THRUSH IN INFANCY

BY

H. LEDERER, M.D., and R. McLAREN TODD, M.D., M.R.C.P., D.C.H.
(From the Child Health Department, University of Liverpool)

Thrush is a disease which has been known since earliest times but its fungoid nature was not recognized until one hundred years ago when Robin (1853) included the micro-organism in the group of *oidium albicans*.

Thrush is usually regarded as a relatively mild parasitic infection of the mouth, especially liable to occur in debilitated children. Trousseau (1869) described it as 'the local expression of a very bad state of the whole system.' Thrush may, however, become a more serious condition by extension to the pharynx, bronchi, oesophagus, or even through the blood stream to such organs as the kidney.

Thrush lesions in infants involving the oesophagus and responsible for severe clinical manifestations have been described by Ebbs (1938) who observed twenty-eight cases of oesophagitis in three years, twenty-two of which were caused by *monilia albicans*. *Monilia oesophagitis* was also described by Reye (1941) who stressed the diagnostic difficulties of this lesion in necropsy material and the relative frequency of this condition in infancy.

Ludlam and Henderson (1942) drew attention to the high incidence of thrush infection in the neonatal period. In a series of eighteen necropsies they found that thrush lesions had spread to the pharynx in eight cases and that the oesophagus was involved in seven cases. Anderson et al. (1944), investigating the incidence and source of thrush infections, confirmed its high incidence in the newborn.

The present observations were carried out during a period of twelve months in which routine necropsies were performed on twenty-eight infants under four weeks of age and on 176 infants between the ages of one and twelve months. In seven of the twenty-eight neonates and in nineteen of the older infants, pharyngeal or oesophageal thrush lesions were found. The high incidence of these lesions has prompted us to record our findings.

History and Clinical Features

An analysis of the previous history of our cases confirmed the observation of other clinicians that bottle-fed babies and babies of low vitality are especially prone to develop thrush. Only three cases were wholly breast-fed, seven were bottle-fed

from birth, and fifteen were bottle-fed by the age of six weeks. Twenty-two babies were born at full-term, but the birthweights of five of these were below 7 lb.; two babies were born prematurely, their birthweights being 5 lb. 4 oz., and 4 lb. 3 oz.

On admission to hospital thrush lesions were visible on the buccal mucous membrane in nine cases, dehydration was noted in fourteen cases, and diarrhoea and vomiting or vomiting alone occurred in eighteen cases. The vomiting associated with thrush lesions may be projectile and simulate congenital pyloric stenosis, as in two of our cases, but more commonly regurgitation or dribbling from the mouth occurs shortly after feeds. Refusal of feeds was present in four cases.

The commonest findings in the seven newly born infants were visible mouth lesions (six cases), vomiting (four cases), dehydration (four cases), and refusal of feeds (three cases).

While in hospital dehydration was encountered as a serious and recurrent complication in twenty-two of these twenty-six cases, and necessitated intravenous fluids on one occasion in fifteen cases, and more than once in seven cases. The sudden onset of toxæmia was another striking feature and it developed within three days of admission in eleven cases. The development of purulent otitis media was also noted in ten cases. In three cases (Nos. 155, 169, 226) there was vomiting of dark brown material which contained blood. A rise in temperature was not recorded except as a terminal event. Sudden collapse, dyspnoea, and cyanosis shortly after a feed occurred in six cases and is related to the finding of food material in the bronchial tree at necropsy.

The early diagnosis of thrush in infants and the newly born may be difficult clinically, especially when visible oral lesions are absent. Routine mouth swabs from all babies admitted to hospital may be of value in early diagnosis, for it is known that in many cases culture is positive for *monilia albicans* in the absence of visible lesions.

