased part of the small intestine were often slightly enlarged and oedematous. In 77 cases there was a diffuse hyperaemia, and in 55 cases haemorrhages were seen in the marginal sinuses. In 30 pigs the emphysema in the mesentery continued up into the mesenteric lymph nodes. The mesenteric lymph nodes draining the apparently unaffected part of the bowel generally showed no demonstrable macroscopical changes. It will be seen from Table 2 that the haemorrhagic and emphysematous changes in the mesentery and mesenteric lymph nodes were found most frequently in pigs of Groups I and II.

#### *Alternating necrotizing enteritis*

Sometimes the pathological picture in necrotizing enteritis deviated from the description given above. In some cases the lesions did not occur continuously through the whole length of the affected part of the small intestine, but stretches with lesions would alternate with apparently normal stretches. In other cases lesions of different types occurred alternately. Such alternating enteritis was found in 12 pigs. The lesions, which included haemorrhage, necrosis and emphysema, varied in extent and localization from animal to animal, as will be seen from the following 4 examples.

*Example 1.* The first 25 cm of the small intestine appeared normal. Then followed a stretch of 50 cm with necrosis of the mucous membrane and thickening of the wall, in which there was diffuse haemorrhage and emphysema. Through the next 225 cm, unchanged stretches alternated with haemorrhagic, emphysematous and necrotic stretches varying in length from 2 to 10 cm. The last 65 cm of the small intestine showed no appreciable changes.

*Example 2.* The duodenum was slightly congested. In the

anterior half of the jejunum there was heavy engorgement of the small blood vessels, and the mucous membrane was hyperaemic. In the posterior part of the jejunum and in the ileum, opposite the attachment of the mesentery, there were, in the Peyer patches, areas about  $\frac{1}{2}$  cm in breadth and 3 cm in length with necrosis and haemorrhage.

*Example 3.* The anterior part of the small intestine was without demonstrable changes for a length of 60 cm. Then followed a stretch of 72 cm with necrosis of the mucous membrane and petechial haemorrhages and emphysema in the wall. Through the next 35 cm, sections with diffuse necrosis without haemorrhage alternated with areas with petechial haemorrhages and emphysema. These sections varied in length from 5 to 10 cm. The changes ended in the posterior part of the small intestine with a 130 cm long section with necrotic changes without haemorrhage, which continued back to the ileocaecal valve.

*Example 4.* The changes commenced at a distance of 135 cm from the pylorus with a 30 cm long stretch where 1—2 cm long sections with necrosis alternated with apparently normal sections of 1—5 cm. After that there was a 34 cm long stretch of apparently normal intestine, which interrupted by a 1 cm long necrotic section, continued for a further 85 cm. In the following 75 cm there were alternately necrotic sections (1—12 cm long) and apparently normal sections (1—15 cm long). Then came 50 cm of apparently normal intestine, followed by a 6 cm long necrotic section which ended at the ileocaecal valve.

#### *Changes in other organs (Table 3)*

*Serous cavities.* In the pleural cavity of 89 pigs there were varying amounts (1—20 ml) of fluid, which, in the majority of cases, was sero-haemorrhagic and slightly turbid, in other cases purely serous and straw-coloured, and in a few cases sero-fibrinous. The pleura had a normal appearance in all instances, except for a few pigs which had subserous petechiae on the thoracic surface of the diaphragm.

There was exudation to the peritoneal cavity in 76 cases. In 62 cases the exudate was rather haemorrhagic, and in a few cases it was turbid, yellowish and flocculent. The amount of fluid in the peritoneal cavity varied from about 1 ml to about 10 ml. Besides the fine fibrinous deposits found on the serous surface of haemorrhagic sections of the small intestine, there

Table 3. Patho-anatomical changes in other organs.

