Granulomatous Peritonitis Due to Cellulose Fibers From Disposable Surgical Fabrics:

Laboratory Investigation and Clinical Implications

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Two patients with postoperative granulomatous peritonitis were found to have lesions with a distinctive type of foreign body. Laboratory investigation revealed this foreign body to be cellulose, morphologically identical with fibers derived from disposable surgical gowns and drapes, and cotton. The same type of foreign body granulomas was produced experimentally by introducing lint prepared from these gowns and drapes into the peritoneal cavities of rats. Since disposable gowns and drapes are being used with increasing frequency, cellulose lint derived from these sources should be added to the list of hazardous foreign materials which are potential wound contaminants.

IATROGENIC foreign body contamination of the peritoneal cavity may produce granulomatous peritonitis with well defined clinical and pathologic characteristics.[2,7] Glove lubricants have been found responsible for many examples of this entity, thus lycopodium[1] and talc[3,9] were incriminated and replaced by starch powder. Although at first considered innocuous,[8] it too was found capable of causing the same syndrome.[2,6,7,10,12]

Two of our patients, displaying the clinical picture of intra-abdominal abscess, were found at laparotomy to have foreign body granulomas containing doubly refractile, trilaminar-appearing fibers but no starch granules. The morphology of the fibers was identical with that of cellulose fibers and quite different from that of silk or catgut sutures.

The observation that the shaking and handling of disposable surgical gowns and drapes made from nylon or rayon supported cellulose wadding releases a considerable amount of lint into the air, led us to examine this material microscopically. It was found to have the structure of cellulose fibers and was identical to the fibers found in our two patients. An identical granulomatous peritonitis was produced experimentally by introducing the lint from these fabrics into the peritoneal cavity of rats.

Our purpose is to report the occurrence of such lesions in a group of patients from the Department of Surgery of the Long Island Jewish-Hillside Medical Center-Queens Hospital Center Affiliation and to correlate them with the lesions created in our experimental animals.

Case Reports

Case #1 B.B. A 37-year-old black male was admitted on January 26, 1972 to Queens Hospital Center with signs and symptoms of partial intestinal obstruction. Barium enema demonstrated a constricting lesion of the ascending colon and on February 4 a right hemicolectomy and ileo-transverse colostomy were performed for a non-perforating adenocarcinoma. The patient had an uneventful postoperative course and was discharged on February 14. He was readmitted on February 24 with a four-day history of diffuse abdominal pain, anorexia and a low grade fever. On physical examination his abdomen was slightly distended with diffuse tenderness, most marked in the right lower quadrant where an ill-defined mass was palpable. During two weeks of observation, his rectal temperature was 37.8–39.2 C. A mild leukocytosis with eosinophilia was present. On March 10 an exploratory laparotomy was performed for suspected intro-abdominal abscess. Minimal amounts of straw-colored fluid were present, but no abscesses were found. The entire peritoneum including the mesenteric and bowel surfaces were studded with grey-white nodules varying 2–5 mm in diameter, associated with thick omental adhesions. This was thought to represent diffuse carcinomatosis. Biopsies revealed an organizing panniculitis showing fibrous tissue, lymphocytes, eosinophils and noncaseating foreign body granulomas which contained fiber-like, curved, doubly refractile trilaminar inclusions. (Figs. 1 and 2) Postoperatively, his fever subsided, and he was discharged on March 27. Cultures of the peritoneal fluid showed no bacterial growth.

Case #2 M.M. A 16-year-old black male was admitted on March 10, 1973 to Queens Hospital Center with a stab wound in the left upper quadrant of the abdomen. Exploratory laparotomy failed to reveal any intra-abdominal injury. His postoperative course was uneventful and