Pathology of pharyngo-oesophageal thrush. Oral thrush is easily recognized at necropsy, unless the patient has been treated with gentian violet or the oral cavity has been plugged with cotton wool after death. As post-mortem oral plugging was carried out as a ward routine, the absence of visible oral lesions in this series was not considered significant. In five cases, however, in which neither gentian violet treatment nor post-mortem plugging

had been carried out, no oral lesions were found, although severe oesophageal changes were present. Pharyngo-oesophageal thrush occurs in milder cases as whitish spots, distributed mainly in the pyriform recesses and the narrow parts of the oesophagus. In the more advanced cases the lesions form large confluent patches which, like the small spots, can be wiped off. In the severe cases, thick pseudomembranes are formed and, if removed, an ulcerated, often bleeding, base is exposed. These lesions present no diagnostic difficulties. In a large number of cases, however, haemorrhages cause the lesion to assume a dirty, greyish-brown colour and sloughing of the pseudomembrane occurs. The presence of gastric contents in the oesophagus and post-mortem digestion of the superficial layers, particularly in cases where the thrush lesion is confined to the distal third of the oesophagus, may make the naked eye diagnosis difficult, if not impossible, as in case 169. In such cases bacteriological and histological examination are necessary to reveal the nature of the lesion.

The histological picture varies according to the severity of the lesion. In the early lesion (fig. 1) there is oedema of the stratified epithelium; mycelia and spores can be seen extending between the epithelial cells and often reaching and perforating the basal membrane. A felt of mycelial threads and spores is superimposed on the epithelium and may contain epithelial debris, red blood cells, and later, masses of Gram-positive and Gram-negative cocci and bacilli. There is generally, even in mild lesions, congestion and dilatation of the submucous capillaries. In more severe lesions (fig. 2), the mucosa is ulcerated and mycelial strands extend to and beyond the muscularis mucosae, and the

FIG. 1.—Early lesion of pharynx (case 146). $\times 95$.

FIG. 2.—Inflammatory reaction of oesophagus involving submucosa (case 169). $\times 120$.

submucosa shows infiltration with inflammatory cells, which are mainly mononuclear cells, lymphocytes, and less frequently, polymorphs. Capillary haemorrhages are often present. The inflammatory reaction usually extends far beyond the ulcerated area. In severe lesions a thick pseudomembrane is formed consisting of the sloughed-off mucosa, masses of mycelia and spores, and large numbers of organisms. The mycelium may extend beyond the muscularis mucosae and involve the muscular coat. We have found mycelia outside the muscular coat in sections in which the lesion involved the epithelium only. When post-mortem digestion has occurred the diagnosis of thrush lesions may be difficult. Infiltration with inflammatory cells and congestion of the submucosa will draw attention to the possibility of an underlying thrush infection and serial sections may reveal spores or mycelial threads. Gram-stained sections are of help as spores and hyphae generally give a Gram-positive reaction, but at times the organisms do not take the stain uniformly. Spores may be mistaken for lymphocytes in sections stained with haematoxylin and eosin. Fuentes' method (1946) for differentiating *monilia albicans* in tissues has not given satisfactory results in our hands.

Continued growth of the fungus and infiltration of the underlying tissue after the death of the patient has been observed in a number of cases, and the absence of any tissue reaction has been taken as evidence of post-mortem spread.

The diagnosis of oesophageal or pharyngeal thrush was made on naked eye evidence alone in six cases of the series; in a further six cases by bacteriological examination; in three cases by histological examination without bacteriological examination; and in the remaining cases by bacteriological and histological examination.

The bacteriological diagnosis was made by examination of smears from the lesions and culture on Sabouraud's medium and blood agar plates both directly and after ether treatment of a serum broth culture to eliminate Gram-negative organisms (Pearce, 1946).

Complications of Pharyngo-oesophageal Thrush

Involvement of the respiratory system. Regurgitation of feeds into the air passages occurs frequently in patients with pharyngo-oesophageal thrush and the incidence of this complication in our series was high. Eleven cases showed microscopical evidence of aspiration pneumonia and in a further six cases the aspirated material blocked the air passages, thus causing sudden death (see table). During the same period of observation fifty-nine children in the same age group died from gastro-enteritis or marasmus, and in twenty-one of these aspiration had occurred. In seventy-two infants who died from various other conditions evidence of aspiration was found in eight cases only. The histological examination of the lungs may reveal aspirated material containing monilia albicans and other organisms covering the bronchial mucosa or present in the alveolar lumen. Occasionally, there is invasion of the bronchial wall by the mycelium, with inflammation and necrosis of the wall (fig. 3) and peribronchial pneumonia.

FIG. 3.—Thrush lesion of bronchus with monilia hyphae penetrating bronchial wall (case 169). $\times 120$.

