Polyethylene Catheter Embolism

Review of the Literature and Report of a Case with Associated Fatal Tricuspid and Systemic Candidiasis

By Klaus F. Wellmann, M.D., Arthur Reinhard, M.D., and Edgardo P. Salazar, M.D.

SUMMARY
A 62-year-old man died from tricuspid monilial endocarditis and systemic candidiasis associated with embolization to the right heart of a 36-cm fragment of one polyethylene catheter received in the venous system approximately one year earlier. Thirty-six additional cases of catheter embolism are reviewed and tabulated. In 17 of the 37 patients the catheter fragment had reached the right side of the heart, and in eight, a branch of the pulmonary artery. In six of 13 patients who died, catheter embolism was the exclusive or a major contributory cause of death. Measures designed to prevent the breakage and embolization of polyethylene tubes and to facilitate their retrieval in case of loss are discussed. If a catheter fragment has been lost into the venous system, it should be located and removed at once.

Monilial endocarditis and systemic candidiasis are briefly reviewed. The reported case is the first in which these entities have been associated with catheter embolism to the heart, and the fourth in which monilial endocarditis affected the tricuspid valve.

Additional Indexing Words:
Foreign body embolism Plastic tube embolism Tricuspid moniliasis
Systemic moniliasis Fungal endocarditis Tricuspid valve endocarditis

ONE OF THE COMPLICATIONS an indwelling plastic catheter can produce is its breakage or detachment and the subsequent embolization of the liberated fragment. If the lost piece of tubing is allowed to reach the heart or the pulmonary arterial bed, serious consequences may threaten the patient's life.

In this communication a fatal case of polyethylene catheter embolism is described, and the available clinical and pathological data of 36 additional cases collected from the literature are discussed and tabulated. Since our patient is the first on record in whom catheter embolism was associated with, and causally linked to, monilial endocarditis and systemic candidiasis, these two infrequently encountered entities are also reviewed briefly.

Report of Case

Clinical Data
The patient, a 62-year-old male Negro who had been a heavy drinker, was admitted to the Jewish Chronic Disease Hospital with a 1-week history of nausea, vomiting, and diarrhea. One year earlier he had been hospitalized elsewhere for a laparotomy following trauma; this had been his only other hospitalization.

Physical examination revealed a stocky Negro in no distress. His temperature was 101.8 F, the pulse rate 104/min, the respiration rate 16/min, and the blood pressure 130/80 mm Hg. The neck veins were moderately distended. A few rales were heard over both pulmonary bases. There was an apical systolic murmur, and the second pulmonary sound was accentuated. An electrocardiogram showed inverted T waves in leads V1 through V4. Radiographic examination of the chest revealed moderate cardiomegaly; films of the abdomen were considered unremarkable.

Because of the history of alcoholism and on the basis of certain laboratory data, cirrhosis of...
the liver, perhaps with a superimposed cholecystitis or pancreatitis, was suspected initially. He was treated with intravenous fluids. When the fever persisted and abdominal rigor developed, penicillin in daily doses of 30 million units and streptomycin in daily doses of 1 g were added to the regimen on the fourth hospital day. By the sixth hospital day the patient was afebrile and eating, and much of the abdominal tenderness was gone. On the following day, however, he became very dyspneic and orthopneic, and his cervical veins were markedly distended. An apical diastolic gallop rhythm, together with systolic and diastolic murmurs at Erb's point, was heard. Digitalis, mercuhydrin, aminophylline, and oxygen were administered. The patient, however, expired 6 hours later.

**Autopsy Findings**

Only data which are pertinent in the context of this report will be recorded.

**Gross Observations**

A linear surgical scar was noted in the left upper abdominal quadrant. There were two venous cutdown scars, one each in the right and left cubital fossa. The heart weighed 320 g; its size and shape were within normal limits. When the chambers were opened, a polyethylene tube, 36 cm long and 0.2 cm in diameter, was encountered in the lumen of the superior vena cava, the right atrium, and the right ventricle (fig. 1). The atrial aspect of the tricuspid valve, which measured 11 cm in circumference at its base, was completely covered by a bulky, fungating, moderately friable, grey-red thrombotic mass which adhered to the valve proper (fig. 1). The latter was slightly deformed and thickened; its lumen was narrowed to about one half of its normal size by the thrombus; its chordae tendineae were thin, of usual length, and were not fused with one another. A portion of the described thrombus was traversed by the catheter. The right atrium appeared moderately thickened and distended. The remaining parts of the heart, including the three other valves, were unremarkable.

