Indwelling Pleural Catheters

Audra J. Schwalk, MD, MBA[a,*], David E. Ost, MD, MPH[b]

KEYWORDS

• Indwelling pleural catheter • Tunneled pleural catheter • Malignant pleural effusion
• Nonmalignant pleural effusion • Pleurodesis

KEY POINTS

- Indwelling pleural catheters may be used in the management of recurrent, symptomatic malignant and nonmalignant pleural effusions and are the treatment of choice for nonexpandable lung.
- Indwelling pleural catheters and thoracoscopic or chest tube chemical pleurodesis both improve patient symptoms of breathlessness and health-related quality of life to a similar extent.
- Indwelling pleural catheter placement plus pleural sclerosant administration may be both a palliative and cost-effective treatment option for patients with an expandable lung.
- Many indwelling pleural catheter-related infectious complications can be managed without catheter removal.

INTRODUCTION

Pleural effusion is a common clinical problem estimated to affect 1.5 million people in the United States each year.[1] A large proportion are either nonmalignant or related to infection,[2] but malignant pleural effusions (MPEs) may also lead to significant health care resource use with an estimated 150,000 cases annually.[3,4] Lung cancer is the leading cause of MPE and is present in up to 15% of patients at diagnosis, with an even greater proportion of patients developing MPE at some point in the course of their disease.[5] MPE can complicate almost any cancer[6] and may also develop as the primary manifestation of a disease, as is the case with malignant mesothelioma.

After the identification of a symptomatic pleural effusion, a thoracentesis is typically performed for cytologic and laboratory evaluation of pleural fluid, as well as for assessment of symptom improvement and lung re-expansion. Despite initial drainage, more than one-half of MPEs will recur within 90 days.[7] Recurrent effusions may cause significant dyspnea, cough, and chest discomfort, resulting in a poor quality of life for these patients. A definitive pleural procedure is recommended for patients with recurrent, symptomatic MPE,[3,6,8] except in cases of slow fluid reaccumulation, an expected rapid and marked response to treatment, or a very short life expectancy. Several options are available for the definitive management of MPE.

Indwelling pleural catheters (IPCs) are one option for definitive MPE management. IPCs are being placed with increasing frequency since their introduction more than 30 years ago[9] and the body of evidence pertaining to their use continues to grow. Initially, observational studies and retrospective reviews comprised the majority of publications, but several larger, randomized controlled trials (RCTs) are now available. Many compare IPC placement to chemical pleurodesis, either thoracoscopic or via chest tube, but the primary outcomes between studies are inconsistent, making direct comparison of results difficult. Until recently, most of the available literature on IPCs pertained to patient selection, indications, and postprocedural outcomes; however, guidelines

[a] Division of Pulmonary and Critical Care, The University of Texas Southwestern Medical Center, Professional Office Building II, 5939 Harry Hines Boulevard, Dallas, TX 75390, USA; [b] Department of Pulmonary Medicine, The University of Texas MD Anderson Cancer Center, Unit 1462, 1515 Holcombe Boulevard, Houston, TX 77030, USA
* Corresponding author.
E-mail address: Audra.schwalk@utsouthwestern.edu

Clin Chest Med 42 (2021) 739–750
https://doi.org/10.1016/j.ccm.2021.08.009

and expert panel recommendations regarding postinsertion IPC management are now available. This review summarizes the latest, high-quality evidence and recommendations for IPC use.

THERAPEUTIC OPTIONS

Before discussing IPCs in greater detail, it is important to review available options for the management of recurrent, symptomatic MPE. Historically, definitive treatment involved a surgical procedure and hospitalization, with a median length of stay ranging from 5 to 10 days depending on the specific procedure performed.[5] Thoracoscopic talc pleurodesis may be performed by an interventional pulmonologist in an endoscopy suite using one access port with local anesthesia and moderate sedation. A video-assisted thoracoscopic surgery (VATS) pleurodesis procedure, however, is usually performed by a thoracic surgeon in an operating room. This procedure is more invasive because it typically requires multiple access ports, a double-lumen endotracheal tube, and general anesthesia. Both procedures allow for biopsy of the parietal pleura, evaluation of full lung re-expansion, lysis of simple adhesions, and adequate instillation of pleural sclerosants, but VATS may allow for improved visualization of the pleura given the lung is fully deflated.[5] VATS also provides the ability to perform complementary procedures such as mechanical abrasion, lysis of more complex adhesions, decortication for treatment of nonexpandable lung, and parietal pleurectomy, which may be beneficial in certain clinical scenarios.[5] VATS is typically reserved for patients with good functional status who are deemed acceptable surgical candidates, but for those not meeting these criteria, alternative treatment methods are typically pursued.

Chest tube drainage followed by pleurodesis with a sclerosing agent is another option for the management of recurrent, symptomatic MPE. This method may be an option for patients who are not surgical candidates or for patients who already have a chest tube in place; however, similar to VATS pleurodesis, it requires an inpatient hospital stay of several days.[10–13]

IPCs are now commonly being offered as an alternative to surgical pleurodesis and other definitive procedures.[9,14] This change is likely secondary to the ease of placement and lack of need for hospitalization and sedation,[9,10] while still providing improvement in symptoms.[15] IPC placement may be performed by a variety of practitioners, such as pulmonologists, surgeons, and interventional radiologists. The administration of talc and other sclerosants through an IPC is also a viable treatment option in some patients and has been the focus of recent publications.[16]

PREPROCEDURE PLANNING

Patients with a recurrent pleural effusion that experience symptom improvement after initial pleural fluid drainage should be considered for IPC placement or other definitive treatment.[3,6,8] Preprocedure counseling pertaining to IPC placement, home drainage procedures, and catheter-related care should be routine.[17] Patients should provide their informed consent, demonstrate an adequate understanding of the IPC and potential complications, and also have a reliable caregiver available to assist in catheter drainage and routine care before consideration of IPC placement. Insurance often covers IPC drainage bottles and related supplies, but this factor should also be confirmed before catheter placement to avoid any interruptions in patient care.