Most frequently the typical picture of aspiration pneumonia is found, and monilia may or may not be present in the alveolar exudate.

The following cases show the typical features of these respiratory complications.

CASES 121 AND 122. These infants were three weeks old and dehydrated. The pyriform recesses were coated with a thick layer of thrush, and in case 121 there was patchy involvement of the oesophagus. In both cases the trachea and main bronchi were blocked with gastric contents. The liver was fatty in case 122, and showed slight fatty changes and small foci of erythropoiesis in case 121.

CASE 174. This infant was three weeks old, wasted, and deeply jaundiced. A confluent brown stained membrane covered the distal oesophagus, and there was a little altered blood in the stomach. Small areas of atelectasis and haemorrhagic consolidation were scattered throughout the lungs. The liver was of normal size and yellowish brown in colour.

Histological examination showed that in the oesophagus large sloughing areas of mucosa were replaced by masses of necrotic cells, monilia, and red blood cells. Hyphae extended into the submucosa, which showed oedema and cellular infiltration. There was oedema and cellular infiltration of the adventitia, extending into the substance of the diaphragm. No organisms were visible in the adventitia.

Involvement of pleura. Extension of the inflammation through and beyond the muscular coat of the oesophagus may, in some cases, lead to direct spread of infection into the pleural sac. In the following two cases (Nos. 123 and 215) empyemata were found at necropsy and we consider that direct spread from the oesophagus was the probable cause. It is also possible that the empyemata were secondary to lung infection.

CASE 123. The child, a girl aged four months, was dehydrated and jaundiced. There was an empyema of the right pleural sac causing compression of the lower lobe and fibrinous pericarditis was also present. The thrush lesion involved the upper third of the oesophagus and there was post-mortem digestion of the distal third. Pus was present in the tympanic cavities and mastoid air cells.

Histological examination showed extensive sloughing of the mucosa of the upper third of the oesophagus. A dense felt of mycelia, spores, and a large variety of organisms and necrotic debris covered the exposed muscularis mucosae which was penetrated by hyphae. Inflammatory infiltration of the submucosa was present. In the distal third the mucosa and submucosa were largely missing owing to post-mortem digestion, but where present the submucosa showed oedema and infiltration with mononuclears, but mycelia or spores could not be demonstrated. The outer coat of the oesophagus showed identical inflammatory changes. Bacteriological examination revealed the presence of

TABLE
ANALYSIS OF NECROPSIES ON 26 INFANTS WITH THRUSH LESIONS

Necropsy number	Age on admission	Sex	Birth-weight	Type of feeding	Site of thrush lesions (post-mortem)	Evidence of inhalation of gastric contents
63	Four months	M.	7 lb. 11 oz.	Breast-fed 1 month, then 'Ostermilk,' then National Dried Milk.	Pharynx: mouth	Vomit in bronchial tree (massive)
72	Eight weeks	F.	7 lb. 2 oz.	Breast-fed	Mouth: oesophagus kidney	Aspiration pneumonia
82	Three weeks	M.	7 lb. 13 oz.	Breast fed 2 weeks, then 'Ostermilk.'	Mouth: oesophagus	Haemorrhagic pneumonia
84	Four weeks	F.	6 lb. 5 oz.	Breast-fed 1 month, then 'Cow and Gate'	Mouth: oesophagus	Haemorrhagic pneumonia
89	Eight weeks	F.	6 lb. 6 oz.	Breast-fed 5 weeks, then 'Ostermilk'	Mouth: pharynx: oesophagus	Vomit in bronchial tree
121	Three weeks	F.	4 lb. 3 oz.	Breast-fed 2 weeks, then 'Cow and Gate'	Mouth: pharynx: oesophagus	Vomit in bronchial tree (massive)
122	Two weeks	M.	6 lb.	'Cow and Gate'	Mouth: pharynx	Vomit in bronchial tree (massive)
123	Ten months	M.	—	Breast-fed 1 month; then National Dried Milk	Oesophagus: left mastoid	—
141	Nine weeks	F.	5 lb. 4 oz.	National Dried Milk	Oesophagus	Vomit in bronchial tree
142	Three months	M.	6 lb. 8 oz.	Breast-fed 6 weeks, then National Dried Milk	Mouth: pharynx	—
146	Three weeks	F.	5 lb. 10 oz.	Breast-fed 4 days, then National Dried Milk	Mouth: pharynx	—
147	Four weeks	F.	7 lb.	Breast-fed with supplements of National Dried Milk	Mouth and pharynx Tonsils	Vomit in bronchial tree
155	Five weeks	F.	7 lb.	Breast-fed	Mouth: oesophagus	—
156	Eight months	M.	—	National Dried Milk	Pharynx: oesophagus	Vomit in bronchial tree
169	Twelve months	M.	7 lb. 12 oz.	Breast-fed	Oesophagus: kidney: ileum	Aspiration pneumonia
174	Three weeks	M.	6 lb. 7 oz.	Breast-fed 4 days, then National Dried Milk	Oesophagus	Haemorrhagic pneumonia
181	Ten weeks	F.	6 lb. 13 oz.	Breast-fed, 6 weeks, then National Dried Milk	Oesophagus	Vomit in bronchial tree (massive)
184	Ten months	M.	—	—	Oesophagus	Vomit in bronchial tree (massive)