There were bilateral pleural effusions of 100 ml each. The lungs were moderately edematous. Liver and spleen were congested; there was no cirrhosis, cholecystitis, or pancreatitis.

**Microscopic Observations**

The tricuspid valve showed a partially organized thrombus attached to its atrial surface (fig. 2); granulation tissue extended from the valve proper into the base of this thrombotic mass. Extensive and dense conglomerations of yeastslike fungi, together with pseudomycelial threads, were noted throughout the thrombus, especially in its peripheral portions (figs. 2 and 3). These fungi had the morphological characteristics of a *Candida* species; regrettably, cultures had not been prepared.

In sections from the lungs, several smaller pulmonary arteries were seen to harbor fresh thrombotic material together with fungi (fig. 4). A few alveoli contained exudate consisting of polymorphonuclear leukocytes and a few *Candida* organisms. Most other alveoli were filled with edema fluid. Leukocytes and fungi were also present in several glomeruli and in the interstitium of both kidneys.

**Autopsy Diagnosis**

The autopsy diagnosis was as follows: (1) status post exploratory laparotomy, following traffic accident 1 year before death; (2) healed cutdown incisions in both arms, presumably 1 year old; (3) retention of 36-cm fragment of intravenous polyethylene catheter in superior vena cava, right atrium, and right ventricle; (4) subacute tricuspid monial endocarditis, with fungating, partially organized thrombus around
Figures 2 and 3

POLYETHYLENE CATHETER EMBOLISM

Figure 4

Portion of large pulmonary artery branch. Part of the wall of the artery occupies most of the left and lower regions of the picture. The lumen contains thrombotic material with many yeast-like cells (black). Methenamine silver stain, × 280.

retained catheter and along entire circumference of tricuspid valve, with partial stenosis of latter; (5) acute systemic candidiasis with mycotic emboli in branches of pulmonary artery, focal acute monilial pneumonia, and focal acute renal (glomerular and interstitial) moniliasis; (6) bilateral pleural effusion; (7) moderate bilateral pulmonary edema; and (8) moderate chronic passive congestion of liver and spleen.

Postmortem Review of X-Ray Films

Postmortem review of the patient's roentgenograms revealed the very faint outline of a catheter fragment superimposed upon the cardiac shadow (fig. 5). This was visible only in a corner of one of the abdominal films.

Although the patient had received fluids intravenously in this hospital, these were administered through a medium-sized Intracath tube, measuring 20 cm in length while the intracardiac catheter embolus measured as much as 36 cm in length. We, therefore, concluded that the embolized catheter fragment must have been introduced during the patient's only other period of hospitalization, 1 year before his death. Our inquiry at the other hospital, however, failed to elicit any pertinent information.

Discussion

Polyethylene Catheter Embolism

Embolization of a fragment of an indwelling intravenous polyethylene catheter, first reported in 1954 by Turner and Sommers,1 is not as rare an event as one might suspect; indeed, it twice became a matter for editorial concern as early as 1963.2,3 A review of the literature disclosed a total of 36 such cases recorded to date,4-28 to which a case of our own has been added (tables 1 and 2). The true incidence of this event is undoubtedly higher, as implied by several authors who refer to additional, not, or not completely, documented instances of polyethylene catheter embolization that have come to their knowledge.10, 22, 24, 27 One may safely infer that still other cases may never have been reported at all.

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Pertinent clinical and anatomic data on the 37 patients with catheter embolism are summarized in tables 1 and 2. Twelve female and 24 male patients, ranging in age from 4 months to 86 years, were affected; the sex of the remaining person was not specified. The length of the retained catheter fragment was recorded in 23 cases and varies from 3.5 to as much as 72 cm. The list of principal clinical diagnoses is heterogeneous, but all patients were sick enough to require intravenous intubation for one purpose or another.