PROCEDURAL APPROACH

Several IPC options are available and the decision to use one catheter over another depends on local availability as well as patient and provider preference. Each of the catheters have slight differences, but all are made of soft silicone and have multiple fenestrations to allow for the drainage of pleural fluid. The Merit Medical Aspira pleural drainage system is designed to drain pleural fluid with low pressure via gravity,[18] whereas the PleurX and Rocket pleural drainage systems are designed to drain pleural fluid via a vacuum bottle.[19,20]

The details of IPC placement may vary between institutions and depending on what specific catheter is being placed, but generally are quite similar. One approach to IPC placement is provided in **Box 1**. Videos for PleurX, Aspira, and Rocket catheter placement may be viewed at: https://www.bd.com/en-us/company/video-gallery?video=903266637001 (procedure begins at 3:46 minutes), https://www.myaspira.com/videos/ (insertion of a peritoneal catheter, although similar kit contents and technique), and https://sales.rocketmedical.com/products/indwelling-drainage-catheters, respectively.

Complications during IPC placement are rare but should be recognized because they can occur in 2.8% to 6% of procedures. Complications are similar to those encountered with any pleural procedure and include pneumothorax (generally not clinically significant because these usually arise from the entry of atmospheric air as opposed to visceral pleural injury and there will now be a catheter in the pleural space), bleeding, subcutaneous

Box 1
Outlined procedure for IPC placement

1. Place the patient in a semirecumbent position. Other positions are acceptable depending on patient tolerance and expected insertion site.
2. Secure the patient's ipsilateral arm above the head or across the chest to fully expose the potential pleural entry site.
3. Identify the optimal site for IPC insertion and exit with the use of ultrasound examination and mark these sites. When possible, avoid areas of skin with evidence of active infection or malignant skin infiltration.
4. Clean the pleural entry and exit sites as well as the surrounding chest wall.
5. Don sterile personal protective equipment and prepare the IPC insertion kit.
6. Use the filter straw to prepare syringes with 1% lidocaine and then anesthetize the skin, subcutaneous tissue and parietal pleura with the 22G or 25G needles.
7. Advance the guidewire introducer with needle in the anesthetized area, while applying suction, until pleural fluid is aspirated.
8. Hold the needle and syringe stable and advance the guidewire introducer into the pleural space until it is flush against the patient's skin. Remove the needle. Pleural fluid may drain out of the guidewire introducer at this point.
9. Insert the J-tip wire through the guidewire introducer and into the pleural space.
10. Remove the guidewire introducer, leaving the guidewire in place.
11. Use the scalpel to make an approximate 1-cm incision around the wire in the patient's skin and subcutaneous tissue. This is the pleural entry site. Make a second incision approximately 5 cm from the pleural entry site. This will serve as the catheter exit site.
12. Attach the metal tunneler to the fenestrated end of the pleural catheter and tunnel the catheter under the skin and subcutaneous tissue, entering at the catheter exit site and directing the tunneler toward the pleural entry site. Pass the tunneler out through the pleural entry site (where the guidewire is located). Pull the tunneler through the pleural entry site until the catheter cuff is just under the skin at the catheter exit site. Once in position, remove the metal tunneler from the catheter.
13. Advance the peel-away introducer over the wire and into the pleural space.
14. Remove the central dilator and the wire while leaving the peel away sheath in place. Pleural fluid may drain out of the peel away sheath at this point.
15. Insert the fenestrated end of the catheter through the peel away sheath and into the pleural space.
16. Peel away the sheath while advancing the catheter into the pleural space using a thumb.
17. Ensure the catheter is inserted fully into the pleural space and feel for any evidence of a kinked catheter.
18. Attach the catheter tip to the specialized drainage bottle or suction using the appropriate adapter with access tip. Drain the pleural space. This process ensures that the catheter is functioning well after placement and allows for any necessary troubleshooting while the patient is in the procedure area.
19. Remove the access tip and drainage line and place the specialized cap on the end of the catheter.
20. Use the 2-0 silk, straight needle suture to secure the IPC to the skin.
21. Use the 4-0 absorbable, curved needle suture to close the insertion site incision.
22. Place the foam catheter pad on the skin and coil the catheter on top of it, then cover with gauze.
23. Use the provided self-adhesive dressing for optimal coverage and catheter protection.

emphysema, pain, and unintended mispositioning of the catheter (Fig. 1).[21] Postprocedure chest radiography is often obtained to document proper IPC placement and the patient is typically discharged the same day.

POSTPROCEDURE RECOVERY AND MANAGEMENT

IPC drainage can be performed by a variety of people, including the patient, spouse or other caregivers, and medical providers. Routine IPC education is again provided before discharge and is typically accomplished with hands-on training, in addition to instructional videos and handbooks provided by the IPC manufacturer.

A specific follow-up schedule for patients with an IPC has not been established given the lack of formal studies pertaining to this topic. Regular follow-up is recommended, even in the absence of catheter-related concerns, with the frequency being determined on an individual basis.[4] The

Fig. 1. A malpositioned IPC as seen outside the pleural space in this chest computed tomography image. This catheter was replaced without significant long-term complications.

hope is that potential complications or concerns are identified and addressed early in the process. It is important to acknowledge that many patients with cancer report a substantial time burden related to treatment and follow-up appointments[22]; therefore, personalized decision-making should be used when determining the optimal follow-up plan.

Drainage protocols and algorithms for IPC removal vary between institutions. General recommendations are to decrease drainage frequency when output decreases to less than a certain volume, often 50 to 100 mL.[14] One example of a conservative IPC drainage and removal algorithm is provided in **Fig. 2**. The reported incidence of successful pleurodesis allowing IPC removal is variable, but seems to be less than 50%.[15,23,24] Before removal, patients should be made aware of the potential need for future pleural interventions because up to 10% of pleural effusions may recur after IPC removal.[15,25]

CONSIDERATIONS

Nonexpandable Lung

An IPC may be placed in almost any patient and allows for regular home drainage of pleural fluid with resultant improvement in symptoms and quality of