TABLE (continued)

Necropsy number	Age on admission	Sex	Birth-weight	Type of feeding	Site of thrush lesions (post-mortem)	Evidence of inhalation of gastric contents
190	Twelve months	M.	—	National Dried Milk	Pharynx: oesophagus left mastoid	—
192	Seven months	M.	6 lb. 9 oz.	Breast-fed 1 month, then National Dried Milk	Oesophagus	—
206	Seven weeks	M.	8 lb. 8 oz.	Breast-fed 3 weeks, then National Dried Milk	Oesophagus: right mastoid	Haemorrhagic pneumonia
212	Nine months	M.	—	National Dried Milk	Mouth: oesophagus: right mastoid	Vomit in bronchial tree (massive)
215	Five months	F.	7 lb. 12 oz.	'Cow and Gate'	Oesophagus	—
226	Four months	F.	7 lb. 7 oz.	Breast-fed 5 weeks, then National Dried Milk	Oesophagus	Aspiration pneumonia
235	Three months	F.	7 lb. 10 oz.	Breast-fed 1 month, then 'Cow and Gate'	Mouth: oesophagus	—
254	Ten weeks	F.	7 lb. 12 oz.	Breast-fed 1 month, then National Dried Milk	Oesophagus: lungs	—

B. Friedländer and *Ps. pyocyanea* in the mastoid pus, empyema fluid, and the oesophagus. *Monilia albicans* was found in mastoid pus and the oesophagus only.

CASE 215. The child was a girl, aged six months with generalized oedema. There was an extensive ulcerative thrush lesion of the oesophagus and a large amount of greenish, gelatinous pus in the right pleural sac with compression of the lower and parts of the upper lobe. The left lung and pleura showed no abnormality.

Histological examination of the distal third of the oesophagus revealed thrush ulceration involving the mucosa in its entire circumference and it extended in places into the muscularis mucosae. The sub-mucosa showed no inflammatory reaction, but outside the muscular layer there was dense infiltration with mononuclears, polymorphs, and lymphocytes. The infiltration extended into the adherent pericardial sac. Histological examination of the right lower lobe of the lung showed atelectasis and congestion. The pleural exudate consisted mainly of mononuclear cells and scanty polymorphs and a few Gram-positive cocci but no monilia. Culture of the oesophageal lesion yielded *monilia albicans*, *staphylococcus aureus* (coagulase-positive), non-haemolytic streptococci, and *B. proteus*. *Monilia albicans*, *staphylococcus aureus*, and non-haemolytic streptococci were grown from the pleural pus.

Septicaemia. *Monilia albicans* is a parasite thriving on the exposed surface of the alimentary tract and producing superficial ulceration. Extension of the lesion in width and depth may expose a large area to the action of staphylococci and other organisms normally present in the upper alimentary tract, with subsequent septicaemia or pyaemia. In five of our cases pyaemic abscesses were found in various organs. Staphylococci were isolated in two cases and in three cases there was a mixed bacterial flora, including staphylococci, enterococci, coliform bacilli, and *Ps. pyocyanea*.