		Group	I	II	III-1	III-2	Total	%
No. of pigs examined			80	58	12	43	193	100
Organ	Change							
Pleural cavity								
	Exudation		63	21	2	3	89	46.1
	Subserous petechiae		1	3	0	0	4	2.1
Peritoneal cavity								
	Exudation		44	24	1	7	76	39.4
	Fibrinous peritonitis		41	21	1	4	67	34.7
	Fibrinous adhesions		1	7	0	2	10	5.2
	Subserous petechiae		0	3	0	0	3	1.6
	Subserous oedema		2	0	0	0	2	1.0
Pericardium								
	Slight exudation		48	21	4	5	78	40.4
Lungs								
	Alveolar emphysema		37	37	3	28	105	54.4
	Congestion		11	19	3	2	35	18.1
	Subserous petechiae		1	0	0	1	2	1.0
	Catarrhal pneumonia		1	1	0	0	2	1.0
Heart								
	Dilated		14	14	1	13	42	21.8
	Subendocardial petechiae		46	32	3	18	99	51.3
	Subendocardial and subepicardial petechiae		22	6	2	3	33	17.1
	Subepicardial petechiae		0	1	0	0	1	0.5
Liver								
	Congested		18	36	4	23	81	42.0
	Degenerated		28	6	2	5	41	21.3
Spleen								
	Swollen		6	6	0	5	17	8.8
	Subcapsular petechiae		1	2	0	1	4	2.1
Kidneys								
	Slightly swollen		56	31	6	22	115	59.6
	Subcapsular petechiae		47	47	7	26	127	65.8
	Hyperaemic papillae		12	15	5	12	44	22.8
	Amorphous orange-coloured sediment		13	27	5	14	59	30.6
Bladder								
	Well-contracted		73	41	11	9	134	69.5
	Submucous haemorrhage		2	1	0	1	4	2.1
	Haematuria		0	1	1	0	2	1.0
Skin and subcutis								
	Subcutaneous oedema		26	9	1	4	40	20.7
Muscles								
	Pale and moist		51	49	6	29	135	69.9
	Haemorrhage		4	2	1	0	7	3.6
Central nervous system								
	Static hyperaemia in leptomeninges		49/72*)	24/49	5/9	16/35	94/165	57.0
	Haemorrhage in leptomeninges		3/72	2/49	0/9	0/35	5/165	3.0
	Gelatinous exudation around spinal cord		7/10	10/10	0/0	4/4	21/24	87.5

\*) Change demonstrated in 49 out of 72 pigs examined.

was in 67 pigs a severe diffuse fibrinous peritonitis, which in a few cases had led to adhesions between the coils of the intestine.

The pericardium of 78 pigs contained a small amount of clear, serous or sero-haemorrhagic fluid.

The protein content of the peritoneal and pleural fluids is shown in Table 4. It will be seen that in pigs of Group I the amount of protein varied from 3.2 to 6.3 % in the peritoneal fluid, and from 2.3 to 4.2 % in the pleural fluid. It will also be

Table 4. Amount of protein in peritoneal and pleural fluids.

	Group I		Group II	
	Peritoneal cavity	Pleural cavity	Peritoneal cavity	Pleural cavity
No. of specimens examined	28	31	11	9
Protein % max.	6.3	4.2	5.1	4.5
mean	4.4	3.3	3.6	3.3
min.	3.2	2.3	2.3	2.4
No. of specimens with < 2.5 %	0	2	1	1

seen that the average content of protein was considerably higher in peritoneal than in pleural fluid. In pigs of Group II, the average protein content was about the same in fluids from the 2 cavities, viz. 3.6 and 3.3 %, respectively. A protein content of less than 2.5 % was found in 4 cases only. The protein content in peritoneal fluids of 3 pigs of Group III varied from 3.0 to 5.3 %.

Generally only a small amount of sediment was found in pleural fluid after centrifugation. Microscopy revealed Gram-positive rods in a number of smears. There were very few cells, mainly red blood cells, pleural epithelial cells, and a small number of white blood cells.

There was often a quite voluminous sediment in fluid from the peritoneal cavity. On microscopy of this Gram-positive rods were found in rather great numbers in the majority of the smears. As a rule there was a very great number of cells, including peritoneal cells, red blood cells and a few white blood cells.

Both in pleural and peritoneal fluids, epithelial cells and red blood cells predominated, while there were only small numbers of white cells. Owing to quite extensive degenerative changes,

the white cells were difficult to differentiate. Granulocytes were seen in a few instances with both lobate and band-shaped nuclei, but also more primitive myeloid cell forms were observed.

*Heart.* The myocardium, which was generally well contracted and of normal texture, was in about half the cases slightly lighter in colour than normal. Subendocardial haemorrhages were seen in 99 pigs, and both subendocardial and subepicardial haemorrhages in 33 animals.

*Lungs.* In the majority of cases the lungs were poorly collapsed as the result of alveolar emphysema and in some cases the lungs were heavily congested. Petechial haemorrhages and catarrhal pneumonia were seen in rare cases.