How, then, does a catheter embolus get started? As the tables document, four different mechanisms are evident. In 15 patients, the largest group, the polyethylene tube was pierced by the sharp bevel of a needle harboring the catheter. Six times the catheter broke apparently without preceding needle injury. In four cases the catheter became detached from a connecting piece of tubing or from an adapter. In two patients, finally, the tube was inadvertently severed during a dressing change or during adjustment maneuvers. The mechanism of the accident remained unknown in the remaining 10 cases, and the catheter fragment in most of these was simply listed as having disappeared into the vein. Restlessness and violent arm or leg movements in many patients contributed substantially to all of these initiating events.

The portal of entry for the detached catheter fragment was an arm vein in 28 cases, the vein of a leg in four, a neck vein in three, and the pudendal vein in one; in the remaining case the site of entry was not known. The embolized fragment was recovered from a peripheral leg vein once, from a peripheral vein of the arm in six patients, and from the inferior vena cava in one patient. In 17 patients, almost one half of the group, the catheter piece lodged in the right atrium or ventricle, often extending into the superior or inferior vena cava. It had traversed the heart and reached a pulmonary artery branch.
in eight cases, including three in which recovery had not been attempted. There were four more patients who still harbored their catheter emboli when their cases were reported.

Is the retention of a polyethylene catheter fragment harmful to the patient? Is it true that “polyethylene is quite obviously nonpyrogenic, durable, relatively inert, and not harmful to body tissues,” and that it “may be safely tolerated by the body for long periods”? In 25 of the 37 cases, no detrimental clinical or pathological effects were recorded (tables 1 and 2). In many of these patients, however, the catheter piece had been removed from the cardiovascular system within minutes, hours, or days after its disappearance. On the other hand, two patients, one with hemophilia, who still harbored their catheter emboli were alive and well 2 and 3 years, respectively, after the date of the accident. In Lamprecht’s remarkable case, a 40-cm fragment of tubing, the second longest on record, had become partially incorporated in the wall of the superior vena cava and the right heart where it was incidentally discovered at autopsy 6 years after it had entered the body. Yet, in other cases, fever and thrombus formation around the catheter have been observed within 24 hours of the accident. And in six of the 13 deceased patients, catheter embolism was the exclusive, or a significant contributory, cause of death (table 1). Massive intracardiac thrombosis, pulmonary embolism, perforation of right atrium or ventricle by the tip of the catheter fragment, with ensuing hemopericardium and bacterial or mycotic endocarditis (present case), were the major findings at autopsy in these six patients.

**Measures to Prevent Embolization of Catheter**

Many authors proposed measures designed to prevent the embolization of catheter fragments or to facilitate their retrieval should embolization have occurred. The first group of these suggestions concerns the manufacturer of plastic tubing rather than the physician. All catheters should be rendered radiopaque to permit their ready visualization by the radiologist, even though contrast venograms may occasionally suffice for this purpose. If a needle is used through which the catheter is inserted, the inner surface of its bevel should be dull to prevent easy piercing of the enveloped plastic tube. Also, any freely exposed catheter end should have a diameter considerable larger than the lumen of the punctured vein so that the tube cannot glide into the blood vessel in toto.

Secondly, particular caution should be exercised with restless patients and if the catheter is to be inserted near joints (which may be moved), into deep veins (where thrombosis occurs more easily), or for extended periods of time (which increases the dangers of thrombosis and infection). It is obvious that a catheter fragment to which thrombi or microorganisms are attached is much more dangerous than a band, sterile piece of tubing when carried away with the bloodstream.

Furthermore, the proper technique should be followed when a catheter is being inserted. Complete sterility is mandatory; the topical application of antibiotic ointments or the use of nylon instead of polyethylene tubing may assist in reducing the incidence of infection at the needle site. Catheters should be fixed securely. A single loop knot may be placed in its exposed portion, in addition to the usual taping of excess catheter, and a drop of collodion may be placed upon, or a suture tied around, the catheter as it enters the skin. A bevel cover designed to protect the needle point portion of the tube is essential, but it, too, may become dislodged on occasion. Under no circumstances should the catheter be withdrawn through the needle as the sharp bevel edge of the latter may cut the catheter. The nursing staff should know the length of the inserted tubing and measure the catheter after removal.

