THE USE OF INDWELLING PLEURAL CATHETER FOR MALIGNANT PLEURAL EFFUSION

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ABSTRACT

Malignant Pleural Effusion (MPE) is one of the metastatic processes that occur due to lung cancer. MPE condition can be used as one of the parameters to assess the degree of disease and prognosis of lung cancer patients. Shortness of breath is the most common symptom experienced by lung cancer patients. Indwelling Pleural Catheter (IPC) are recommended as effective management for shortness of breath in patients. The use of IPC also has a pleurodesis effect on problems in the pleura. Palliative therapy with the use of IPC can reduce the length of hospitalization and drainage treatment can be done on an outpatient basis. The development of IPC selection as the first line in MPE cases is also supported by several recent studies so its use is more recommended to be applied to MPE. Some other studies mentioned that IPC is rarely used due to limitations for installation techniques and long-term care is needed after IPC installation.
Keywords: Procedure, Indwelling Pleural Catheter, Malignant Pleural Effusion

ABSTRAK

Efusi Pleura Ganas (EPG) merupakan salah satu proses metastasis yang terjadi akibat kanker paru. Kondisi EPG dapat digunakan sebagai salah satu parameter untuk menilai derajat penyakit dan prognosis pasien kanker paru. Sesak napas merupakan gejala yang paling umum dialami oleh pasien kanker paru. Indwelling Pleural Catheter (IPC) direkomendasikan sebagai tatalaksana yang efektif untuk mengatasi sesak napas pada pasien. Penggunaan IPC juga memiliki efek pleurodesis terhadap masalah di pleura. Terapi paliatif dengan penggunaan IPC dapat mengurangi lama rawatan di rumah sakit dan perawatan drainase dapat dilakukan dengan rawat jalan. Perkembangan pemilihan IPC sebagai lini pertama pada kasus EPG juga didukung oleh beberapa studi terbaru sehingga penggunaannya lebih direkomendasikan untuk diterapkan pada EPG. Beberapa studi lain menyebutkan bahwa IPC jarang digunakan akibat keterbatasan untuk teknik pemasangan dan dibutuhkan perawatan jangka panjang setelah pemasangan IPC.
Kata kunci: Prosedur, Indwelling Pleural Catheter, Efusi Pleura Ganas

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INTRODUCTION

In situations of malignancy, Malignant Pleural Effusion (MPE) is the most frequent issue.[1] MPE accounts for between 15 and 35 percent of all pleural effusion cases global each year.[2] A malignant disease, such as lung cancer, can develop complications or show early symptoms when there is a history of recurrent effusion.[3] In 2022, there will be 125,000 new instances of lung cancer diagnosed using MPE in Europe, compared to around 150,000 cases annually in the United States of America.[3,4] Additionally, studies at England indicate that there are about 50,000 instances of MPE annually, with an estimated 50% of these cases being metastatic diseases. Breast cancer, lymphoma, gastric cancer, and mesothelioma are a few of the additional cancers most frequently linked to MPE.[4]

One of the poor prognostic indications in individuals with lung cancer is the MPE status. Shortness of breath, coughing, and chest pain are the most typical signs of MPE. According to certain research, patients with lung cancer with MPE have a maximum 6 month survival time after diagnosis.[5] This implies that patients with lung cancer require a palliative care management strategy.[6] Palliative care concentrates on symptom management in order to enhance the patient's quality of life. Palliative care should be provided in a personalized, multidisciplinary manner in MPE.[7]

One alternative for palliative therapy in cases of MPE is the placement of an Indwelling Pleural Catheter (IPC). The advantages of utilizing IPC include improved symptom control, a shorter hospital stay, and fewer pleural interventions with fewer consequences. According to certain research, IPC usage also has the potential to cause spontaneous pleurodesis within 28 days.[8] A systematic review of 19 research found that employing IPC had a 95% clinical success rate in 1,370 patients.[9,10] IPC use generally results in minimal morbidity and is well tolerated.[11]

MALIGNANT PLEURAL EFFUSION

Pleural effusion caused by the MPE condition is a malignant process, as shown by the detection of malignant cells through cytology or histopathology investigation.[12] One of the frequent side effects of the metastatic process is the MPE condition. Up to 15% of cancer patients experience metastatic processes that appear as MPE. Following the lung, other cancer types are the organs most frequently implicated in the metastatic process.[13,14] The most typical symptoms that MPE patients report are chest discomfort and shortness of breath. The volume or amount of the pleural effusion and the patient's cardiac health both influence how severe the MPE symptoms are.[14]