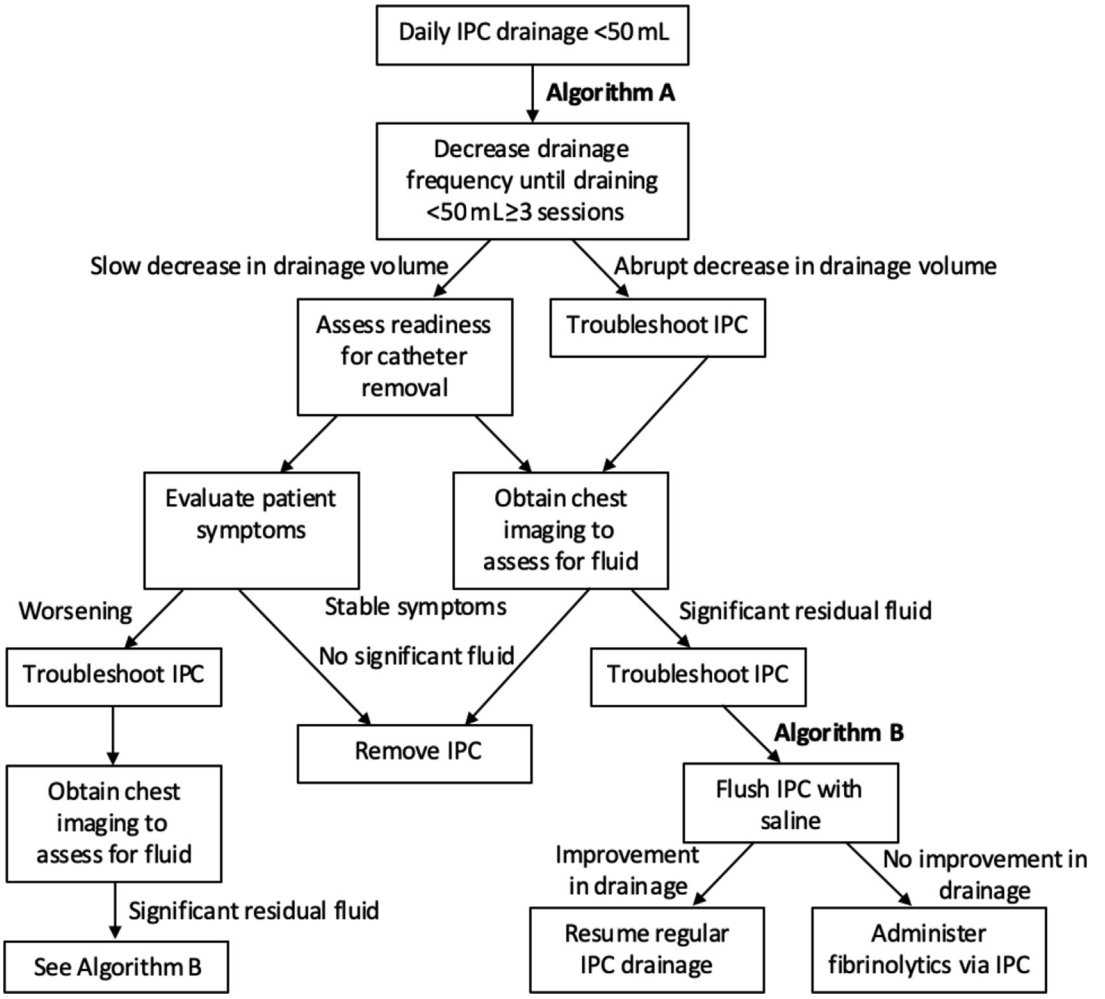

Fig. 2. IPC drainage and removal algorithm.

life.[10,15,23,24] Specific patient populations may benefit more from IPC placement when compared with other definitive management approaches. In patients with a nonexpandable lung, where adequate apposition of the parietal and visceral pleura are not achieved after pleural fluid drainage, guidelines recommend the placement of an IPC over chemical pleurodesis.[6–8] One of the first publications to report the use of IPCs for MPE and nonexpandable lung was by Pien and colleagues in 2001,[26] when they described their experience with 11 patients, 3 of whom had previously been treated with radiation therapy, attempted talc pleurodesis, or decortication without successful resolution of symptoms. Although the specific details regarding how symptom and radiographic improvement were determined were not provided, all patients were reported to have symptomatic benefit in cough, dyspnea, and exercise tolerance.[26] Several larger observational studies on the use of IPC for patients with nonexpandable lung have since been published, each reporting various patient outcomes, including symptom improvement, pleurodesis rate, median survival after IPC placement, and complications.[27–32] It is difficult to directly compare results from these studies because the units of measurement for the outcomes are quite variable, but most studies report symptomatic improvement in the majority of patients. More recent RCTs have shown improvement in dyspnea and quality of life that is comparable with that achieved in patients with a fully expandable lung after talc pleurodesis.[10] It should also be noted that, in the AMPLE-2 trial, approximately 50% of patients with a nonexpandable lung achieved pleurodesis at 6 months.[23] In addition to patients with a nonexpandable lung, IPC placement may be the best treatment strategy for those with interconnected pleural loculations, especially if deemed a poor surgical candidate.[7]

Failed Pleurodesis Procedure

A pleurodesis procedure may be unsuccessful in up to 30% of patients[33]; therefore, further interventions may be necessary in a good proportion of these patients.[27] IPCs are often placed at the time of a talc poudrage procedure. This practice allows for continuous pleural fluid drainage after the procedure, facilitating visceral and parietal apposition and hopefully improving the chance of successful pleurodesis, while also serving as a back-up therapy in the event that pleurodesis fails.[9,34,35] This strategy may shorten hospital length of stay because a standard chest tube is not required and patients can continue regular drainage after hospital discharge.[34,35]

Other Clinical Considerations

IPC placement is a straightforward procedure that is performed using local anesthesia without the need for sedation. It provides a good alternative treatment option for patients unable or unwilling to undergo a surgical procedure, as well as for patients wishing to minimize hospitalization.[10–13] Patients with a very short life expectancy, however, may be best managed with repeat thoracentesis and other supportive measures, rather than an IPC or pleurodesis procedure.[25]

After a discussion of viable treatment options, patient preference should take priority. Swimming, submerging in bath water, diving, or otherwise performing activities that may result in soaking of the IPC dressing are not recommended for some of the IPCs owing to fears of an increased risk of infection; however, there are no data to support this supposition. If the patient is interested in performing these activities, it may be necessary to discuss alternative methods for symptom management.