**Retrieval of Catheter Embolus**

If a catheter fragment has been lost in the venous system, it should be located and
Patients with Catheter Embolism Followed by Death (Thirteen Cases)

<table>
<thead>
<tr>
<th>Author(s), reference, year</th>
<th>Age (yr)</th>
<th>Sex of patient</th>
<th>Principal clinical diagnosis</th>
<th>Length (cm) of lost catheter</th>
<th>Mechanism of loss of catheter fragment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turner &amp; Sommers, 1954</td>
<td>54</td>
<td>F</td>
<td>Myocardial infarct</td>
<td>22</td>
<td>Catheter disappeared</td>
</tr>
<tr>
<td>Brown &amp; Kent, 1956</td>
<td>27</td>
<td>F</td>
<td>Barbiturate poisoning</td>
<td>ns</td>
<td>Catheter disappeared</td>
</tr>
<tr>
<td>Ayers, 1957</td>
<td>33</td>
<td>M</td>
<td>Gangrenous appendicitis</td>
<td>ns</td>
<td>Catheter disappeared</td>
</tr>
<tr>
<td>Knutson &amp; Stenberg, 1959</td>
<td>81</td>
<td>M</td>
<td>Carcinoma of colon</td>
<td>3.5</td>
<td>Catheter broke</td>
</tr>
<tr>
<td>Scharf et al., 1959</td>
<td>83</td>
<td>M</td>
<td>Bronchial carcinoma</td>
<td>8</td>
<td>Catheter broke</td>
</tr>
<tr>
<td>Barry et al., 1962</td>
<td>64</td>
<td>M</td>
<td>Pyloric ulcer</td>
<td>ns</td>
<td>Catheter detached</td>
</tr>
<tr>
<td>Tulgan &amp; Budnitz, 1963</td>
<td>86</td>
<td>M</td>
<td>Urinary incontinence</td>
<td>ns</td>
<td>Catheter detached</td>
</tr>
<tr>
<td>Lamprecht, 1965</td>
<td>67</td>
<td>M</td>
<td>Cholecystitis</td>
<td>40</td>
<td>Catheter disappeared</td>
</tr>
<tr>
<td>Coblentz, 1966</td>
<td>80</td>
<td>M</td>
<td>Heart failure</td>
<td>ns</td>
<td>Unknown</td>
</tr>
<tr>
<td>Borgeskov et al., 1966</td>
<td>1/3</td>
<td>F</td>
<td>Hydrocephalus</td>
<td>5</td>
<td>Catheter broke</td>
</tr>
<tr>
<td>Johnson, 1966</td>
<td>50</td>
<td>M</td>
<td>Hepatic cirrhosis</td>
<td>15</td>
<td>Catheter cut by needle</td>
</tr>
<tr>
<td>Northcutt, 1966</td>
<td>61</td>
<td>M</td>
<td>Pheochromocytoma</td>
<td>4</td>
<td>Catheter cut by needle</td>
</tr>
<tr>
<td>Present case</td>
<td>62</td>
<td>M</td>
<td>Septicemia</td>
<td>36</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

ns = not stated.

Cardiopulmonary angiography demonstrates the catheter as a filling defect within the injected contrast material in the vena cava, heart, or pulmonary artery.

With or without the help of a tourniquet placed proximal to the puncture site, an embolized piece of tubing has occasionally been retrieved before it could travel to the heart, but more often such efforts have not met with success. In the legs, venous valves may block the migration of the lost fragment. Even if the catheter fragment reaches the heart, cardiotomy may not be required; thus, Massumi and Ross have recently retrieved a polyethylene tube fragment from the right atrium with the help of a wire loop introduced through the saphenous vein and Hufnagel accomplished the same result by inserting a rigid tube into the patient’s heart via the jugular vein.
## Monilial Endocarditis and Systematic Candidiasis

The authors' case is the first on record in which polyethylene catheter embolism to the right heart has been associated with fungal (monilial) valvular endocarditis. The entities of fungal endocarditis and disseminated candidiasis have gained increasing prominence in medical articles published during the past decade, and more or less comprehensive reviews have been presented by various authors.38-48