An estimated 500,000 new cases of MPE each year in the United States and Europe make it one of the major causes of cancer morbidity. Cancer patients with MPE are also among those with poor prognostic indicators, with a 3-12 months survival rate.[14,34] Although epidemiologic research on MPE are uncommon, the incidence is thought to be around 15% of all instances of cancer. MPE instances made up 15% of the 191 cases of malignancy, according to a study conducted in the United States of America. Based on data from all types of malignancy cases, almost one third of MPE cases are caused by lung cancer.[13,35]

Non-small Cell Lung Cancer (NSCLC), which has a proportion of 40% Adenocarcinoma, 23% Squamous Cell Carcinoma, and 17.6% Small Cell Carcinoma, is the most common cause of MPE. This happens because NSCLC has one of the highest incidences of lung cancer, accounting for nearly 75% of all cases. Another study found that breast cancer and

lung tumor metastases account for roughly 50–60% of MPE cases, with lymphoma, tumors of the gastrointestinal and genitourinary systems, and tumors of uncertain original origin accounting for 7-15% of cases.[35]

PATHOPHYSIOLOGY

The lymphatic system in the parietal pleura physiologically produces 10 to 20 ml of pleural fluid each day, which is then reabsorbed. Increased pleural fluid production and/or decreased pleural fluid absorption create an imbalance that leads to pleural effusion. The parietal and visceral pleura are responsible for producing pleural fluid. Since the parietal pleura has a larger pressure gradient than the visceral pleura and produces pleural fluid mostly through capillaries or stomas, it serves as the primary drainage component. Systemic diseases like heart failure, renal failure, or infection are frequently linked to the mechanism of increased pleural fluid generation.[15]

On the basis of intrinsic and extrinsic factors, the mechanism of decreased pleural fluid reabsorption can be differentiated. A reduction in the lymphatic system's capacity to contract can typically be the source of intrinsic causes. Cancer cells can invade the lymphatic system, causing this, as can hormone imbalances or anatomical anomalies. Limitations in breathing patterns, mechanical compression of the lymphatic system, or lymphatic system blockage are examples of extrinsic influences. Figure 1 gives an overview of the pathophysiology of the pleural effusion discussed above.[16]

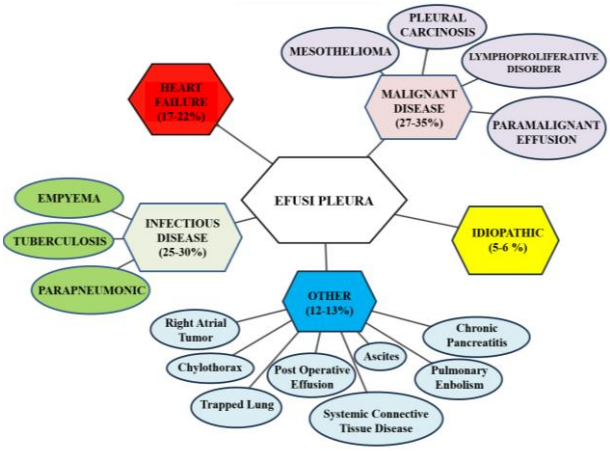

Figure 1. Pathophysiology of Pleural Effusion.[15]

MPE will appear in about 55–60% of patients with pleural metastases. When tumor cells have hematogenously or lymphogenously invaded the pleural cavity, the pathophysiology of MPE starts to develop. The development of tumor cells obstructs lymphatic drainage, which leads to fluid collection in the pleural cavity.[17] Interconnected interactions between tumor cells and pleural molecular groups will occur as a result of the carcinogenesis process. Vascular Endothelial Growth Factor (VEGF) is secreted by tumor cells to promote the angiogenesis process. Additionally, pleural region inflammation and enhanced capillary permeability are brought on by tumor cell development. Additionally, the carcinogenesis process's atelectasis causes a drop in intrapleural pressure, which can lead to pleural effusion.[18,19]