GOALS

Given that MPE is generally considered a poor prognostic factor,[8] the main goals for treatment are palliation of symptoms, limiting unnecessary pleural procedures, and minimizing the need for hospitalization, as well as decreasing the hospital length of stay when required. Historically, pleurodesis rates have been the focus of many early IPC studies. More recent publications, however, emphasize patient-centered outcomes such as dyspnea, quality of life, complications, and hospital length of stay.[10–12,23] It is from these studies that we know IPCs improve patient symptoms, but are only associated with modest improvements in quality-adjusted lifedays and utility. The greatest improvements are seen in patients with worse baseline shortness of breath and those who pursue systemic chemotherapy or localized radiation after placement.[15] There are also potential disadvantages to treatment with an IPC, including complications, cost, and the need for regular drainage procedures. These issues further highlight the need for a thorough discussion regarding patient preferences and expected outcomes during individualized management of an MPE.

CLINICAL OUTCOMES

Pleurodesis Rates

Because IPC use is increasing and drainage may be performed at the convenience of the patient, investigations to identify optimal drainage regimens

have been conducted. Two RCTs, ASAP (Impact of Aggressive vs Standard Drainage Regimen Using a Long Term IPC) and AMPLE-2 (Australasian Malignant PLeural Effusion-2) evaluated patient outcomes with various drainage regimens. The ASAP trial compared daily with every other day drainage of the same volume of fluid,[24] whereas the AMPLE-2 study compared daily with symptom-guided IPC drainage.[23] Both studies defined pleurodesis as pleural fluid drainage of less than 50 mL on 3 consecutive drainage attempts and improved radiographic scores, but the ASAP trial also specified a lack of patient symptoms.[23,24] Each study determined that daily IPC drainage was more likely to result in either complete or partial pleurodesis after IPC placement, with associated fewer catheter-days, when compared with a less aggressive drainage regimen, although pleurodesis rates were not the primary outcome in the AMPLE-2 trial.[23,24] Most cases of pleurodesis and catheter removal occurred in the first 60 days after placement.[23,24] If IPC removal is a patient priority, then an aggressive drainage regimen should be used, but in instances when this is not a strong consideration, symptom-guided drainage is reasonable.[4]

The pleurodesis rates of IPC in conjunction with pleural sclerosants has also been evaluated. Bhatnagar and colleagues[16] randomized patients to IPC plus talc slurry or placebo and found those treated with IPC plus talc slurry achieved pleurodesis at a significantly higher rate, at least during the initial follow-up period. A small study evaluating the safety of silver nitrate–coated IPCs also reported high pleurodesis rates with a median time to pleurodesis of 4 days. No formal conclusions can be drawn from this study given the small sample size, but results from a larger, multicenter RCT should be available in the near future.[36]

Whereas patient-centered outcomes should be a priority when managing recurrent MPE, pleurodesis rates are important from a cost perspective. A recent analysis evaluating the cost effectiveness of various drainage regimens and IPC plus talc administration determined daily IPC drainage was not cost effective in any clinical scenario.[37] Symptom-guided IPC drainage was most cost effective for patients with a life expectancy of less than 4 months or an expected probability of pleurodesis greater than 20%.[37] Considering individual patient-related factors such as life expectancy and desire to minimize catheter-days, IPC plus pleural sclerosant administration may provide a palliative and cost-effective option for the treatment of recurrent, symptomatic MPE.[37]

The optimal IPC drainage regimen in patients with a nonexpandable lung is less clear than in those with a fully expandable lung because of a lack of formal studies evaluating this topic. Approximately one-third of the patients included in the AMPLE-2 trial had nonexpandable lung. Although patients with a nonexpandable lung had an overall lower pleurodesis rate than patients whose lungs expanded, aggressive IPC drainage was still associated with a higher pleurodesis rate when compared with symptom-guided drainage in patients with nonexpandable lung.[23] Although this data may provide insight as to the effect of daily drainage on patients with a nonexpandable lung, it should be interpreted with caution because it was obtained after a post hoc analysis of very few patients. If catheter removal is a priority, then an aggressive IPC drainage strategy can be considered, even in the setting of a nonexpandable lung, but in patients who experience significant discomfort with daily drainage, this regimen is not recommended.[4]

Chemical pleurodesis rates are variable and depend on the sclerosing agent as well as the underlying method of instillation.[25,38] IPC-related pleurodesis rates are typically lower when compared with chemical or surgical pleurodesis performed as a slurry via chest tube or via poudrage, but as discussed elsewhere in this article, patient-centered outcomes, rather than the achievement of pleurodesis, may be the best measures of successful MPE management.[15,25]

Symptomatic Improvement

Although it is now well-established that IPCs provide symptomatic improvement in patients with MPE,[15,23,24] many studies have sought to determine if there is a significant difference in improvement when compared with that achieved with chemical pleurodesis. The TIME2 (Second Therapeutic Intervention in Malignant Effusion) RCT evaluated whether IPCs were more effective at relieving dyspnea than chest tube placement and talc slurry pleurodesis as measured on a 100-mm visual analog scale. Both groups experienced an improvement in dyspnea and there was no significant difference between the 2 groups at 3 months, but at 6 months patients with an IPC had less dyspnea than patients who underwent talc pleurodesis.[10] A second, smaller RCT compared IPC with talc pleurodesis with the primary end point being improvement in the baseline Modified Borg Score. Again, dyspnea improved in both groups after the intervention, but the magnitude of improvement was not significantly different between the 2 groups.[12] Two other RCTs evaluated both dyspnea and quality of life improvement in patients with IPC compared with chemical pleurodesis.[11,13]

Whereas the measurements of breathlessness and quality of life were different in the 2 studies, both reported high baseline breathlessness scores and poor quality of life that improved after the respective interventions. Putnam and colleagues[13] noted that patients with IPC had significantly improved Borg scores after exercise at 30 days when compared with the doxycycline pleurodesis group, but this difference was not sustained throughout the follow-up period. No other significant between group differences were identified in breathlessness or quality of life in either study.[11,13] One propensity-matched observational study compared symptom palliation in patients with IPC versus VATS talc pleurodesis. Although the long-term follow-up was poor, no significant difference in Eastern Cooperative Oncology Group performance status was identified.[39] A review of the available data shows that IPC placement leads to an improvement in breathlessness and quality of life comparable with that achieved with chemical pleurodesis. In addition, the combination of IPC plus talc slurry administration further improves patient breathlessness and quality of life scores at various timepoints when compared with IPC alone.[16] The usefulness of other pleural sclerosants in conjunction with IPCs is currently being evaluated.