Factors found or suspected of predisposing to monilial endocarditis include prolonged antibiotic50, 46, 49-57 or corticosteroid46, 52, 55 treatment, preexisting rheumatic40, 42, 52, 58, 50 or bacterial41, 45, 46, 50, 55, 60, 61 endocarditis, cardiac surgery,44, 48, 51-53, 62, 63 narcotic addiction in "mainliners,"42, 45, 56, 61, 64, 65 diabetes,41, 66 and intravenous glucose infusions.63, 67 In the vast majority of cases of systemic candidiasis, extended antibiotic treatment has been recorded.48, 57, 67-72 Large doses of penicillin as well as streptomycin were given in our case only during the last few days of the patient's life but may have contributed to the dissemination of fungi since the monilial lesions found in the lungs and kidneys at autopsy were exclusively fresh ones. Mechanisms by which antibiotics increase the incidence and severity of candidiasis and alter the immunological defense of the body have recently been discussed by Seelig.73

Intravenous46, 52, 55, 59, 63 and intraperitoneal72 catheters have been suspected of providing yeast cells with access to the body. Whereas only bacteria but no fungi were cultured from many indwelling catheters39 or venous cutdown wounds,34 Candida albicans was grown in at least one case from

<table>
<thead>
<tr>
<th>Site of entry</th>
<th>Site of recovery</th>
<th>Length of interval from loss to recovery</th>
<th>Was death solely or partially caused by accident?</th>
<th>Pertinent autopsy findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm vein</td>
<td>Superior vena cava, right atrium</td>
<td>2 days</td>
<td>Yes</td>
<td>Myocardial infarct, thrombus in right heart</td>
</tr>
<tr>
<td>Femoral vein</td>
<td>Inferior vena cava, right heart</td>
<td>63 days</td>
<td>Yes</td>
<td>Perforation of right heart, hemopericardium</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Right heart</td>
<td>45 days</td>
<td>Yes</td>
<td>Bacterial endocarditis pulmonary abscesses</td>
</tr>
<tr>
<td>Femoral vein</td>
<td>Pulmonary artery</td>
<td>Some days</td>
<td>Yes</td>
<td>Thrombus around catheter fragment</td>
</tr>
<tr>
<td>Pudendal vein</td>
<td>Inferior vena cava</td>
<td>1 day</td>
<td>No</td>
<td>Bronchial carcinoma, bronchopneumonia</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Superior vena cava, right atrium</td>
<td>2 wk</td>
<td>No (?)</td>
<td>Myocardial infarct, thrombus around catheter</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Superior vena cava, right atrium</td>
<td>10½ mo</td>
<td>No</td>
<td>No pertinent alterations</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Superior vena cava, right atrium</td>
<td>6½ yr</td>
<td>No</td>
<td>Catheter incorporated in wall of vein and heart</td>
</tr>
<tr>
<td>Unknown</td>
<td>Pulmonary artery</td>
<td>Unknown</td>
<td>No</td>
<td>Not described</td>
</tr>
<tr>
<td>Jugular vein</td>
<td>Right atrium</td>
<td>ns</td>
<td>No (?)</td>
<td>No autopsy</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Right heart</td>
<td>14 days</td>
<td>Yes</td>
<td>Perforation of right heart, hemopericardium</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Right atrium</td>
<td>4 wk</td>
<td>No</td>
<td>No pertinent changes</td>
</tr>
<tr>
<td>Arm vein</td>
<td>Superior vena cava, right heart</td>
<td>About 1 yr</td>
<td>Yes</td>
<td>Tricuspid &amp; systemic candidiasis</td>
</tr>
</tbody>
</table>
### Table 2