CASE 254. The child, a girl, was aged four months and had generalized oedema. The distal two-thirds of the oesophagus was covered by an adherent, dirty, brownish-red membrane. Mucopus was present in both tympanic cavities and mastoid air cells. The lungs contained numerous small atelectatic areas.

Histological examination revealed that the mucosa of the oesophagus was completely and uniformly necrotic and replaced by a mass of cellular debris, hyphae, and spores. The muscularis mucosae was invaded by hyphae and the submucosa was congested. There was scanty cellular infiltration of the outer coat of the oesophagus which also contained a few spores and hyphae. The kidneys contained small pyaemic staphylococcal abscesses. In the lungs, a film of aspirated material covered the bronchial epithelium and spores and bacteria were

present in the alveoli. There was no inflammatory reaction.

Monilia albicans, *staphylococcus aureus* (coagulase-positive), coliform bacilli, and enterococci were isolated from swabs of the oesophagus, mastoid air cells, and bronchi.

Monilaemia. We have found evidence of metastatic lesions in the kidneys in two of our cases.

CASE 72. This was a girl of nine weeks who was emaciated and dehydrated. Petechiae were present on the abdominal skin and the buttocks were excoriated. There was thick pus in the tympanic cavities and mastoid air cells. Thrush of the tongue and buccal mucosa and patchy thrush lesions in the distal third of oesophagus were present. Numerous foci of aspiration bronchopneumonia were scattered throughout the lungs. The cortex of the kidney was yellowish brown and small miliary granules were prominent on the cut surface.

On histological examination the kidney (fig. 4) showed numerous miliary granulomata consisting of a centre formed by masses of spores in small arteries or tubules, surrounded by collections of mononuclear cells.

CASE 169. This child was a boy of twelve months who had pyaemia with multiple embolic abscesses in the lungs and kidney, and purulent fluid in the posterior horn of the lateral ventricles. In addition to the pyaemic (*staphylococcal*) abscesses, granuloma-like lesions containing hyphae and spores were found in the kidneys (fig. 5).

The dissemination of thrush lesions to various organs by the blood stream has been mentioned by several authors. The total number of cases reported

FIG. 4.—Thrush lesion of kidney (case 72). $\times 85$.

FIG. 5.—Thrush lesion of kidney (case 169). $\times 120$.

in the literature is, however, small, and the majority of reported instances involve drug addicts in whom mycotic endocarditis was found at necropsy. In Wessler and Browne's case (1945) *monilia albicans* was isolated from blood cultures on five occasions in a patient suffering from acute tracheobronchitis. The same organism was isolated from faeces, urine, bronchial secretion, and the pharynx of the patient who recovered with sulphonamide treatment. Purpuric lesions in a case of monilaemia are mentioned by Wickler et al. (1943) but the authors indicate that these may have been caused by an overdose of paraldehyde. Case 72 of our series had a petechial rash during life and purpuric lesions were noted in the abdominal skin at necropsy. Morris et al. (1945) recorded a case of *monilia meningitis* in a man of twenty-three, in whom *monilia albicans* had been isolated from the pus in a tooth socket in the lower jaw. Miale (1943) reported one case of *monilia meningitis* in a man of thirty years who for eight years had been suffering from a monilial granulomatous lesion of mouth and tongue. Zimmerman et al. (1947) reported a case of *monilia meningitis* with recovery after an eight-day course of streptomycin.

Intestinal lesions. Paterson (1947) speaks of 'a tendency for the infection to "work through" the child so that it is accompanied by severe vomiting and diarrhoea and gives rise to grave general symptoms with blood in the stools.' Extensive haemorrhage into the lumen of the stomach was found in four of our cases and into the small gut

in two cases, but no attempts were made in these six cases to demonstrate the presence of monilia albicans by histological or bacteriological examination. In our series there was evidence of intestinal ulceration in four cases, but although similar in naked eye appearance, only one case was proved to be thrush by histological and bacteriological examination. In case 142 there was a greyish adherent membrane consisting of fibrin, sloughed-off mucosal cells, and masses of organisms. Monilia was not found either by histological or bacteriological examination. In case 206 small oblong punched-out areas of ulceration, surrounded by a haemorrhagic zone, were noted. Histological and bacteriological examination did not reveal monilia. In case 72 there was extensive emphysema of the wall of the ulcerated ileum, but thrush was not found. In case 169 a greyish pseudomembrane was present in the upper ileum, and in its lower parts there was extensive ulceration of the mucosa which was covered by yellowish adherent masses. Monilia was found in the section and on culture. The inflammatory reaction extended about 2 inches from the thrush ulcer (fig. 6). Macgregor and Henderson (1943) have described two cases with lesions half-way along the small intestine and above the ileocaecal valve respectively. Ebbs (1938) mentions extension to the intestines in two of his twenty-two cases.