*Liver.* In about 40 % of the cases the liver was dark and congested and very moist on the cut surface. This finding was about twice as common in Group II and III-2 pigs as in the other groups. In about 20 % the liver was of a light, clayey colour and very friable. In the rest of the cases no macroscopical changes were seen in the liver.

*Spleen.* The spleen was generally normal. In a few cases it was slightly swollen and in 4 pigs it showed subcapsular haemorrhages.

*Kidneys.* In about half the cases the kidneys were slightly enlarged and moist on the cut surface. Subcapsular, pin-point haemorrhages were seen in the kidneys in 127 cases, and in 44 cases a pronounced papillary hyperaemia was also seen. In 59 pigs there was a soft, amorphous, orange to salmon-coloured deposit in the renal pelvis. Such deposits were often seen in the bladder too.

*Bladder.* The bladder was generally well contracted and empty or nearly empty, while in other cases it was more or less distended. It will be seen from Table 3 that this latter condition was found most commonly in pigs of Groups II and III-2. Submucous, streaky haemorrhages and haematuria were found in but a few cases.

*Skin, subcutis and muscles.* There were generally no demonstrable changes in the skin, apart from cyanosis of the ventral parts of the head, neck and chest in some cases.

Particularly in pigs of Group I, serous or sero-haemorrhagic oedema of the subcutis was seen on the abdomen, especially in the navel region, but sometimes also in the scrotum or in the vulva.

In the majority of cases the musculature was pale, very moist, and atonic. The blood vessels were engorged, and in a few instances there were haemorrhages in the muscular tissue.

*Brain and spinal cord.* Passive hyperaemia of the cerebral leptomeninges was demonstrated in almost 60 % of the pigs, and in 5 cases haemorrhages were also seen (Fig. 9). The brain tissue was moist, but otherwise without demonstrable changes.

The spinal canal was opened in 24 cases. In most of these there was passive hyperaemia of the meninges, and around the cervical and anterior thoracic part of the spinal cord a yellowish-red, mucoid or gelatinous mass was found in the subdural space (Fig. 10). The cord itself was without macroscopical changes.

#### *Microscopical changes*

Due to the time required for shipment, the pigs had been dead for 1 or 2 days before postmortem examination was performed. The microscopical examination was therefore limited to a few (23) apparently fresh carcasses. The description of the histo-pathological changes should not be taken as final, partly because the material was not sufficiently fresh despite selection, and also because the staining technique used did not permit a complete description of the changes in the central nervous system.

#### *Haemorrhagic parts of the small intestine*

*Group I.* In the lumen of the small intestine extravasated blood and sloughed-off necrotic villi were seen. The latter were surrounded by a rim of Gram-positive rods (Fig. 19). The epithelium was missing and the outer layer of the propria was slightly eosinophilic. In this necrotic and oedematous layer there were pyknotic cell nuclei and several "nests" of Gram-positive rods. Furthermore, threads of fibrin infiltrated the mucosa and muscularis mucosae, and part of the submucosa. The submucosa was thickened, oedematous, and occasionally also emphysematous. In all layers there was heavy engorgement of both large and small blood vessels. There were also profuse haemorrhages, which were in some cases so violent that the tissue structure was obscured in certain areas (Fig. 15). Apart from the severe haemorrhages in the intestinal wall there was no distinct cell

infiltrations, and thus no demarcation of the necrotic masses. In many of the capillaries there were pyknotic endothelial cell nuclei and fibrinous thrombi which filled the vessels completely. In other blood vessels the intima was lined with fibrin, while apparently normal blood was found in the centre of the lumen. Except for the intima, the structure of the vascular wall was often indistinct.

*Group II.* In a few cases the microscopical picture resembled that described for Group I, but in the majority of instances the internal surface of the small intestine was covered by a homogeneous, eosinophilic necrotic membrane of varying thickness (Fig. 16). In the depth of this membrane the outlines of the Lieberkühn's crypts could often be seen. Adjacent to the necrotic membrane, i. e., deep in the propria or superficially in the submucosa, a distinct, demarcating cellular infiltration could be seen, which consisted mainly of granulocytes. Furthermore, there was a diffuse increase in the cell content of the submucosa. Heavy congestion and haemorrhage were seen in the submucosa, muscularis and subserosa. In the remnants of the mucosa there was hyperaemia, but no haemorrhage. There were pyknotic endothelial cell nuclei and fibrinous thrombi in some of the capillaries and lesser blood vessels. In several arteries a homogeneous, strongly folded internal elastic tunic was found, which was clearly distinguishable from the rest of the vascular wall, the delimitation of which against the surrounding tissue was blurred.