IPC drainage regimens have also been evaluated for their effect on symptom improvement. In the AMPLE-2 study comparing daily versus symptom-guided drainage, there was no significant difference in the mean daily breathlessness or quality of life as measured on a 100-mm visual analog scale between the 2 groups; however, patients in the daily drainage group reported a better quality of life than patients in the symptom-guided group as measured by the EuroQoL-5 Dimensions-5 Levels.[23] Similar improvements in both the Karnofsky Performance Score and the RAND 36-Item Short Form Health Survey scores were obtained in the ASAP trial comparing daily versus 3 times a week drainage.[24] IPC drainage regimen does not seem to have a significant effect on breathlessness, but there are conflicting data on whether quality of life is impacted by drainage strategy.

Health Care Resource Use

Patients with MPE spend a substantial amount of time in the hospital, and decreased hospitalization rates and shorter lengths of stay are a priority for many, especially near the end of their life.[11] Two RCTs have compared IPC placement with chemical pleurodesis and evaluated hospital length of stay as the primary study outcome. The AMPLE (Australasian Malignant PLeural Effusion) trial found that, in those treated with an IPC, there was a significant decrease in total hospitalization days within the first year after the initial procedure, including the initial hospitalization. Putnam and colleagues[13] also determined that the initial hospital length of stay was significantly shorter for the IPC group when compared with the pleurodesis group. Two other studies have evaluated hospital length of stay in patients undergoing IPC placement versus talc pleurodesis as a secondary outcome and also found an IPC shortens the duration of the initial hospitalization.[10,12] A smaller observational study came to the same conclusion as these larger RCTs when comparing IPC versus VATS talc pleurodesis.[39] Overall, it is clear from the literature that IPC placement is associated with fewer hospitalization days when compared with chemical pleurodesis using either chest tubes or thoracoscopy.

Although the need for additional procedures has not been the primary outcome of any available study, IPC placement is associated with a significantly decreased need for ipsilateral pleural fluid drainage when compared with either chest tube or thoracoscopic chemical pleurodesis, and this difference becomes more evident the longer patients are followed.[11,12,39,40]

From a health care cost perspective, the initial hospitalization required for thoracoscopic or chest tube pleurodesis is more costly, but a comparison with IPC requires consideration of life expectancy and total cost over the life of the patient to manage the problem of MPE. For patients with a shorter expected survival duration, the total costs of IPC strategies may be lower, whereas for those expected to live longer, chemical pleurodesis may prove to be less expensive because the cost for supplies related to continued IPC use would be less.[37] These cost considerations must be balanced against any differences in quality-adjusted survival.[37] Individual patient preferences strongly impact perceived utility and quality of life, so cost-effectiveness analysis should be applied appropriately and with caution, making sure to take into account individual level factors for each decision.

Survival

From the available data, there does not seem to be a difference in mortality between patients with IPC versus those treated with chemical pleurodesis for recurrent, symptomatic MPE.[40]

Nonmalignant Pleural Effusion

The cause of nonmalignant pleural effusions (NMPEs) is quite variable, but congestive heart failure, hepatic hydrothorax, chylothorax, and

end-stage renal disease are the most common. Management of the underlying disease process is the mainstay of treatment, but symptomatic NMPEs may persist despite optimal management. It should also be noted that patients with advanced heart and liver disease who have pleural effusions may have similar mortality rates to patients with MPE.[41,42] Whereas IPCs were initially designed for treatment of MPE, their use in patients with NMPEs is increasing. Older publications included patients with a variety of etiologies for their NMPE and are composed primarily of low-quality non-RCTs. Newer studies, however, have evaluated the safety and efficacy of IPCs for NMPEs from specific etiologies. This finding is important because the efficacy and complication rates of IPCs varies significantly based on the underlying cause of the effusion.

Complication rates of IPCs when used for hepatic hydrothorax are indeed higher than with MPE. Shojaee and colleagues[43] published a multicenter retrospective evaluation of IPC use in patients with refractory hepatic hydrothorax. No specific information regarding symptom improvement was provided, but 28% of patients experienced pleurodesis, allowing for IPC removal. However, the observed infection rate in this population was 10% with an associated 2.5% mortality rate.[43] Other studies of drainage procedures for patients with hepatic hydrothorax have reported even higher infection rates ranging from 16% with IPCs up to almost 50% with chest tube placement and hospitalization.[44,45] Infectious complications are not the only concern with IPC use for hepatic hydrothorax. Electrolyte disorders, renal failure, and protein loss are other things to consider when placing an IPC for treatment of refractory hepatic hydrothorax. In contrast with hepatic hydrothorax, IPCs are generally well-tolerated and associated with a relatively low risk of infection in patients with congestive heart failure, with most studies reporting empyema rates between 0% and 4%.[45] Pleurodesis rates in patients with congestive heart failure–related effusions may also be higher compared with those with hepatic hydrothorax.[46] Reported pleurodesis rates range from 25% to 44% and even higher when combined with talc administration.[45,47]

Only small case series are available for IPC use in patients with chylothorax or end-stage renal disease–related NMPEs; therefore, we cannot draw strong conclusions. Potechin and colleagues[48] reported the outcomes of 8 patients with end-stage renal disease–related pleural effusions treated with IPC and found that all patients experienced significant improvement in dyspnea with 37.5%, achieving pleurodesis allowing for successful IPC removal. No cases of empyema or other serious complications were reported. Small retrospective case series describing the use of IPC for refractory chylothorax report pleurodesis rates up to 64% with no significant infectious or nutritional complications reported.[49,50] Because the use of IPCs for NMPEs may continue to increase over time, well-designed RCTs will be necessary to determine how suitable they are for long-term use in specific patient populations.