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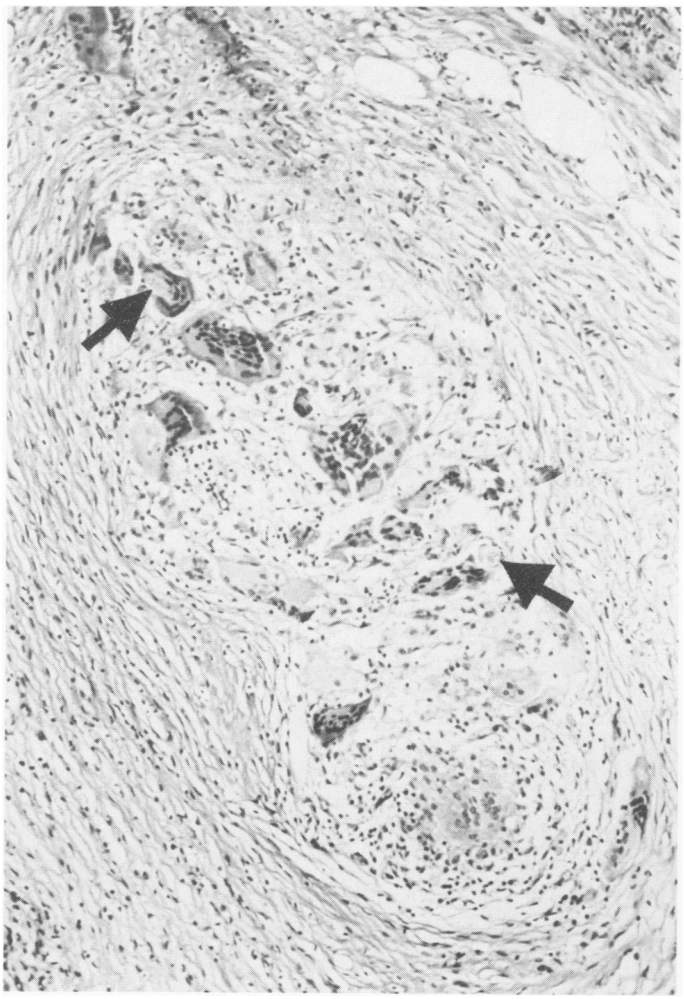

FIG. 1. Case I. Typical granuloma composed of giant cells, macrophages, eosinophils and lymphocytes, with foreign body inclusions (arrows) and surrounding fibrosis (H & E ×50).

he was discharged on March 17. Three days later he was readmitted with abdominal pain, distention and fever. On physical examination there was diffuse abdominal tenderness, most marked in the area of the stab wound which was indurated. It was elected to observe the patient. His temperature ranged 37.8–38.9 C associated with a mild leukocytosis and eosinophilia. The findings persisted and on April 30 his abdomen was explored for a suspected intra-abdominal abscess. At laparotomy the entire peritoneal surface was covered with grey-white nodules. Multiple adhesions were present between loops of bowel, omentum and the abdominal wall. No abscess cavity could be found. Biopsy of a peritoneal nodule, revealed a foreign body granuloma containing the same fiber-like inclusions seen in Case I. (Figs. 3 and 4) Postoperative treatment included Prednisone, 5 mg P.O. every six hours. The fever subsided and he was discharged on May 8. Cultures of the peritoneal fluid revealed no bacterial growth. On May 18 he was readmitted with a clinical picture of partial intestinal obstruction which was successfully treated by intestinal decompression.

Comment

In both cases, the patients were draped and the operating room personnel gowned with disposable fabrics manufactured from nylon supported cellulose fibers. We have subsequently identified eight additional patients in whom foreign body granulomas were found which contained the fiber material. In five patients, the foreign bodies were in soft tissue and of little clinical significance. Three patients, however, required re-operation for intestinal obstruction.

Experimental Methods and Materials

0.6 × 1.5 meter polyethylene bags were rinsed with 500 cc of distilled water and dried. They were then half-filled with sterile disposable gowns and drapes, closed and shaken for half an hour. After the fabric was removed, the remaining lint was collected and sterilized with ethylene dioxide.

Ten mature Sprague-Dawley rats of both sexes were anesthetized with subcutaneous nembutal, their abdomens shaved and prepped with povidone-iodine solution and draped using disposable drapes of the same fabric as those used to provide the lint. The surgeons were gowned with the same fabric and their gloves were carefully washed with normal saline solution until all visible starch was removed. A midline laparotomy incision measuring 1.5 cm

