Editorial

Customizable airway stents—personalized medicine reaches the airways

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Bronchopleural fistula (BPF) remains a difficult to manage complication following pulmonary resection with an incidence varying from 1.5% to 28% depending on etiology, surgical technique, and surgeon experiences (1). Previous publications have shown significant associated morbidity and mortality with post-surgical BPF; including intensive care unit (ICU) readmission, pneumonia, and prolonged hospital stays (2). The management of post-operative BPF has historically involved chest tube drainage of the pleural space followed by surgical closure of the fistula. Given the morbidity associated with both the BPF itself and the subsequent corrective surgery, interest has grown in applying bronchoscopic techniques to BPF management. Within the last 15 years, there has been a surge of publications evaluating the utility of bronchoscopic treatments in the management of BPF. Such treatments have included, but are not limited to: tissue glues/cements, stents, spigots, gel foam, silver nitrate, vascular coils/nets and autologous blood patches (3-8).

In a recent manuscript, Han *et al.* present the treatment of 148 patients with post-operative BPF using customized airway stents. The devices employed in this study were self-expanding, silicone covered metallic stents, customized using measurements from chest CT, bronchoscopy, and airway radiography. The customized stents utilized in this study had one of the following configurations: Y-stent with a closed "bullet" occluding head in one of the two distal arms, hinged self-expandable covered metallic stent with a bullet head, L-shaped self-expandable covered metallic stent, Y-shaped self-expandable covered metallic stent or hinged self-expandable covered metallic stent. All stents were placed under conscious sedation using fluoroscopic guidance. The treatment course included pleural drainage using a pigtail chest tube placed on continuous suction. The primary outcome of technical success—defined as adequate stent placement with immediate cessation of air leak—was seen in 143 patients; a rate of 96.6%. Post-operatively, patients were monitored with monthly chest CT and/or bronchoscopy. Median time to BPF resolution (complete obliteration of the pleural cavity and removal of the chest tube) was 71 days post-airway stenting. The secondary outcome of cure rate after stent removal was defined as disappearance of the residual cavity and chest tube removal. This overall cure rate was 49% (73/148), with 85% (34/40) of lobectomy patients versus 38% (39/102) of pneumonectomy patients achieving cure. One hundred thirty-two patients underwent stent removal, 49% (73/148) due to resolution of BPF, 5% (8/148) due to stent damage, and 34% (51/148) due to symptomatic bronchial stenosis secondary to the development of granulation tissue.

With this manuscript, Han *et al.*, present one of the largest analyses of post-operative BPF treatment via a bronchoscopic approach while introducing a family of customized airway stents. Previous case studies/series have evaluated the utility of airway stenting in patients with post-operative BPF and have included hinged, Y-shaped

and distal plugged stents (9-12) however this is the first and largest study evaluating these various types of stents in a single series. Of note, the study does not quantify the size of the fistulas stented and while it reports a high rate of success in stent placement, less than 50% of patients experienced resolution of their BPF. In addition, the rates of BPF in this study appear to be significantly higher than previously reported and no comment as to the surgical suitability is presented.

The need for alternative approaches for the non-surgical management of BPF has led to the development of a multitude of approaches; none of which have proven to be the great panacea. Recent work has focused on the use of intrabronchial valve placement with success hinging on the ability to isolate the airleak via balloon occlusion (13) however it is clear that there is currently no "one size fits all" approach to this complex problem. While Han *et al.*, provide additional supportive data to the use of airway stenting in the non-surgical management of BPF, they do not provide an innovative alternative to the current approach to the treatment of BPF (i.e., draining the pleural space and closing the defect to allow for adequate healing). However, the presentation of a family of customizable stents does serve to add to the physician's armamentarium of non-surgical approaches. More importantly, by focusing on a patient-specific treatment plan with customizable devices Han *et al.* helps to shift the paradigm of BPF treatment to a more personalized approach, especially as our ability to customize implantable devices continues to expand.

For example, recent work utilizing 3-dimensional printing (3-DP) for the treatment of lung disease has resulted in novel approaches in chest wall reconstruction, stereotactic body radiotherapy dosimetry, tissue engineering and printing, and airway stenting (14-16). Already, 3-DP is widely used to create custom fitted prosthetics, and is increasingly being used on smaller scales, such as 3-DP heart valves. Given the seemingly limitless potential of 3-DP, it seems as if our imagination is the rate limiting factor in how to apply this technology. Could we use 3-DP to customize airway stents via high-resolution chest imaging to allow for better seating to within the airway and BPF itself? Could then the application of 3-DP stent with a "better fit" lead to a decrease in formation of the granulation tissue that was responsible for the removal of a significant number of the stents in this study? Or, are there other advances that we might incorporate into the customization of airway stents which could lead to more longevity and patency of airway stents? In a series of recent publications, tyrosine kinase inhibitors, radioactive iodine seeds, steroids, and cytotoxic chemotherapeutic compounds have been either loaded on or used as a coating for airway stents (17-21). Could we not only customize airway stents for fit using 3-DP, but then go a step further by adding compound eluting properties. To the entirety or certain portions of the stent? Imagine the ability to peri-operatively develop a 3-DP stent that is customized, not only to sit perfectly within the airway, but also to regionally elute different compounds that preferentially inhibit granulation at the open distal ends while simultaneously promoting granulation and healing at the site of the BPF.

We often think narrowly of personalized medicine from a purely systemic pharmacologic perspective (i.e., drug-drug, drug-tumor/human genome interactions). Are we at the dawn of looking through a different face of how a 3-DP jewel could represent personalized medicine? I would suspect so as the light so faint previously, now appears much brighter.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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