Spread to tympanic cavities. The incidence of involvement of the tympanic cavities and mastoid air cells in the present series was high, as would be expected in infants with recurrent vomiting. In ten cases unilateral or bilateral otitis media was

present. In four of these cases (Nos. 123, 190, 206, 212), monilia albicans was found either in smears or on culture; in four cases monilia could not be demonstrated and in two cases bacteriological examination was not carried out. Ebbs (1938) mentions two cases with otitis media, showing thrush spores in the discharge, and greyish pus and bone necrosis at necropsy.

Discussion

Thrush in infancy is so common that its occurrence is generally regarded as of minor importance, but histological examination of thrush lesions of the pharynx and oesophagus may reveal epithelial oedema, desquamation, hyperaemia, and infiltration which may extend into the surrounding tissues. The inflammatory process may spread by direct extension to involve neighbouring structures such as the pleura or diaphragm but dissemination through the blood stream may also occur.

Thrush may pass unrecognized at necropsy unless histological examination is undertaken, because of the lack of specific macroscopical features to suggest the diagnosis. A large variety of organisms may be isolated from swabs taken at necropsy from oesophageal and pharyngeal lesions. In our cases coagulase-positive staphylococcus aureus, non-haemolytic streptococci, enterococci, *Bact. coli*, proteus, and *Pseudomonas pyocyanea* were most commonly found. It is often difficult to resolve one's doubts as to whether one or more of these organisms are primarily responsible for the post-mortem appearances. There are two possibilities, either the thrush lesion is the primary one and this becomes secondarily invaded by other organisms, or other organisms produce the primary lesion which becomes secondarily infected with monilia. The morphology of the early lesion (fig. 1), however, would seem to favour the former view that the fungus by primarily damaging the epithelium provides a basis for invasion of the body by organisms normally present in the alimentary tract. In a control series of fifteen infants who died from a variety of causes but in whom the oesophagus looked normal, swabs were taken from the oesophagus and examined directly and also cultured. *Monilia albicans* was not seen on direct examination in any of these cases, although in two cases a positive culture was obtained on Sabouraud's medium; in addition the same types of organisms as were isolated in our thrush cases were found in these control cases. This suggests that the infiltrating fungus is responsible for the primary lesion and secondary infection occurs from organisms normally present in the oesophagus.

In six of our cases sudden death occurred as a result of blockage of the respiratory passages by food regurgitated from the stomach, and in eleven other cases there was histological evidence of inhalation of vomit. We consider that inhalation of gastric contents is one of the characteristic features of thrush in infancy. This occurrence may be due to interference with the normal act of

FIG. 6.—Inflammatory reaction in intestinal submucosa 2 in. from thrush ulcer (case 169). $\times 165$.

swallowing because of dysphagia caused by painful thrush lesions, or possibly the thrush pseudo-membrane may make the protective pharyngeal reflexes insensitive. These reflexes may also be depressed in other conditions, such as prematurity, congenital malformations (for example, cleft palate), mental deficiency, cerebral haemorrhage, or in debilitated children and children under the influence of narcotics. Gardner (1942) considers that aspiration of vomit is almost exclusively limited to artificially fed babies. He observed that the stomachs of breast-fed babies were small and compact, whereas those of bottle-fed babies were often grossly distended as a result of air swallowed during feeds. He considers that attempts to expel this air lead to aspiration of vomit. White (1948) does not agree that aspiration of vomit is so rare in breast-fed babies, and in his series of twenty-three infants who died suddenly following aspiration of stomach contents, four of the twelve infants whose mode of feeding was known were breast-fed. In our series, three infants were breast-fed, none died from massive aspiration of gastric contents, but in two cases there was histological evidence of aspiration pneumonia. Rhaney and Macgregor (1948) found histological evidence of inhalation of gastric contents in forty-one newborn babies in a series of 939 necropsies. They considered that prematurity, cerebral haemorrhage, and poor general condition of the infant were predisposing factors. Only two of our cases were premature but in both aspiration of vomit had occurred; in none of our cases was cerebral haemorrhage present clinically or at necropsy; fourteen of our cases were dehydrated and in poor general health on admission to hospital.