PROCEDURE MANAGEMENT

Improving the patient's quality of life should be the immediate goal of palliative care. The goal of palliative management is to lessen dyspnea symptoms and discontinue more invasive pleural therapies. The type of original tumor, expected survival, functional status of the patient, and the decision of further care to be made are other

considerations that must be taken into account. The choice of care in MPE cases is customized, and periodic pleural effusion drainage, pleurodesis, and the use of IPC are some of the suggested actions.[20]

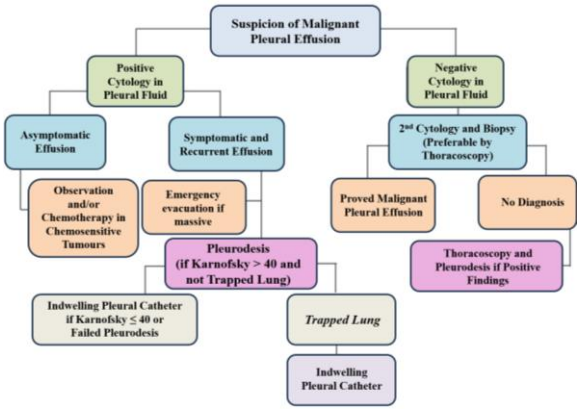

Figure 2. Management Algorithm for Malignant Pleural Effusion.[20]

The most common clinical symptom of MPE is restless breathing, which is occasionally accompanied by a persistent cough and chest pain. Asymptomatic MPE is unintentionally discovered in about 25% of patients during thoracic photo evaluation. The basic goal of treating MPE is to minimize any invasiveness while controlling shortness of breath symptoms.[21] To reduce recurring drainage, one possibility is to use IPC as a conclusive pleural intervention. Before beginning the action, clinical references such as the parameters of the shortness of breath symptoms and the volume or amount of pleural effusion are used. The management strategy for MPE management recommended by the Spanish Society of Interventional Pulmonology and Thoracic Surgery is depicted in figure 2.[20,22]

INDWELLING PLEURAL CATHETER

IPC is one method for pleural fluid drainage that involves percutaneously inserting a silicone catheter into the pleural cavity (Figure 3). This catheter, which has a one-way valve, can sustain lung expansion for a long time via sporadic pleural fluid drainage.[23] The goal of this operation is to manage the MPE related symptoms so that patients can get outpatient therapy and shorten their stay in the hospital. According to certain research, IPC is just as effective as pleurodesis. It is advised that IPC be used as the first line of defense in the management of MPE because it can also be suggested in unsuccessful pleurodesis.[24]

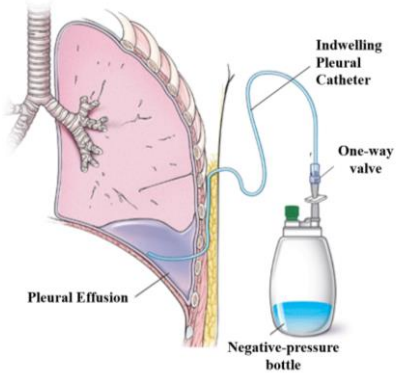

Figure 3. Indwelling Pleural Catheter.[7]

IPC was approved by the British Thoracic Society (BTS) in 2010 as a second line therapy in MPE situations. After conventional pleurodesis with sclerotic agents, individuals with recurrent effusion receive MPE insertion.24 According to the findings of the most recent randomized clinical trial study, IPC is now an effective first-line treatment for reducing shortness of breath symptoms. IPC then contributes to more aggressive therapy by including sclerotic agents to achieve quick pleurodesis.[25,26]

INDICATIONS AND CONTRAINDICATIONS

Recurrent effusions, such those that occur in MPE cases, are the primary indication for the use of IPC. IPC may also be used in MPE patients with trapped lung and in cases of recurrence following pleurodesis.[27] Additionally, non-malignant pleural effusions, which are frequently accompanied by congestive heart failure or hepato-renal syndrome, may be treated with

IPC. Numerous studies have documented the effectiveness of IPC in treating chronic pleural infections and post-transplant pleural effusion. However, it was shown in some other research that choosing IPC was only done as a last resort.[28]

Table 1. IPC Installation Tools and Materials.[7]

Tools:		
• Sterile gloves • Mask • Sterile gown • Boots • Head cover • Safety glasses	• Spuit • Indwelling catheter • Introducer guide wire • Dilator • Vacuum bottle • Hecting set and sterile bowl	• J-tipped wire • Tunnel needle • Peel away catheter insertion sheath
Materials:		
• Povidone iodine • Alcohol 95% • Lidocaine 2%	• Sterile Doek • Sterile gauze • Needle hecting	