*Small intestine with necrosis, but without haemorrhage*

As in the haemorrhagic parts, a number of sloughed-off necrotic villi were found in the lumen of the intestine, surrounded by a rim of Gram-positive rods. Usually the necrotic mucous membrane, which was often quite thick, was demarcated from the deeper layers by a wall of leukocytes (Fig. 18). In rare instances, when the necrosis was quite superficial, the demarcation zone might be missing (Fig. 17). In the submucosa, which was often thickened, a diffuse infiltration of mononuclear cells could generally be observed. There were no haemorrhages and only a moderate congestion. Similar changes in the blood vessels were found in haemorrhagic parts of the intestine (Group II).

*Small intestine without macroscopical changes*

In parts without macroscopical changes the mucous membrane of the intestine was usually intact. Though, the villi were often denuded at the top and occasionally strongly hyperaemic. In a few cases the mucous membrane was thin and necrotic, and in other cases the epithelium and the outer layer of the propria had sloughed off. In the submucosa, which was of normal thickness, the blood vessels were engorged, but there were no haemorrhages. Cellular infiltrations occurred but seldom.

*Mesenteric lymph nodes*

Microscopical findings varied from apparently normal conditions to acute lymphadenitis with oedema, accumulation of red blood cells in the marginal sinuses, focal haemorrhages, and pronounced "washing-off" of the lymphoid cells, whereby the reticular tissue was laid bare. Occasionally also emphysema was seen.

*Other organs*

*Heart.* Apart from quite severe streaky haemorrhages in the subendo- and subepicardial layers of the myocardium (Fig. 20) there were no definite microscopical changes.

*Lungs.* The most frequent microscopical finding was distended alveoli with thin septa and a tendency towards the development of "Spanish walls". In a number of cases capillaries and small blood vessels were engorged, and in a few instances there was oedema in the interstitial connective tissue. No haemorrhages were observed.

*Liver.* No definite changes were found in peracute or acute cases (Group I), except for engorgement of the central veins. In the more protracted cases, stasis was a characteristic feature, and in some of the subacute cases (Group III-2) it was very violent. In these cases there was also haemorrhage to the spaces of Disse and a slight diminution of the liver cell cords near the central veins (slight cyanotic atrophy) (Fig. 21).

*Spleen.* In the majority of cases, the spleen showed no definite microscopical changes. However, the content of cells seemed to be somewhat less than normal. In a few instances there was passive hyperaemia peripherally in the reticular tissue. Haemorrhages or haemorrhagic infarcts were not observed.

*Kidneys.* Haemorrhages were found in the renal cortex, most often in the form of small subcapsular foci, but rather extensive infiltrations were also seen. In some cases there were also a few blood cylinders in the convoluted tubules, whereas haemorrhage to the cavity of the capsule of Bowman was observed in one case only. There were generally no haemorrhages in the medulla, but, particularly in the inner zone, near the papillae, there was a heavy congestion. Pyknotic nuclei were often seen in several of the cells of the tubular epithelium. Sometimes the nuclei were missing and the cytoplasm was detached from the basal membrane. There was often oedema in the interstitial tissue.

*Skeletal musculature.* Apart from oedema in the intermuscular connective tissue, no definite microscopical changes were found in skeletal muscles.

*Brain and spinal cord.* Microscopy of the brain and spinal cord revealed clear differences between the changes in pigs of respectively Group I and Groups II and III-2. In Group I animals lesions were largely limited to a congestion and perivascular oedema. In Group II and III-2 pigs there were, besides degenerative lesions of the vascular walls (pyknotic endothelial nuclei) hyperleukocytosis, and oedema of the nervous tissue itself. Furthermore, varying degrees of glia cell mobilization and ganglion cell degeneration were seen. The most pronounced changes were found in the basal parts of the brain.

## DISCUSSION

The study has shown that the macroscopic changes in the intestinal canal are dominated by necrotic and haemorrhagic lesions, which vary from case to case as regards extent, localization and degree. On the basis of the relative preponderance of these lesions in the jejunum, the material was divided into 3 groups.

Group I represented the peracute to acute cases, Group III-2 the subacute cases. The differences observed in the histo-pathological changes, particularly in the small intestine, liver and central nervous system, and the variations in the age of the pigs at the time of death were in agreement herewith.