Eight infants of this series were born within a period of four months in the same maternity unit. Two infants born on the same day died at the same age of twenty days, three infants born on three successive days died after twenty-nine, thirty-seven, and twenty-three days respectively. Although the number is small, it seems highly probable that the monilial infection was contracted in hospital. This infection appears to have been the cause of the fatal illness. The period of observation was too short to say whether the occurrence, within four months, of a large number of fatal thrush infection in neonates was due to seasonal conditions, to the spread of a particularly virulent strain of *monilia albicans*, or was purely accidental.

We are, because of the relatively small number of observations, not in a position to analyse the incidence of thrush infection in older infants and to state whether or not a thrush infection was primarily responsible for a period of ill health or whether the infection was established secondarily in an ill infant. Nevertheless, once established, the infection may represent a serious danger to the

infant's life and all precautions should be taken to avoid infection and, when present, to avoid spread in and from the affected infant. Ludlam and Henderson (1942) and Anderson and her associates (1944) have investigated the source and spread of moniliasis and their recommendations should be applied.

Summary

In a series of 204 necropsies on infants under twelve months of age, twenty-six cases were encountered in which monilia infection was responsible either directly or indirectly for the fatal outcome. The danger of thrush infection to the infant, namely extension into the oesophagus with the subsequent syndrome of refusal of feeds, vomiting and dehydration, aspiration of vomit, septicaemia, intestinal spread, and monilaemia are described. Diagnostic difficulties in the living and at necropsy may be responsible for a significant number of cases of fatal thrush lesions which remain undetected and unrecorded.

We wish to express our thanks to Professor Norman B. Capon, A. W. Downie and H. L. Sheehan for their advice and criticism, and to Dr. W. E. Crosbie for access to the patients in Alder Hey Hospital.

REFERENCES.

- Anderson, N. A., Sage, D. N., and Spaulding, E. H. (1944). *Amer. J. Dis. Child.*, 67, 450.
 Ebbs, J. H. (1938). *Arch. Dis. Child.*, 13, 211.
 Fuentes, C. (1946). *J. Bact.*, 51, 245.
 Gardner, E. (1942). *Med.-leg. Rev.*, 10, 120.
 Ludlam, G. B., and Henderson, J. L. (1942). *Lancet*, 1, 64.
 Macgregor, A. R., and Henderson, J. L. (1943). *Arch. Dis. Child.*, 18, 186.
 Miale, J. B. (1943). *Arch. Path.*, 35, 427.
 Morris, A. A., Kalz, G. G., and Lotspeich, E. S. (1945). *Arch. Neurol. Psychiat. Chicago*, 54, 361.
 Paterson, D. (1947). 'Sick Children: Diagnosis and Treatment.' London, p. 104.
 Pearce, R. (1946). *Lancet*, 1, 347.
 Reye, D. (1941). *Med. J. Aust.*, 2, 673.
 Rhaney, K., and Macgregor, A. R. (1948). *Arch. Dis. Child.*, 23, 254.
 Robin, C. (1853). 'Histoire Naturelle des Végétaux Parasites.' Paris.
 Trousseau, A. (1869). 'Lectures on Clinical Medicine.' New Sydenham Society, London, 2, 622.
 Wessler, S., and Browne, H. R. (1945). *Ann. Intern. Med.*, 22, 886.
 White, L. L. R. (1948). *Proc. Roy. Soc. Med.*, 41, 866.
 Wikler, A., Williams, E. G., and Wiesel, C. (1943). *Arch. Neurol. Psychiat.*, 50, 661.
 Zimmerman, S. L., Frutche, L., and Gibbes, J. H. (1947). *J. Amer. med. Ass.*, 135, 145.