**Surviving Patients with Catheter Embolism (Twenty-four Cases)**

<table>
<thead>
<tr>
<th>Author(s) reference year</th>
<th>Age (yr)</th>
<th>Sex of patient</th>
<th>Principal clinical diagnosis</th>
<th>Length (cm) of lost catheter</th>
<th>Mechanism of loss of catheter fragment</th>
<th>Site of entry</th>
<th>Site of recovery</th>
<th>Length of interval from loss to recovery</th>
<th>Evidence of injury by catheter fragment</th>
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</thead>
<tbody>
<tr>
<td>Moncrief,15,16 1958</td>
<td>19</td>
<td>ns</td>
<td>ns</td>
<td>33</td>
<td>Catheter cut by needle</td>
<td>Femoral vein</td>
<td>Not recovered</td>
<td>—</td>
<td>None (after 2 yr)</td>
</tr>
<tr>
<td>Trusler &amp; Mustard,16</td>
<td>10</td>
<td>F</td>
<td>Appendectomy</td>
<td>18</td>
<td>Catheter detached</td>
<td>Arm vein</td>
<td>Superior vena cava, rt. atrium</td>
<td>25 days</td>
<td>None</td>
</tr>
<tr>
<td>Beaulieu &amp; Gravel,17</td>
<td>48</td>
<td>F</td>
<td>Pheochromocytoma</td>
<td>16</td>
<td>Catheter disappeared</td>
<td>Arm vein</td>
<td>Superior vena cava, rt. atrium</td>
<td>14 days</td>
<td>None</td>
</tr>
<tr>
<td>Funke et al.,18 1961</td>
<td>6</td>
<td>M</td>
<td>Appendectomy</td>
<td>11</td>
<td>Catheter cut by needle</td>
<td>Vein of hand</td>
<td>Cephalic vein</td>
<td>Hours or minutes</td>
<td>None</td>
</tr>
<tr>
<td>Bennett,19 1963</td>
<td>47</td>
<td>M</td>
<td>Diverticulitis</td>
<td>10</td>
<td>Catheter broke</td>
<td>Arm vein</td>
<td>Not recovered</td>
<td>—</td>
<td>None</td>
</tr>
<tr>
<td>Edwards,20 1963</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 1</td>
<td>78</td>
<td>F</td>
<td>Cholecystectomy</td>
<td>ns</td>
<td>Catheter cut by needle</td>
<td>Saphenous vein</td>
<td>Saphenous vein</td>
<td>Minutes?</td>
<td>None</td>
</tr>
<tr>
<td>Case 2</td>
<td>42</td>
<td>F</td>
<td>Pelvic surgery</td>
<td>15</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Not recovered</td>
<td>—</td>
<td>None (after a few days)</td>
</tr>
<tr>
<td>Case 3</td>
<td>38</td>
<td>M</td>
<td>Bronchial asthma</td>
<td>ns</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Arm vein</td>
<td>Hours</td>
<td>None</td>
</tr>
<tr>
<td>Holder &amp; Crow,21 1963</td>
<td>1/3</td>
<td>F</td>
<td>Hydrocephalus</td>
<td>6</td>
<td>Catheter detached</td>
<td>Neck vein</td>
<td>Right ventricle</td>
<td>17 days</td>
<td>None</td>
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<tr>
<td>Taylor &amp; Rutherford,22</td>
<td>&gt; 40</td>
<td>M</td>
<td>Delirium tremens</td>
<td>ns</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Not recovered</td>
<td>—</td>
<td>None (after 1 mo)</td>
</tr>
<tr>
<td>Udwadia &amp; Edwards23</td>
<td>3</td>
<td>F</td>
<td>Skin grafting operation</td>
<td>15</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Arm vein</td>
<td>Minutes</td>
<td>None</td>
</tr>
<tr>
<td>Irmer,24 1964</td>
<td>45</td>
<td>F</td>
<td>Pelvic surgery</td>
<td>23</td>
<td>Catheter disappeared</td>
<td>Arm vein</td>
<td>Pulmonary artery</td>
<td>1 day</td>
<td>Thrombus at end of catheter</td>
</tr>
<tr>
<td>Steiner et al.,25 1965</td>
<td>11</td>
<td>M</td>
<td>Traffic injuries</td>
<td>ns</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Right heart</td>
<td>Some days</td>
<td>Inflamed area in right atrium</td>
</tr>
<tr>
<td>Borgeskov et al.,12 1966</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Case 2</td>
<td>2</td>
<td>M</td>
<td>Hydrocephalus</td>
<td>17</td>
<td>Catheter broke</td>
<td>Jugular vein</td>
<td>Pulmonary artery</td>
<td>3 wk</td>
<td>None</td>
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<td>Case 3</td>
<td>15</td>
<td>M</td>
<td>Hemophilia A</td>
<td>8-10</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Not recovered</td>
<td>—</td>
<td>None (after 3 yr; catheter in pulmonary artery)</td>
</tr>
<tr>
<td>Case 4</td>
<td>12</td>
<td>M</td>
<td>Cardiac malformation</td>
<td>15</td>
<td>Catheter broke</td>
<td>Arm vein</td>
<td>Axillary vein</td>
<td>Minutes?</td>
<td>None</td>
</tr>
<tr>
<td>Case</td>
<td>Name</td>
<td>Age</td>
<td>Sex</td>
<td>Major Diagnosis</td>
<td>Catheter Position</td>
<td>Arm Vein Location</td>
<td>Duration</td>
<td>Hours?</td>
<td>None</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>-----</td>
<td>-----</td>
<td>-------------------------------------</td>
<td>---------------------------</td>
<td>------------------</td>
<td>----------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Coblenz, 1966</td>
<td>6</td>
<td>F</td>
<td>Injuries of extremity</td>
<td>Arm vein</td>
<td>Arm vein</td>
<td>Hours?</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Abdominal gun shot wound</td>
<td>70</td>
<td>M</td>
<td>Catheter cut during adjustment</td>
<td>Arm vein</td>
<td>Arm vein</td>
<td>Hours?</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dehydration</td>
<td>47</td>
<td>M</td>
<td>Catheter was displaced</td>
<td>Arm vein (?)</td>
<td>Right heart</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Herniorrhaphy</td>
<td>58</td>
<td>M</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Not recovered</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Ileus</td>
<td>71</td>
<td>F</td>
<td>Catheter cut during dressing change</td>
<td>Arm vein (?)</td>
<td>Superior vena cava, rt. atrium</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Alcoholic coma</td>
<td>66</td>
<td>M</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>Not recovered</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mariano et al., 1966</td>
<td>55</td>
<td>M</td>
<td>Convulsive seizures</td>
<td>Catheter cut by needle</td>
<td>Arm vein</td>
<td>7 days</td>
<td>Thrombus at end of catheter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Massumi &amp; Ross, 1967</td>
<td>60</td>
<td>M</td>
<td>Hepatic cirrhosis</td>
<td>Catheter cut by needle</td>
<td>Pulmonary artery</td>
<td></td>
<td>None</td>
<td>(catheter in pulmonary artery)</td>
</tr>
</tbody>
</table>