Besides haemorrhages in the anterior part of the jejunum, the chief postmortem finding in Group II pigs was the necrotic changes. As regards age, this group is intermediary between

Groups I and III-2. In the majority of cases, however, both the macroscopical and microscopical findings in pigs of Group II would seem to indicate a closer relationship of this group to Group III-2 than to Group I, even though all intergrades between haemorrhagic necrotizing enteritis and necrotizing enteritis without haemorrhages were represented in it.

The age at death of pigs referred to Group III-1 presupposes a peracute or acute course of the disease. Possibly, the post-mortem findings in this group correspond to an early stage of the findings characterizing Groups II and III-2.

The changes in the small intestine here described, and their regular localization in the jejunum is in agreement with previously published reports (*Field & Gibson 1955, Szent-Iványi & Szabó 1956, Barnes & Moon 1964, Moon & Bergeland 1965 and Bergeland 1965*).

The changes in the jejunum were generally continuous through the length of the affected part of the bowel. As in the Hungarian studies (*Szent-Iványi & Szabó*), the alternating form of necrotizing enteritis was seen in but few cases (3.5 %).

Besides the jejunum, which was always affected, the duodenum, ileum, coecum and colon showed haemorrhagic or necrotic changes in a number of cases, as has also been observed by *Moon & Bergeland* and *Bergeland*.

Changes in other organs were slight and unspecific as compared to the severe and characteristic changes in jejunum. Yet, haemorrhages were constantly found in the heart and kidneys, but only exceptionally in other organs. Furthermore, fibrinous peritonitis and accumulation of fluid in the pleural and peritoneal cavities were regular findings, particularly in pigs of Groups I and II.

The high protein content in the pleural and peritoneal fluids indicates that these are to be regarded as exudates. It is true that they had only a low content of white blood cells, but this may be explained by the fact that the disease is accompanied by leukopenia (*Høgh 1967*). With its content of red blood cells the peritoneal exudate may be characterized as haemorrhagic. Accordingly, it also had a higher protein content than the pleural exudate.

The microscopical findings generally confirmed the macroscopical observations. However, in a few cases microscopy revealed a catarrhal enteritis or a slight degree of necrotizing en-

teritis in macroscopically apparently normal parts of the bowel, as also observed by *Field & Goodwin* (1959).

There were also changes which could not possibly be recognized macroscopically. The changes in the vascular walls of the small intestine correspond to those which *Bergeland* found in experimentally induced necrotizing enteritis. The lesions of the central nervous system observed in the present study have not been described before, either in spontaneous or experimental cases of necrotizing enteritis in piglets. After intravenous injection of toxin produced by *Cl. perfringens* type C., *Bergeland* observed poliomyelomalacia mainly of the ventral and lateral cornua in the anterior and posterior intumescencia, while changes in the brain were but slightly pronounced. In the spontaneous cases examined in the present study, the changes in the central nervous system were not limited to the spinal cord. The alterations, which were most pronounced in the basal parts of the brain had the character of an encephalomyelomalacia.

*Field & Goodwin* consider the postmortem findings in necrotizing enteritis in newborn piglets to be pathognomonic. *Moon & Bergeland* and *Bergeland* concluded that, although characteristic, the postmortem picture in necrotizing enteritis was not pathognomonic, since *Cl. perfringens* type C was not isolated from all cases. Transmissible gastroenteritis, hog cholera, and *E. coli* infections were mentioned as differential diagnostic problems.

However, as stressed by *Moon & Bergeland* the changes found in transmissible gastroenteritis (*Bay et al.* 1949) and hog cholera (*Dunne* 1963) are not so characteristic as the necrotic and haemorrhagic changes found in infections with *Cl. perfringens* type C. In cases of doubt, a clinical and epizootiological evaluation, particularly with regard to the distribution of cases among age groups, would be of great differential diagnostic value.

Neither transmissible gastroenteritis nor hog cholera exists in Denmark, while enteritis caused by haemolytic *E. coli* is of frequent occurrence. As stated by *Høgh* it may sometimes be difficult to differentiate between necrotizing enteritis and *E. coli* enteritis on the basis of clinical symptoms. The patho-anatomical changes, however, are so different in *E. coli* enteritis (*Saunders et al.* 1960) and necrotizing enteritis that the postmortem findings alone will give a sufficiently certain basis for differential diagnosis.

The haemorrhagic-necrotizing or purely necrotizing changes

in the small intestine of baby pigs described in his study have never under Danish conditions been observed in enteric conditions of other known aetiology.