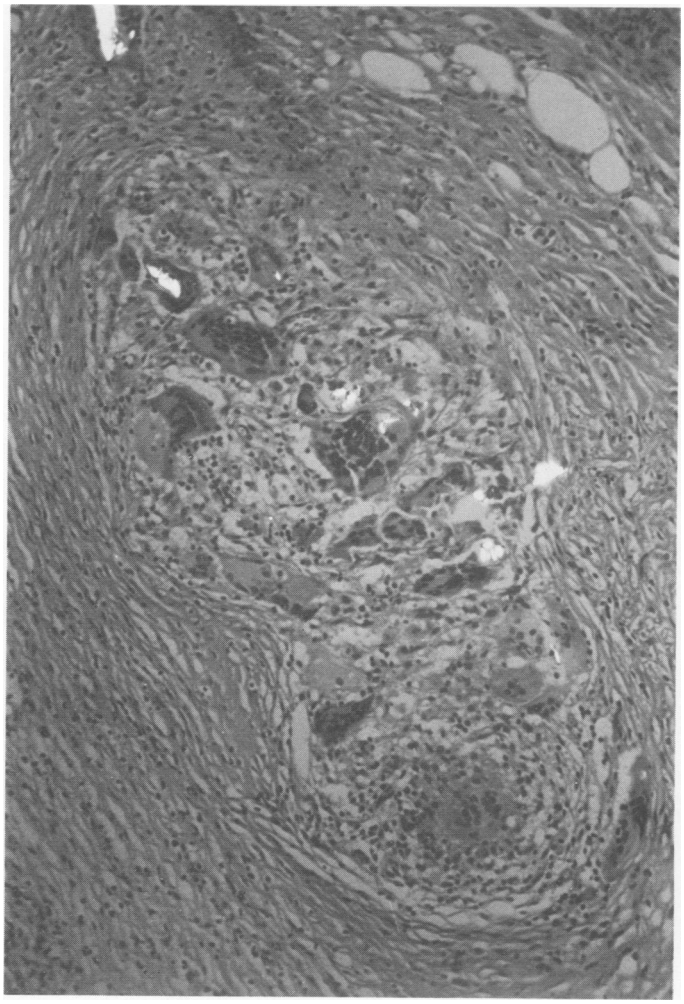

FIG. 2. Case I. Same field as Fig. 1 showing inclusions within giant cell under polarized light (H & E, and polarized light ×50).

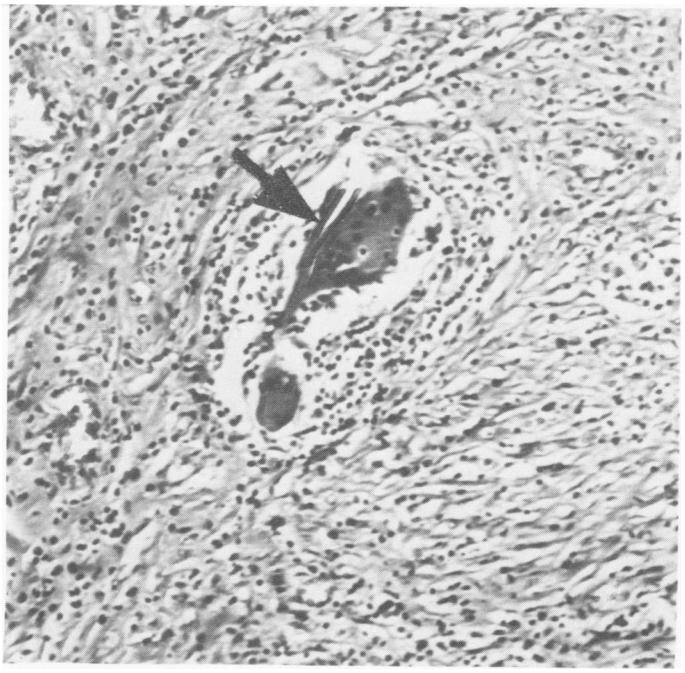

FIG. 3. Case II. Giant cell containing fiber split to produce "forked tongue" appearance (arrow) (H & E ×50).

was performed on each animal and a 2 mm square pledget of the lint was inserted into the peritoneal cavity which was then closed in layers with 4-0 silk.

In a second group of ten rats, lint collected in the same manner from cotton laparotomy pads was introduced into the peritoneal cavity. A third group of ten animals was subjected to the same procedure except that no lint was introduced.

Two animals from each group were sacrificed by decapitation at 1, 5, 6, 9 and 13 days. The peritoneal cavity was entered through an incision remote from the previous one and the appearance of the abdomen noted. The areas with gross pathology were biopsied and microscopic sections prepared.