### Explanation for Tables
- ns = not stated.

**POLYETHYLENE CATHETER EMBOLISM**

A catheter, as Hurley has recently presented, has recently been proven lethal in mice. The route of entry of fungi to the body is of major significance for the extent and severity of the ensuing fungal infection. Thus, organisms introduced directly into the bloodstream stream into the peritoneal cavity or into the peritoneal cavity, and the fungal infection spreads more rapidly than those inoculated into the lungs. In view of the otherwise unexplained fever and the absence of precipitating valvar disease, the possibility of ingrowth of monilial vegetations into the body of the tricuspid valve should also be considered.

In our patient no clinical signs of monilial vegetations, or historical evidence of monilial endocarditis were present. It appears likely, however, that the patient was infected with monilial endocarditis in the majority of cases, and endocarditis was present. It is true that the patient in the present case, in which monilial endocarditis was present, had a similar infection.
the third, no preexisting valvular disease was demonstrable in the tricuspid valve even though the mitral valve of this same patient had been the seat of a Streptococcus viridans infection. In the fourth case, finally, monilial vegetations were present on the endocardium of the right atrium but apparently not on any of the valves.

The clinical features of monilial valvar infection are essentially the same as those of bacterial endocarditis. However, embolization of comparatively large peripheral or, in cases of tricuspid valve moniliasis such as ours, of comparatively large pulmonary arteries is very common owing to the friability and bulkiness of the Candida vegetations on the affected valves. The prognosis is grave; treatment with amphotericin B has saved only three patients’ lives. A fourth patient was cured by Kay and associates who removed the infected portion of the tricuspid valve surgically after amphotericin B treatment had failed to arrest the course of the disease.

Addendum

After the completion of this article, Doering and associates published a review of 26 cases of plastic catheter embolism, including three cases briefly mentioned by Edwards which are not contained in our tabulation. They added no fewer than 23 cases of their own, all of them observed in hospitals of the Los Angeles area. In the discussion of the paper by Doering and associates, Tuell pointed out that the first case of fatal embolization of an intravenous catheter, in a dog, had been reported by him as early as 1948. In two patients of Doering and associates and in a patient of Mirhoseini and associates the embolized catheter fragment was surgically removed from the pulmonary artery.

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KLAUS F. WELLMANN, ARTHUR REINHARD and EDGARDO P. SALAZAR

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