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## SUMMARY

Postmortem findings in 339 piglets with necrotizing enteritis varied from a mainly haemorrhagic enteritis to necrotizing enteritis without haemorrhage in the intestinal wall.

On the basis of differences in the macroscopical findings in the jejunum, the material was divided into 3 groups.

Group I comprised 146 pigs (43.1 %) with haemorrhagic, necrotizing enteritis. The changes in the small intestine were dominated by violent haemorrhages in the wall of the jejunum with severe loss of blood to the lumen (Fig. 3). In about 25 % of the cases, a slight emphysema could be seen under the serous surface. The mucosa was either strongly hyperaemic or transformed into a thin, lustreless, blood-imbibed necrotic membrane, which was firmly attached to the underlying tissue (Fig. 11).

Group II consisted of 95 pigs (28.0 %) with severe necrotizing enteritis (Figs. 4, 5 and 6). In the anterior part of the necrotic stretch there were haemorrhages under the serous surface. Such haemorrhages, which were most often petechial or ecchymotic, were seen more rarely in the whole length of the necrotic part of the intestine. Furthermore, in 44.2 % of the cases there was an extensive emphysema in the wall of this part. The serous surface of the posterior part of the necrotic stretch was diffusely greyish in colour or showed a peculiar longitudinal striation. The mucosa, both in the haemorrhagic and in the purely necrotic section, was transformed into a thick, yellowish or greyish necrotic membrane (Figs. 12 and 13).

Group III comprised 98 pigs (28.9 %) with necrotizing enteritis without haemorrhage. In 22 of these pigs (Group III-1) the necrotic lesions were of a light degree, the intestinal wall being only slightly thickened, the mucosa necrotic, thin, and attached to the underlying tissue (Figs. 7 and 14). In the remaining 76 pigs (Group III-2) the necrotic part of the intestine had the same appearance as the posterior part of the jejunum in pigs of Group II (Figs. 8 and 13).

The necrotic and haemorrhagic changes were always found in the jejunum (Table 1) and in a number of cases also in one or more of the other parts of the intestine (Table 2). In rare cases, stretches with and without visible lesions, or stretches with lesions of different appearance, alternated along the length of the affected part of the small intestine.

Lymph nodes draining haemorrhagic stretches were often the seat of an acute, haemorrhagic lymphadenitis, while lymph nodes draining purely necrotic stretches were generally enlarged and oedematous, but without haemorrhages.

In cases of haemorrhagic necrotizing enteritis (Group I) and necrotizing enteritis with haemorrhage in the anterior part of the small intestine (Group II), there was often exudation to the peritoneal and pleural cavities and to the pericardium. Furthermore, fibrinous peritonitis was a frequent finding in pigs of these 2 groups. Apart from subendocardial and subepicardial haemorrhages and subcapsular

haemorrhages in the kidneys, lesions of other organs were only slight and uncharacteristic' (Table 3).

Microscopical examination of sections stained by the conventional methods confirmed the macroscopical findings (Figs. 15—21) and, in addition, revealed degenerative changes in blood vessels, and lesions of the central nervous system which could be characterized as an encephalomyelomalacia.

While it may be difficult clinically to differentiate between necrotizing enteritis and *E. coli* enteritis, which often occurs among piglets in Danish herds, these 2 diseases are so different as regards patho-anatomical changes that the postmortem findings will give a sufficient basis for a differential diagnosis. The necrotic and haemorrhagic changes, which are very characteristic, have never under Danish conditions been observed in piglets with enteric diseases of other known aetiology.

#### ZUSAMMENFASSUNG

*Infektiöse nekrotisierende Enteritis bei Saugferkeln verursacht von Clostridium perfringens Typ C. III. Pathologische Veränderungen.*

Bei einer Untersuchung von 339 Saugferkeln mit nekrotisierender Enteritis wurde gefunden, dass die Veränderungen im Dünndarm von einer überwiegend hämorrhagischen Enteritis bis zu einer nekrotisierenden Enteritis ohne Hämorrhagie in der Darmwand variierten.

Auf Grund der Unterschiede in den makroskopischen Veränderungen im Jejunum wurde das Material in 3 Gruppen eingeteilt.