There are currently no clear limitations on the use of IPC. Some studies use the same general restrictions that apply to non-invasive surgery. The primary obstacle to IPC insertion is refusal of informed permission. Infections like abscesses and cellulitis at the IPC insertion area are also not advised since they could make the infection worse or spread farther. Conditions like broken ribs and uncontrolled bleeding are also prohibited since they could make implantation more difficult. Severe malnutrition and a patient's life expectancy of less than one month are other circumstances that contraindicate IPC.[29]

INSTALLATION TECHNIQUE

IPC insertion starts once the patient or the patient's family has provided their informed consent. Then, as shown in table 1 and figure 4, the equipment and supplies for the IPC installation operation are arranged. The patient is placed in a lateral decubitus position to make it easier to reach the pleural fluid leak. If the patient is unable to lie completely flat, raise the bed 45^{o} or use a pillow to put them in a more comfortable position for the IPC installation. The patient's arms are raised and folded behind or beside the head if they are in the lateral decubitus posture so that the side of the chest that needs to be incised may be viewed clearly.[30,37]

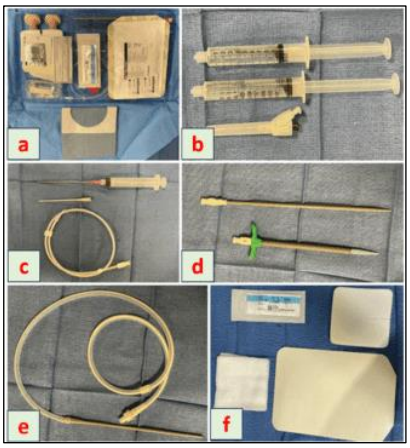

Figure 4. Catheter insertion kit contents: (a) Insertion kit just after opening, (b) Syringes with lidocaine and needle, (c) Guidewire introducer needle and j-tipped wire, (d) Dilator and peel away catheter insertion sheath, (e) Silicone catheter with multiple fenestrations and attached metal tunneler, (f) Suture for anchoring catheter and dressing contents.[37]

As a preliminary evaluation, an ultrasonography (USG) examination is carried out to confirm the location and gauge the size of the pleural effusion. In order to pinpoint the precise incision area, the IPC's insertion point is also identified via an ultrasound examination. The insertion location is typically right at or close to the mid axillary line between the fourth and fifth ribs. This insertion point's position is frequently referred to as the safety triangle, which is also utilized as a guide while pleural punching. A marking is placed on the skin's surface for the silicone catheter tunnel incision after the insertion spot has been identified (Figure 5).[30,37]

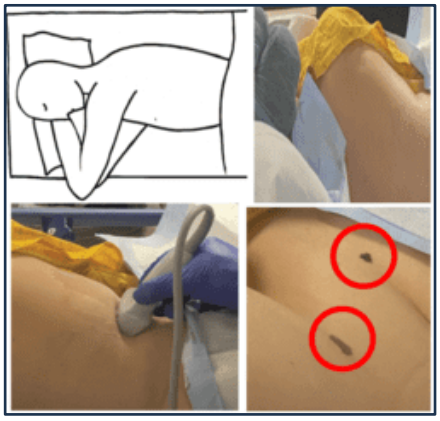

Figure 5. Patient positioning (lateral decubitus or supine), ultrasound of the pleural space and marking of appropriate IPC insertion sites.[37]

A modified Seldinger approach was used to insert IPC. Hand cleaning and the use of personal protection equipment, such as masks, goggles, sterile gowns, sterile gloves, and boots, are the first steps in the procedure. After that, take septic and antiseptic precautions on the incision site. Use sterilized doek to limit the region of effect. On the skin's surface, an incision is made, and the region is then covered with local anesthetic. Site-1 refers to this region, and Site-2 to the IPC catheter tunnel. From the subcutaneous tissue to the parietal pleura, local anesthetic is injected. To make sure there is no resistance while putting the needle into the pleura, pleural fluid is aspirated (Figure 6).[28,37]