COMPLICATIONS

Despite all the highlighted benefits of IPCs, there are potential complications. The most common long-term complications include a nondraining catheter, tract metastasis, and infection, but each of these are relatively rare occurrences. Removal of an IPC in response to any complication occurs in fewer than 10% of patients.[25]

A nondraining catheter may be a sign of successful pleurodesis, but may also be related to catheter malfunction, an issue reported to occur in 5% to 14% of patients.[4] Evaluation of the pleural space with chest imaging as well as a review of patient symptoms is indicated when catheter drainage ceases, especially when it occurs suddenly. Catheter malfunction is likely in the presence of a persistent pleural effusion and respiratory symptoms. Occlusion of the IPC with a fibrin clot may occur and symptomatic pleural loculations may also develop. Flushing the IPC with saline is the recommended first step for treatment of catheter malfunction. If pleural fluid drainage does not improve after the saline flush, administration of intrapleural fibrinolytics may be indicated. Several studies have evaluated the use of intrapleural fibrinolytics via IPC for the treatment of symptomatic pleural loculations, with a variety of medications and dosages being reported.[4,51,52] Most studies show fibrinolytic administration may be successful in improving IPC drainage after a dwell time of 60 to 120 minutes, but many patients will require repeat administration.[4] Alteplase is the most commonly reported fibrinolytic, usually at a dose of 2 to 10 mg. A recent consensus statement from Gilbert and colleagues recommends alteplase to reestablish IPC patency, whereas guidelines from Miller and colleagues do not recommend any particular fibrinolytic or dose.[4,14] Although reported to occur in less than 3% of patients with a nondraining catheter, bleeding is the most common complication of fibrinolysis and, therefore, individual bleeding risk must be considered before use.[4,51,52]

Infections, particularly empyema, are the most worrisome potential complications associated with IPC use. Cellulitis and exit site infections

occur slightly more frequently, but pleural space infections are reported to occur in less than 5% of patients with an IPC for MPE.[4,7] The largest study evaluating clinical outcomes of patients with IPC-related pleural infections reported an associated mortality rate of 6%, suggesting that the outcomes are much better than previously reported.[53] Recent guidelines and expert panel recommendations for the management of IPC-related infectious complications are now available.[4,14] Specific recommendations depend on the individual process (**Table 1**), but despite previous notions, removal of an IPC is often not required. Cellulitis, exit site, and tunnel tract infections can usually be managed with outpatient antibiotics that adequately cover skin pathogens, although longer courses of treatment may be necessary for tunnel tract infections. When a pleural space infection is suspected, pleural fluid cultures should be obtained, although the ideal method for obtaining the fluid (via the catheter or a thoracentesis) has not been evaluated formally. Broad spectrum intravenous antibiotics, including consideration of anaerobic coverage, should be started while awaiting culture results. Continuous or increased frequency of pleural fluid drainage should also be

Table 1
Summary of IPC infectious complications and management recommendations[4,14]

Type of Infectious Complication	Recommended Management	Indications for IPC Removal
Cellulitis Erythema, warmth, edema and pain of the skin and immediate subcutaneous tissue Exit site Purulent drainage at the catheter skin exit site Erythema, edema, induration and tenderness may be present Localized within 2 cm of the exit site Tunnel tract Erythema, edema, induration and tenderness greater than 2 cm along the catheter tract	Antibiotic therapy Adequate coverage of typical skin pathogens Outpatient management usually sufficient Longer duration of treatment may be necessary for tunnel tract infections	Failure of antibiotics to resolve the infection
Pleural space Either: Purulent material draining from the catheter Clinical symptoms of infection and positive pleural fluid Gram stain or culture Clinical symptoms of infection and apparent infectious pleural fluid based on lactate dehydrogenase, glucose, or pH	Obtain pleural fluid for microbiological studies Attempt continuous or increased frequency drainage of IPC Consider instillation of fibrinolytics and DNase via IPC if inadequate drainage Administer broad spectrum antibiotics initially and de-escalate based on microbiological studies	Concomitant tunnel tract and pleural space infection Inadequate pleural drainage despite fibrinolytic administration Lack of clinical improvement despite aggressive care

Data from Miller RJ, Chrissian AA, Lee YCG, et al. AABIP Evidence-informed Guidelines and Expert Panel Report for the Management of Indwelling Pleural Catheters. *J Bronchology Interv Pulmonol.* 2020;27(4):229-245 *and* Gilbert CR, Wahidi MM, Light RW, et al. Management of Indwelling Tunneled Pleural Catheters: A Modified Delphi Consensus Statement. *Chest.* 2020;158(5):2221-2228.

Fig. 3. Tunnel tract metastases diagnosed via biopsy after no significant improvement was seen with antibiotic therapy. (Photo courtesy of Dr. Horiana Grosu.)

initiated. If drainage is incomplete or significant loculations are present, intrapleural fibrinolytics and DNase are recommended in an attempt to prevent the need for lung decortication. There are several instances where the removal of an IPC and the placement of a chest tube may be necessary. These circumstances include concomitant tunnel tract and pleural space infection, poor pleural fluid drainage despite fibrinolytic administration, or a poor clinical response to aggressive treatment.[4,14] Historically, there have been concerns that patients actively treated with chemotherapy may be at increased risk of IPC-related infectious complications, but current evidence suggests otherwise.[4,54] There are currently no recommendations for prophylactic IPC removal before chemotherapy administration or to withhold placement in preparation for systemic treatment.[4]

Tunnel tract metastasis is an uncommon occurrence seen in less than 5% of patients with an IPC (**Fig. 3**). It is thought to occur from migration of tumor cells from the pleural space through the subcutaneous tissue and is most common in patients with mesothelioma. Diagnosis can be obtained with a percutaneous biopsy and treatment generally consists of localized radiation.[21]

SUMMARY

The breadth of knowledge regarding IPCs has increased substantially in the last decade. Available research has established that IPCs are effective at improving patient symptoms and minimizing hospitalization rates and lengths of stay, but are associated with a risk of potential complications. Fortunately, recent research has shown that the complication rates are relatively low, albeit not negligible. Pleurodesis rates achieved with IPCs are lower when compared with chemical or surgical pleurodesis, but IPCs are associated with a decreased need for repeat pleural procedures and similar quality of life.