Gruppe I umfasste 146 Ferkel (43,1 %) mit hämorrhagischer nekrotisierender Enteritis. Die Veränderungen im Dünndarm waren von starken Blutungen in der Darmwand und einem grossen Blutverlust zum Darmlumen dominiert (Fig. 3). In etwa 25 % der Fälle war ein kleines Emphysem unter der Serosafläche des Darmes zu sehen. Die Schleimhaut war entweder stark hyperämisch oder in einen matten, blutimbibierten, dünnen, nekrotischen und festsitzenden Membran umgebildet (Fig. 11).

Gruppe II umfasste 95 Ferkel (28,0 %) mit stark nekrotisierender Enteritis (Fig. 4, 5 und 6). In dem oralen Teil des nekrotischen Abschnittes waren Blutungen unter der Serosafläche des Darmes zu sehen. Die Blutungen, die am häufigsten petechial oder ecchymotisch waren, waren in vereinzelt Fällen in der ganzen Länge des nekrotisierten Darmabschnittes zu sehen. Ausserdem war in 44,2 % der Fälle ein verbreitetes Emphysem in der Wand dieses Darmabschnittes zu sehen. Die aborale Partie präsentierte sich von der Serosafläche gesehen mit einer diffus grauen Farbe oder eigentümlich longitudinal gestreift. Die Schleimhaut, sowohl in dem hämorrhagischen wie in dem rein nekrotischen Abschnitt, war in einen dicken, gelblichen oder gräulichen nekrotischen Membran umgebildet (Fig. 12 und 13).

Gruppe III umfasste 98 Ferkel (28,9 %) mit nekrotisierender Enteritis ohne Hämorrhagie. Bei 22 von diesen Ferkeln war die nekrotisierende Enteritis von geringem Umfang (III-1). Die Darmwand war leicht verdickt und die Schleimhaut nekrotisch, dünn und festsitzend

(Fig. 7 und 14). Bei den übrigen 76 Ferkeln (III-2) hatte der nekrotische Darmabschnitt dasselbe Aussehen wie der aborale Darmabschnitt des Jejunum bei den Schweinen in Gruppe II (Fig. 8 und 13).

Die nekrotischen und hämorrhagischen Veränderungen waren immer im Jejunum (Tabelle 1) und in einem Teil der Fälle ausserdem in einem oder in mehreren der übrigen Darmabschnitte anzutreffen (Tabelle 2). In selteneren Fällen kamen veränderte und scheinbar normale Darmabschnitte oder veränderte Abschnitte von verschiedenem Aussehen alternierend in der Länge des angegriffenen Darmabschnittes vor.

Die Lymphdrüsen, die die hämorrhagischen Darmabschnitte dränierten, waren oft Sitz einer akuten hämorrhagischen Lymphadenitis, während die Lymphdrüsen auf der Höhe der rein nekrotischen Darmabschnitte in der Regel angeschwollen und ödematös, jedoch ohne Hämorrhagie, waren.

Bei hämorrhagisch-nekrotisierender Enteritis (Gruppe I) und bei nekrotisierender Enteritis mit Hämorrhagie in den vorderen Darmabschnitten (Gruppe II) kam oft Exsudation nach Bauchhöhle, Brusthöhle und Herzsack vor. Ausserdem war fibrinöse Peritonitis ein häufiger Befund bei Ferkeln in diesen beiden Gruppen. Ausser subendoet subepicardialen Blutungen und subkapsularen Blutungen in den Nieren waren die Veränderungen in den übrigen Organen wenig ausgesprochen und uncharakteristisch (Tabelle 3).

Die mikroskopische Untersuchung von Schnitten, nach den konventionellen Farbmethode gefärbt, hat teils die makroskopischen Befunde (Fig. 15—21) bestätigt, und teils degenerative Veränderungen in den Blutgefässen und in dem Zentralnervensystem enthüllt. Die Veränderungen in dem zentralen Nervensystem konnten als eine Encephalomyelomalazie charakterisiert werden.

Während die klinische Differentialdiagnose zwischen nekrotisierender Enteritis und *E. coli* enteritis schwierig sein kann, sind die pathologisch-anatomischen Veränderungen so verschieden, dass der Sektionsbefund eine genügend sichere Grundlage für die Differentialdiagnose ausmacht. Die nekrotischen und hämorrhagischen Veränderungen, die ausgesprochen charakteristisch waren, sind unter dänischen Verhältnissen nie bei kleinen Saugferkeln bei enteralen Leiden von anderer bekannter Ätiologie festgestellt worden.