The following techniques were used to stain the tissue, identify the fiber structure and differentiate it from other fibrous materials: 1) hematoxylin and eosin; 2) periodic acid schiff; 3) chlorzinc iodide; 4) cyanin-erythrosin stains; and 5) polarized light microscopy. In addition, specimens of raw lint and cotton were examined microscopically both unstained with polarized light and stained as described above.

FIG. 4. Case II. Split fiber seen in Fig. 3 under polarized light (H & E, and polarized light ×80).

Results

Necropsy of animals from groups one and two revealed nodular adhesions between the omentum and the anterior abdominal wall in the area where the lint had been implanted. Microscopic examination of the tissue from the serially sacrificed animals revealed the sequential development of typical foreign body granulomas containing the characteristic fiber inclusions.

Twenty-four hours after implantation, fibers of variable length were suspended in edema fluid with a demarcating zone of polymorphonuclear leukocytes. By the fifth day, fibrin and polymorphonuclear leukocytes were abundant, and surrounded by granulation tissue (Fig. 5). Subsequently, a few foreign body giant cells appeared and by the ninth day, noncaseating granulomas were well formed with the giant cells containing the fibers. Interstitial fibrosis appeared by the thirteenth day (Fig. 6). The foreign body granulomas have the same general appearance as the biopsy specimens from cases I & II (Figs. 1–4), with the additional presence in the human lesions of significant numbers of eosinophils. Animals from the third group revealed no intra-abdominal gross pathology.

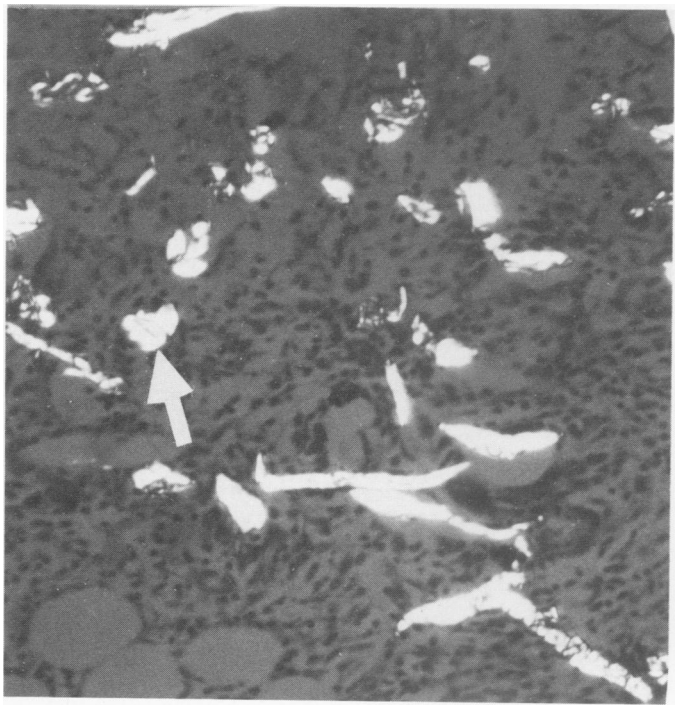

FIG. 5. Rat tissue, five days after implantation, showing fibers. Note trilaminar structure, transverse folds and doughnut configuration (arrow) (H & E polarized light ×50).