Understanding individual patient preferences and utilities is essential when determining optimal management for a recurrent, symptomatic pleural effusion and this information should influence treatment decisions. The future of MPE management likely lies in combined therapies, such as IPC plus a pleural sclerosant, at least in patients whose lung expands with drainage. This combination therapy may provide more optimal benefits than each individual procedure, although further research is needed. Effective pleurodesis and subsequent IPC removal is important, especially in regard to cost effectiveness and burden of catheter-related care, but future research should ideally focus on patient-centered outcomes.[15] Consistency of measurements between studies would also allow for a more direct comparison of results and add to the current body of knowledge.

CLINICS CARE POINTS

- IPCs improve baseline breathlessness and quality of life, while also decreasing hospital length of stay when compared with chest tube and thoracoscopic pleurodesis.
- IPC-related infectious complications contribute to less patient morbidity and mortality than previously believed.
- Well-designed RCTs emphasizing patient-centered outcomes should be the focus of future IPC studies.

DISCLOSURE

A.J. Schwalk has no relevant disclosures. D.E. Ost has worked as a consultant for Becton Dickinson.

REFERENCES

1. Light RW. Pleural effusions. Med Clin North Am 2011;95(6):1055–70.
2. Wrightson JM, Davies HE, Lee GY. Pleural effusion, empyema and pneumothorax. In: Spiro S,

Silvestri G, Agusti A, editors. Clinical respiratory medicine. 4th edition. Elsevier; 2012. p. 818–36.
3. Antony V, Loddenkemper R, Astoul P, et al. Management of malignant pleural effusions. Am J Respir Crit Care Med 2000;162:1987–2001.
4. Miller RJ, Chrissian AA, Lee YCG, et al. AABIP evidence-informed guidelines and expert panel report for the management of indwelling pleural catheters. J Bronchol Interv Pulmonol 2020;27(4):229–45.
5. Koegelenberg CFN, Shaw JA, Irusen EM, et al. Contemporary best practice in the management of malignant pleural effusion. Ther Adv Respir Dis 2018;12. 1753466618785098.
6. Roberts ME, Neville E, Berrisford RG, et al, Group BTSPDG. Management of a malignant pleural effusion: British Thoracic Society pleural disease guideline 2010. Thorax 2010;65(Suppl 2):ii32–40.
7. Feller-Kopman DJ, Reddy CB, DeCamp MM, et al. Management of malignant pleural effusions. An Official ATS/STS/STR clinical practice guideline. Am J Respir Crit Care Med 2018;198(7):839–49.
8. Bibby AC, Dorn P, Psallidas I, et al. ERS/EACTS statement on the management of malignant pleural effusions. Eur Respir J 2018;52(1):1800349.
9. Ost DE, Niu J, Zhao H, et al. Quality gaps and comparative effectiveness of management strategies for recurrent malignant pleural effusions. Chest 2018;153(2):438–52.
10. Davies HE, Mishra EK, Kahan BC, et al. Effect of an indwelling pleural catheter vs chest tube and talc pleurodesis for relieving dyspnea in patients with malignant pleural effusion: the TIME2 randomized controlled trial. JAMA 2012;307(22):2383–9.
11. Thomas R, Fysh ETH, Smith NA, et al. Effect of an indwelling pleural catheter vs talc pleurodesis on hospitalization days in patients with malignant pleural effusion: the AMPLE randomized clinical trial. JAMA 2017;318(19):1903–12.
12. Boshuizen RC, Vd Noort V, Burgers JA, et al. A randomized controlled trial comparing indwelling pleural catheters with talc pleurodesis (NVALT-14). Lung Cancer 2017;108:9–14.
13. Putnam JB, Light RW, Rodriguez RM, et al. A randomized comparison of indwelling pleural catheter and doxycycline pleurodesis in the management of malignant pleural effusions. Cancer 1999;86:1992–9.
14. Gilbert CR, Wahidi MM, Light RW, et al. Management of indwelling tunneled pleural catheters: a modified Delphi consensus statement. Chest 2020;158(5):2221–8.
15. Ost DE, Jimenez CA, Lei X, et al. Quality-adjusted survival following treatment of malignant pleural effusions with indwelling pleural catheters. Chest 2014;145(6):1347–56.
16. Bhatnagar R, Keenan EK, Morley AJ, et al. Outpatient talc administration by indwelling pleural catheter for malignant effusion. N Engl J Med 2018;378(14):1313–22.
17. Gilbert CR, Lee HJ, Akulian JA, et al. A quality improvement intervention to reduce indwelling tunneled pleural catheter infection rates. Ann Am Thorac Soc 2015;12(6):847–53.
18. Medical M. Aspira Drainage System Clinician Product Brochure 2019.
19. Patient information - PleurX system BD. 2021. Available at: https://www.bd.com/en-us/offerings/capabilities/interventional-specialties/peritoneal-and-pleural-drainage/about-the-pleurx-drainage-system/patient-information-pleurx-system. Accessed March 5, 2021.
20. Plc. RM. IPC indwelling drainage catheters - pleural & peritoneal. 2011-2019. Available at: https://sales.rocketmedical.com/products/indwelling-drainage-catheters. Accessed March 5, 2021.
21. Chalhoub M, Saqib A, Castellano M. Indwelling pleural catheters: complications and management strategies. J Thorac Dis 2018;10(7):4659–66.
22. Henry DH, Viswanathan HN, Elkin EP, et al. Symptoms and treatment burden associated with cancer treatment: results from a cross-sectional national survey in the U.S. Support Care Cancer 2008;16(7):791–801.
23. Muruganandan S, Azzopardi M, Fitzgerald DB, et al. Aggressive versus symptom-guided drainage of malignant pleural effusion via indwelling pleural catheters (AMPLE-2): an open-label randomised trial. Lancet Respir Med 2018;6(9):671–80.
24. Wahidi MM, Reddy C, Yarmus L, et al. Randomized trial of pleural fluid drainage frequency in patients with malignant pleural effusions. The ASAP trial. Am J Respir Crit Care Med 2017;195(8):1050–7.
25. Fortin M, Tremblay A. Pleural controversies: indwelling pleural catheter vs. pleurodesis for malignant pleural effusions. J Thorac Dis 2015;7(6):1052–7.
26. Pien GW, Gant MJ, Washam CL, et al. Use of an implantable pleural catheter for trapped lung syndrome in patients with malignant pleural effusion. Chest 2001;119(6):1641–6.
27. Bazerbashi S, Villaquiran J, Awan MY, et al. Ambulatory intercostal drainage for the management of malignant pleural effusion: a single center experience. Ann Surg Oncol 2009;16(12):3482–7.
28. Warren WH, Kalimi R, Khodadadian LM, et al. Management of malignant pleural effusions using the Pleur(x) catheter. Ann Thorac Surg 2008;85(3):1049–55.
29. Qureshi RA, Collinson SL, Powell RJ, et al. Management of malignant pleural effusion associated with trapped lung syndrome. Asian Cardiovasc Thorac Ann 2008;16(2):120–3.
30. Sioris T, Sihvo E, Salo J, et al. Long-term indwelling pleural catheter (PleurX) for malignant pleural effusion unsuitable for talc pleurodesis. Eur J Surg Oncol 2009;35(5):546–51.