#### SAMMENDRAG

*Infektios nekrotiserende enteritis hos pattegrise forårsaget af Clostridium perfringens type C. III. Patologiske forandringer.*

Ved undersøgelse af 339 pattegrise med nekrotiserende enteritis fandtes forandringerne i tyndtarmen at variere fra en overvejende hæmorrhagisk enteritis til en nekrotiserende enteritis uden hæmorrhagi i tarmvæggen.

På grundlag af forskelle i de makroskopiske forandringer i jejunum blev materialet delt i 3 grupper.

Gruppe I omfattede 146 grise (43,1 %) med hæmorrhagisk-nekrotiserende enteritis. Forandringerne i tyndtarmen var domineret af voldsomme blødninger i tarmvæggen og et stort blodtab til tarmens

lumen (Fig. 3). I ca. 25 % af tilfældene sås et ringe emfysem under tarmens serosaflade. Slimhinden fandtes enten stærkt hyperæmisk eller omdannet til en mat, blodimbiberet, tynd, nekrotisk og fastsiddende membran (Fig. 11).

I gruppe II er samlet 95 grise (28,0 %) med en kraftig nekrotiserende enteritis (Fig. 4, 5 og 6). I den orale del af det nekrotiske afsnit sås blødninger under tarmens serosaflade. Blødningerne, der oftest var petecchiale eller ecchymotiske, sås i sjældnere tilfælde i hele det nekrotiske tarmafsnits længde. Desuden sås i 44,2 % af tilfældene et udbredt emfysem i væggen af dette tarmafsnit. Det aborale parti præsenterede sig med en diffus grålig farve eller med en ejendommelig longitudinal stribning set fra serosafladen. Slimhinden, såvel i det hæmorrhagiske som i det rent nekrotiske afsnit, var omdannet til en tyk, gullig eller grålig nekrotisk membran (Fig. 12 og 13).

Gruppe III omfattede 98 grise (28,9 %) med nekrotiserende enteritis uden hæmorrhagi. Hos 22 af disse grise var den nekrotiserende enteritis af ringe grad (III-1). Tarmvæggen var let fortykket og slimhinden nekrotisk, tynd og fastsiddende (Fig. 7 og 14). Hos de øvrige 76 grise (III-2) havde det nekrotiske tarmafsnit samme udseende som det aborale afsnit af jejunum hos grisene i gruppe II (Fig. 8 og 13).

De nekrotiske og hæmorrhagiske forandringer fandtes altid i jejunum (Tabel 1) og i en del af tilfældene tillige i et eller flere af de øvrige tarmafsnit (Tabel 2). I sjældne tilfælde forekom forandrede og tilsyneladende normale tarmafsnit eller forandrede afsnit af forskelligt udseende alternerende i det angrebne tarmafsnits længde.

De lymfeknuder, der drænerede hæmorrhagiske tarmafsnit, var ofte sæde for en akut, hæmorrhagisk lymfadenitis, mens lymfeknuderne ud for de rene nekrotiske tarmafsnit i reglen var svulne og ødematøse, men uden hæmorrhagi.

Ved hæmorrhagisk-nekrotiserende enteritis (gruppe I) og ved nekrotiserende enteritis med hæmorrhagi i det forreste tarmafsnit (gruppe II) forekom ofte exsudation til bughule, brysthule og hjertesæk. Desuden var fibrinøs peritonitis et hyppigt fund hos grisene i disse 2 grupper. Ud over subendo- og subepicardiale blødninger og subkapsulære blødninger i nyrene var forandringerne i de øvrige organer lidet udtalte og ukarakteristiske (Tabel 3).

Den mikroskopiske undersøgelse af snit, farvet efter de konventionelle farvemethoder, har dels bekræftet de makroskopiske fund (Fig. 15—21) og dels afsløret degenerative forandringer i blodkarrene og i centralnervesystemet. Forandringerne i centralnervesystemet kunne karakteriseres som en encephalomyelomalaci.

Mens det klinisk kan være vanskeligt at differentialdiagnosticere mellem nekrotiserende enteritis og *E. coli* enteritis, der hyppigt forekommer hos pattegrise i danske svinebesætninger, er de patologisk-anatomiske forandringer ved disse to sygdomme så forskellige, at sektionfundet yder et tilstrækkeligt sikkert differentialdiagnostisk grundlag. De nekrotiske og hæmorrhagiske alterationer, der var særdeles karakteristiske, er under danske forhold aldrig påvist hos spæde pattegrise ved enterale lidelser af anden kendt ætiologi.