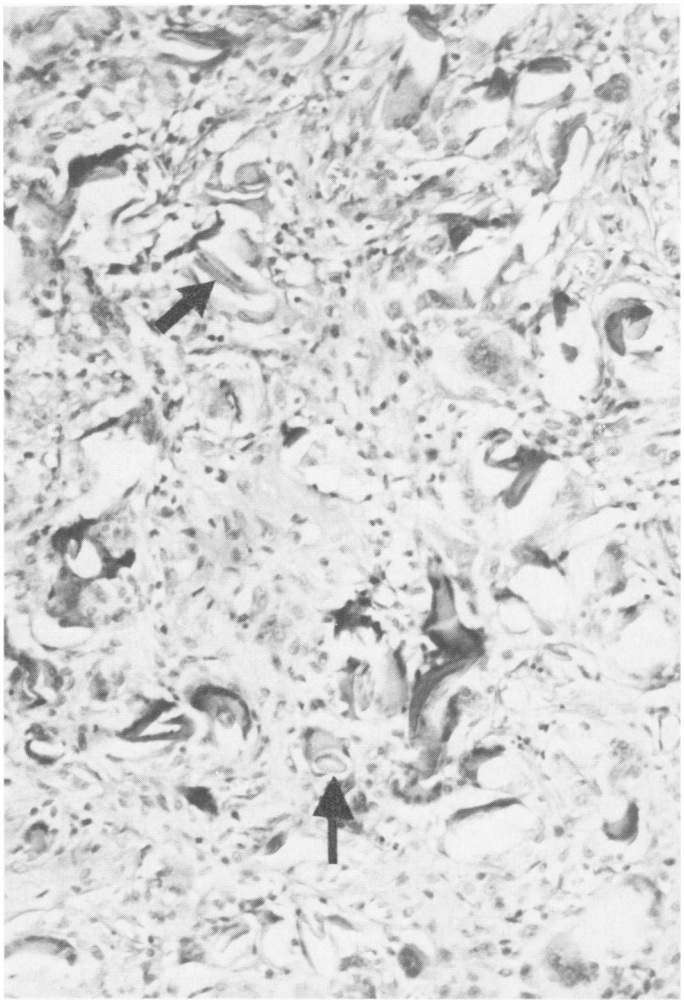

FIG. 6. Rat tissue 13 days after implantation showing numerous "forked tongue," trilaminar and doughnut configurations of the fibers in giant cells (arrows) (H & E ×80).

The unstained fibers range 5–15 μ in width and up to several hundred μ in length. They are bent at many levels demonstrating obliquely transverse folds. A trilaminar appearance is seen with three apparent layers extending in the longitudinal direction; the two outer layers are dense with a central lumen. The structure is doubly refractile with polarized light and exhibits dichroism, changing from port wine color to prussian blue when the polarizing lens is rotated (Fig. 7).

In both human and rat tissue sections the fibers are present as variable short segments approximately 100 μ in length, owing to sectioning for microscopic preparation. They are seen in transverse section to be irregularly ovoid with an empty central lumen resembling an elongated doughnut. They are also seen to have been partially split longitudinally producing a "forked tongue" appearance in tissue. In all other respects they are identical with the untreated lint described above.

The fibers from both cotton and the disposable fabrics have the following staining characteristics whether in tissue sections or mounted on a slide. They stain pink with H & E, are PAS positive, diastase resistant, and are positive with chlorzinc iodide (consistent with carbohydrate). With the cyanin-erythrosin stain, the fibers from both sources stain pink, confirming their cellulose content. In addition, larger diameter fibers from the disposable fabrics stain blue, indicating the presence of lignin.[4] The larger fibers constitute about 20% of the sample.

Discussion

Our findings demonstrate that lint emanating from disposable gowns and drapes can produce a peritoneal reaction. This response is characterized clinically by signs and symptoms of acute peritoneal irritation and histologically by a giant cell foreign body granuloma containing fibers