31. van den Toorn LM, Schaap E, Surmont VF, et al. Management of recurrent malignant pleural effusions with a chronic indwelling pleural catheter. Lung Cancer 2005;50(1):123–7.
32. Efthymiou CA, Masudi T, Thorpe JA, et al. Malignant pleural effusion in the presence of trapped lung. Five-year experience of PleurX tunnelled catheters. Interact Cardiovasc Thorac Surg 2009;9(6):961–4.
33. Dresler CM, Olak J, Herndon JE 2nd, et al. Phase III intergroup study of talc poudrage vs talc slurry sclerosis for malignant pleural effusion. Chest 2005; 127(3):909–15.
34. Boujaoude Z, Bartter T, Abboud M, et al. Pleuroscopic pleurodesis combined with tunneled pleural catheter for management of malignant pleural effusion- a prospective observational study. J Bronchol Interv Pulmonol 2015;22:237–43.
35. Reddy C, Ernst A, Lamb C, et al. Rapid pleurodesis for malignant pleural effusions: a pilot study. Chest 2011;139(6):1419–23.
36. Bhatnagar R, Zahan-Evans N, Kearney C, et al. A novel drug-eluting indwelling pleural catheter for the management of malignant effusions. Am J Respir Crit Care Med 2018;197(1):136–8.
37. Shafiq M, Simkovich S, Hossen S, et al. Indwelling pleural catheter drainage strategy for malignant effusion: a cost-effectiveness analysis. Ann Am Thorac Soc 2020;17(6):746–53.
38. Bhatnagar R, Piotrowska HEG, Laskawiec-Szkonter M, et al. Effect of thoracoscopic talc poudrage vs talc slurry via chest tube on pleurodesis failure rate among patients with malignant pleural effusions: a randomized clinical trial. JAMA 2019;323(1):60–9.
39. Freeman RK, Ascioti AJ, Mahidhara RS. A propensity-matched comparison of pleurodesis or tunneled pleural catheter in patients undergoing diagnostic thoracoscopy for malignancy. Ann Thorac Surg 2013;96(1):259–63 [discussion 263–4].
40. Iyer NP, Reddy CB, Wahidi MM, et al. Indwelling pleural catheter versus pleurodesis for malignant pleural effusions. A systematic review and meta-analysis. Ann Am Thorac Soc 2019;16(1):124–31.
41. Walker SP, Morley AJ, Stadon L, et al. Nonmalignant pleural effusions: a prospective study of 356 consecutive unselected patients. Chest 2017; 151(5):1099–105.
42. DeBiasi EM, Pisani MA, Murphy TE, et al. Mortality among patients with pleural effusion undergoing thoracentesis. Eur Respir J 2015;46(2):495–502.
43. Shojaee S, Rahman N, Haas K, et al. Indwelling tunneled pleural catheters for refractory hepatic hydrothorax in patients with cirrhosis: a multicenter study. Chest 2019;155(3):546–53.
44. Liu LU, Haddadin HA, Bodian CA, et al. Outcome analysis of cirrhotic patients undergoing chest tube placement. Chest 2004;126(1):142–8.
45. Bramley K, DeBiasi E, Puchalski J. Indwelling pleural catheter placement for nonmalignant pleural effusions. Semin Respir Crit Care Med 2018;39(6): 713–9.
46. Aboudara M, Maldonado F. Indwelling pleural catheters for benign pleural effusions: what is the evidence? Curr Opin Pulm Med 2019;25(4):369–73.
47. Majid A, Kheir F, Fashjian M, et al. Tunneled pleural catheter placement with and without talc poudrage for treatment of pleural effusions due to congestive heart failure. Ann Am Thorac Soc 2016;13(2):212–6.
48. Potechin R, Amjadi K, Srour N. Indwelling pleural catheters for pleural effusions associated with end-stage renal disease: a case series. Ther Adv Respir Dis 2015;9(1):22–7.
49. DePew ZS, Iqbal S, Mullon JJ, et al. The role for tunneled indwelling pleural catheters in patients with persistent benign chylothorax. Am J Med Sci 2013;346(5):349–52.
50. Jimenez CA, Mhatre AD, Martinez CH, et al. Use of an indwelling pleural catheter for the management of recurrent chylothorax in patients with cancer. Chest 2007;132(5):1584–90.
51. Thomas R, Piccolo F, Miller D, et al. Intrapleural fibrinolysis for the treatment of indwelling pleural catheter-related symptomatic loculations: a multicenter observational study. Chest 2015;148(3): 746–51.
52. Vial MR, Ost DE, Eapen GA, et al. Intrapleural fibrinolytic therapy in patients with nondraining indwelling pleural catheters. J Bronchol Interv Pulmonol 2016;23(2):98–105.
53. Fysh ETH, Tremblay A, Feller-Kopman D, et al. Clinical outcomes of indwelling pleural catheter-related pleural infections: an international multicenter study. Chest 2013;144(5):1597–602.
54. Mekhaiel E, Kashyap R, Mullon J, et al. Infections associated with tunnelled indwelling pleural catheters in patients undergoing chemotherapy. J Bronchol Interv Pulmonol 2013;20:299–303.