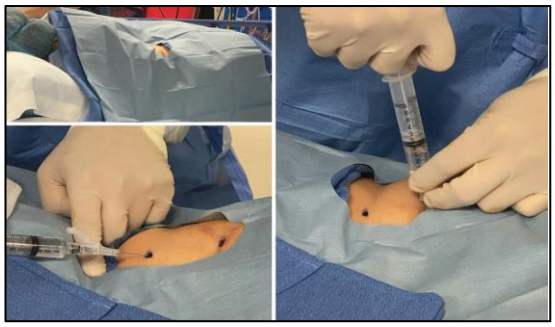

Figure 6. Sterilized and draped patient and injection of lidocaine to anesthetize the IPC insertion site and tunnel tract.[37]

Until pleural fluid is aspirated, the j-tipped guidewire introducer is introduced at site-1 with a 22G or 25G abocath. After that, the guidewire introducer is taken out and the j-tipped wire is put into the pleural cavity. The catheter entry point is then created at site-1 with a 1-2 cm long incision. A 1-2 cm incision is then made at site 2, which is roughly 5 cm away from site 1 and will serve as the catheter outlet. Through the subcutaneous tissue, introduce the catheter tube from site-2 to site-1 by connecting the catheter tip to a tunnel needle. Once the polyester cuff or catheter cuff is directly in the subcutaneous tissue, roughly 1 cm away from site-2, the tunnel needle is then let go. A percutaneous tunnel is then created by applying a little amount of pressure in a circular motion (Figure 7).[37]

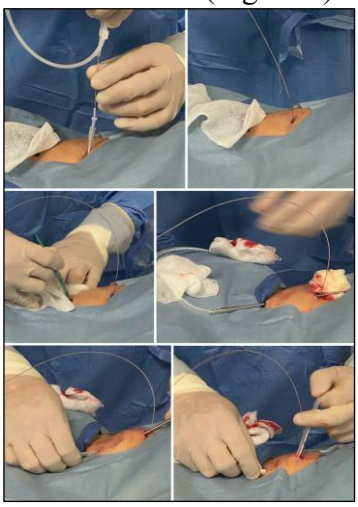

Figure 7. Guidewire insertion followed by tunneling of the catheter.[37]

The next step is to extend the catheter pathway to the pleural cavity by inserting the dilator and sheath catheter via the guidewire at site-1 (Figure 8a). In order for the pleural fluid to exit through the sheath catheter, the dilator and guidewire are then simultaneously let go (Figure 8b). The IPC catheter tube's proximal end is then introduced into the pleural cavity through the catheter sheath (Figure 8c). The skin on the catheter sheath is peeled off while the IPC catheter tube is pressed (Figure 8d). It is verified that the IPC catheter is not kinked

or folded after it has passed into the pleural cavity.[28,37]

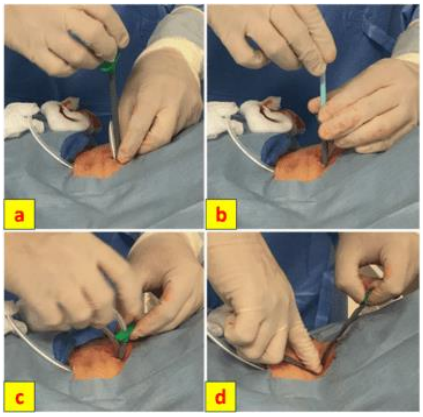

Figure 8. Dilator and peel away sheath insertion into the pleural space over the guidewire, feeding of IPC through the sheath and peeling of the sheath while holding the catheter in place.[37]

The IPC catheter tube was then fixed to the skin with a suture after being connected to the drainage bottle. Both incision regions were sutured and secured with thick sterile gauze (Figure 9c). For two to three weeks following surgery, the suture wound healing process was monitored. To make sure the IPC catheter tube insertion is working properly, pleural fluid is drained. A one-way valve on the exterior of the catheter allows for the staged evacuation of pleural fluid (Figure 9b). As a starting point for pleural fluid assessment during outpatient care, a post-operative thoracic photo examination is carried out (Figure 9).[37]

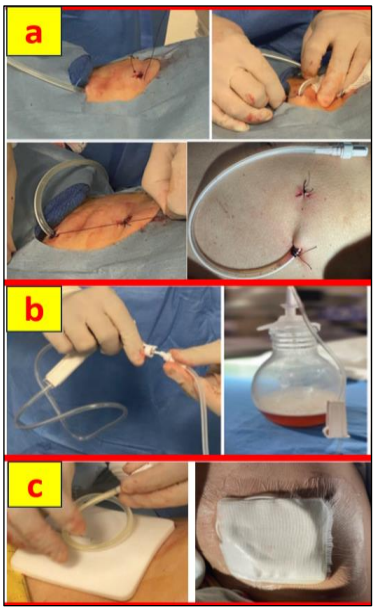

Figure 9. Suture placement, IPC drainage and sterile dressing application.[37]