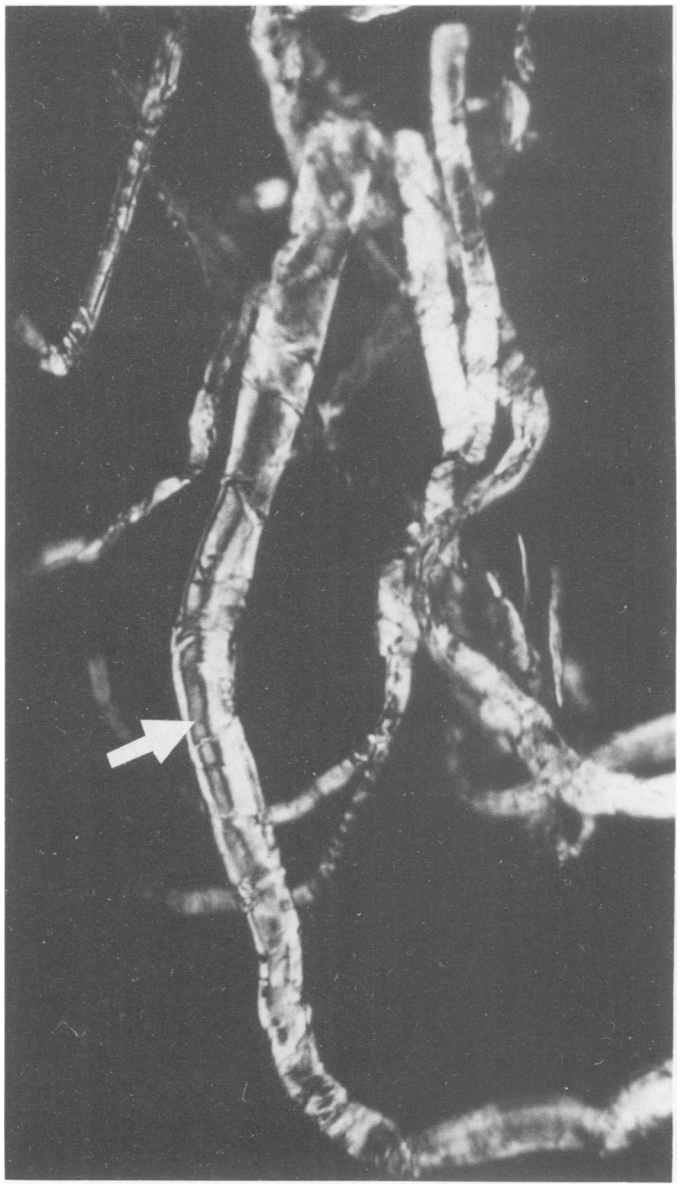

FIG. 7. Unstained fiber from disposable fabric under polarized light. Note trilaminar structure and obliquely transverse folds. Arrow indicates dark zone which shines brilliantly prussian blue in color preparations, with contrasting reddish zone (polarized light ×80).

indistinguishable from the material obtained from the disposable, non-woven fabrics. In our experimental animals, similar lesions were reproduced by the intra-peritoneal implantation of this material.

Non-woven disposable gowns and drapes are fabricated from cellulose wadding bonded to a nylon or rayon scrim. The source of the cellulose incorporated in the disposable fabric is at least partially from wood, as indicated by the presence of lignin in approximately 20% of the untreated fibers, predominantly those of larger diameter. Cotton contains no lignin.[13] The disposable fabric lint, as prepared manually and implanted in rats, is seen in the tissue to contain the large diameter, lignin positive fibers. However, in the human tissues, not only were the fibers few in number, but the fragments of fibers encountered were predominantly of small caliber and not positive for lignin. Presumably, the smaller fibers are more readily loosened and shed from the non-woven disposable fabric. They can thus be disseminated in the air, picked up on instruments or, by direct contact, contaminate the peritoneal cavity.

The fibers observed in the granulomas demonstrate the morphologic criteria of cellulose vegetable fibers: they exhibit a trilaminar structure, transverse folds and, on cross section, demonstrate an irregular ovoid configuration with a central lumen. Classically, wood fibers are described as having nodes or junctions which appear as transverse folds. These are absent in cotton fibers.[5,13,14] In microscopic sections, however, it has been impossible to differentiate cotton from cellulose fibers of wood origin by morphologic criteria, because the cotton undergoes artifactual bending within the tissues.

Despite the widespread use of disposable surgical fabrics, only a few of our patients have reacted to this form of lint and developed recognizable complications. The presence of leukocytosis with eosinophilia and the prevalence of eosinophils in the foreign body granulomas suggests an allergic or hypersensitivity reaction which warrants further investigation. A similar mechanism has been postulated with respect to starch peritonitis.[2,7,15]

Of concern is the fact that cellulose is not normally broken down by human enzyme systems and one may not anticipate that foreign body lesions due to cellulose fibers will resolve in time, as do starch granulomas.[2,6,7] The future course of such patients is not known. We do not know if diagnostic paracentesis would have been of help in these patients[15] since they had little ascitic fluid and no starch granules were found on microscopic examination of the tissues.

Most of the materials left in tissue by the surgeon, whether accidentally or purposefully, produce a characteristic reaction. The response to various suture materials and glove lubricants is well known. Woven cotton laparotomy pads, gowns and drapes have been used for decades without widely recognized untoward effects, although gauze pads have been implicated in the formation of adhesions.[11,16] In our patients, we could not identify any of the known elements. The only foreign bodies which could be identified were cellulose fibers. Since these foreign bodies are so striking to the pathologist, one would expect them to have been described and well recognized many years ago, if indeed they were produced by shedding from cotton fabrics. The ability of lint from the disposable fabrics to elicit an identical foreign body reaction was demonstrated in our animal experiments. We believe this adds another etiologic agent to the list of foreign materials which are potentially hazardous to our patients.

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