COMPLICATIONS

IPC therapy evaluation comes next after IPC insertion. The IPC insertion method can have several of issues that should be considered when evaluating IPC treatment.[31] Pleural infection is the most probable consequence. Most cases of pleural infections caused by catheters can be treated with antibiotics without having to remove the catheter because they are often minor. The transformation of pleural fluid into purulent fluid and the presence of bacteria in the culture findings can be used to make a diagnosis. The incidence of pleural infections caused by catheter tubes was 4.9%, according to the Fysh et al study. Antibiotic treatment was effective in treating up to 94% of patients who had this infection. Cellulitis, empyema, and tunnel-related infections can also be caused by catheter-related pleural infections.[32]

With only 5% of patients, metastatic problems in the tunnel are extremely uncommon. Mesothelioma patients account for almost all metastases in the tunnel region. Tumor self-seeding or seeding process is the term used to describe

secondary metastasis of cancer cells. Malignant cells move through the subcutaneous channel through the catheter, which causes seeding. Increased intra pleural pressure, which results in fluid leakage following catheter insertion, is another factor contributing to this illness. Drainage by thoracosynthesis can be performed before IPC insertion to avoid this. Radiotherapy can be used to treat metastases that are localized.[33]

With a 36% prevalence, individuals frequently feel chest discomfort following IPC placement. Typically, chest discomfort symptoms are not severe and go away three days after IPC placement. Analgesic administration can also be utilized to ease patient complaints. Negative pressure from IPC drainage can also produce pain, but it can be controlled by reducing or temporarily ceasing the drainage. Patients with confined lungs experience this kind of pain more frequently. The management must release the IPC if the pain is severe and persistent.[33]

In 13% of cases, catheter tube leaking also happened. The majority of the time, the problem is reversible and surgery is rarely necessary. Metastasis in the tunnel is assumed to be the cause of the leakage mechanism. This happens as part of the atelectasis process, which causes an increase in intrapleural pressure and catheter leaking. Draining the pleural fluid before inserting the IPC helps stop catheter leakage. An additionally defense against these issues is proper fixation.[31,33]

In 14% of patients using IPC, localized pleural effusion and clinical symptoms also happened. The septa and many loculations that are produced as result of fibrin material building up are related to the etiology. These loculations and septations hinder fluid outflow. Studies have shown that individuals with IPCs can benefit from the administration of fibrinolytic medications like tissue Plasminogen Activator (tPA), streptokinase, or urokinase by improving drainage. Other therapeutic approaches that could be suggested include pleurocoscopy, Video Assisted Thoracoscopy (VATS), combined intrapleural fibrinolysis with tPA and DNase, and intra pleural dornase alfa (DNase).[34]

The uncommon consequence of catheter blockage only affects about 5% of MPE patients. More often than complete occlusion, partial obstruction occurs. Obstruction develops when fibrinous exudate builds up inside or outside the catheter lumen. Spooling the catheter with saline is one treatment option. Spooling the catheter with tPA and performing an after-action review can be used to continue an obstruction that cannot be cleared. In case that spooling is still unsuccessful, the catheter is removed and reinserted.[34]

CONCLUSION

An extensive buildup of exudate fluid from a malignant disease, as shown by cytologic or histopathologic investigation, causes a malignant pleural effusion. One prognostic indication for cancer patients is the MPE. By percutaneously inserting a silicone catheter into the pleural cavity, IPC is used to drain pleural fluid. Palliative management is one of the indications for IPC and is advised as the initial course of treatment in cases of malignancy with MPE. The use of IPC in cancer patients can shorten the duration of therapy and in the hospital, preventing secondary infections while the patient is there. Recurrent effusion after pleurodesis, lung-trapped MPE situations, and patients without non-malignancy are some additional indications for the use of IPC. Pleural infection, metastasis of the catheter line, chest discomfort, catheter leakage, localized pleural effusion, and occlusion of the IPC catheter tube are complications of IPC placement.

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