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REVIEW ARTICLE

Expanded central role of the respiratory physiotherapists in the community setting

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Abstract
The development of community hubs through the Slaintecare initiative will rely on respiratory physiotherapists and clinical nurse specialists for the management of chronic respiratory diseases. The role of the respiratory physiotherapist has evolved dramatically over the last decade. We review the increasing scope of practice of the physiotherapist and the evidence base for same. We pay particular attention to the role of the physiotherapist in areas such as pulmonary rehabilitation, sputum clearance, neuromuscular disease, chronic respiratory failure, ambulatory oxygen assessments and dysfunctional breathing. We give an in depth review of sputum clearance techniques. We also address areas of potential future expansion for the role of the physiotherapist such as prescription and initiation of non-invasive ventilation.

Keywords Chronic respiratory failure · Dysfunctional breathing · Neuromuscular disease · Physiotherapist · Slaintecare · Sputum clearance

Introduction

Following the Oireachtas Committee on the Future of Healthcare Sláintecare Report in Ireland in 2017, a complete change in the way we look after chronic diseases in the community has been reimagined [1]. There has been a massive investment in staff and money in the community management of diabetes, elderly care, cardiac disease, COPD and asthma. These community care groups have been called "Hubs", and these are to improve links between primary care and acute hospital services, to improve clinical governance and accountability and to integrate care between different specialties [2].

Respiratory physiotherapists and clinical nurse specialists will work very closely in these hubs to effect the changes mentioned above [1]. These community hubs are just coming together in the last few months, thus the timing of this article. We wish to draw attention to the skills of the modern respiratory physiotherapist which has changed dramatically in the last decade [3, 4]. Over this time, the scope of practice has evolved to encompass interventions such as the assessment of complex shortness of breath, airway clearance and dysfunctional breathing patterns as well as the management of patients with neuromuscular weakness and patients with life-threatening respiratory failure and chronic respiratory failure [3, 4].

The relevant roles for Sláintecare can be broken down into following areas:

1. Pulmonary rehabilitation (PR)
2. Sputum clearance
3. Assessing neuromuscular disease
4. Treatment of chronic respiratory failure
5. Ambulatory oxygen assessments
6. Dysfunctional breathing

In Sláintecare, it is not envisioned that respiratory physiotherapists will look after acute respiratory failure in the community. However, their high-level exposure to acute non-invasive ventilation and high flow nasal oxygen in the acute hospitals during their training gives them the pre-requisite skills to start domiciliary non-invasive ventilation and high flow nasal oxygen and also troubleshoot any problems [5].

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Pulmonary rehabilitation

PR has been shown to be the most effective treatment for breathlessness in COPD patients. It has no effect on the lungs directly but works by increasing aerobic fitness over 6–8 weeks, thereby reducing the production of lactic acid from muscles in response to exercise [6, 7]. There is therefore less drive to breathing, less breathlessness and better quality of life [8, 9]. Moreover, a recent Cochrane review has shown that if PR is started within 4 weeks of hospital discharge for an acute exacerbation of COPD (AECOPD), it can reduce the risk of readmission over the next 3 months by up to 50% and may reduce mortality [10, 11].

The majority of the clinical data supporting PR is in COPD patients; however, there is moderate evidence that it is also helpful in patients with asthma and bronchiectasis [12–15]. This is not surprising as in obstructive lung conditions there is a natural "brake" on the respiratory rate because of dynamic hyperinflation. Here, due to the ball valve effect of the small airways, the residual volume increases as COPD patients exercise (dynamic hyperinflation). This process leads to further and further collapse of the small airways, and thus, the patient takes longer and longer to exhale [16].

PR is more challenging in patients with pulmonary fibrosis. Pathophysiologically in these individuals, there is no airflow limitation, and the respiratory rate can rise abruptly in response to even modest exercise. Often they have profound desaturation, making it difficult to push these patients harder week to week. Moreover, some usual interstitial pneumonia patients have such a rapidly downward disease trajectory, and they may actually deteriorate over the 8-week rehab period [17]. During the COVID–19 epidemic, virtual PR has been shown to be just as effective as in-person PR [18]. In the last 5 years, enhanced recovery programmes (ERP) have emerged where patients perform PR pre- and post-thoracic surgery. These programmes have been shown to improve outcomes including survival [19].

Sputum clearance (Table 1)

Sputum clearance is a critical role for the respiratory physiotherapist. Sputum volume, tenacity, distal and proximal airway collapse and weak respiratory muscles all play a role in sub-optimal sputum clearance. This can lead to atelectasis, shortness of breath, bronchitis, pneumonia, rib and occasionally sternal fractures, cough syncope and urinary incontinence, the latter in both sexes [20, 21].

In order for the patient to move mucus proximally, their peak expiratory flow rate (PEFR) must exceed peak inspiratory flow rate (PIFR) by > 10%. Also, the PEFR must exceed 30–60 L min to overcome the adhesive strength by which the mucus is attached to the airway wall [22].

The following techniques are used for sputum clearance:

Active cycle of breathing (ACBT)

This is the simplest technique shown to patients. This is to cope with volume and low to moderate sputum tenacity. The patient breathes in to vital capacity and then performs frequent forced expiratory manoeuvres against an open glottis (huffing). There is less force generated than by standard coughing, but the manoeuvres can be done with less energy and greater frequency. The sub-maximal effort and the open glottis also cause less upper airway collapse [4, 20, 23].

Autogenic drainage (AD)

This technique capitalises on the phenomenon that there are conserved communications between adjacent lung lobes. These channels provide "collateral ventilation" even if the feeding bronchi to that lobe are completely blocked. Normally, these collaterals have a high resistance to airflow. However, in a lobe that is plugged and atelectatic, a high negative pressure can be generated on inspiration that opens these collaterals [22, 24].

Due to the advent of endobronchial valve treatment for COPD/ emphysema, we know a lot more about this entity. Initially, these valves often failed to cause the desired lung

Table 1 Utility of different modes of sputum clearance

Modes of sputum clearance	Volume of secretions present	Helpful for tenacious secretions	Main indication
Active cycle of breathing technique (ACBT)	+ + +	+ +	Bronchiectasis
Autogenic drainage (AD)	variable	+ + +	Mucus plugging
Oscillating PEP devices (OPEP)	+ + +	+ + +	Bronchiectasis, CF, COPD
PEP- based devices (PEP)	+ +	+ + +	Proximal airway collapse in COPD or asthma
BIPAP	+ +	+ + +	Proximal airway collapse in COPD and bronchiectasis
Cough-assist devices	+ +	+ + +	MND, other neuromuscular disorders

Airway clearance techniques should always be personalised to the patient. AD, OPEP and PEP would often be combined with forced expiratory techniques

atelectasis because of these collaterals [24]. In AD, tidal breathing is performed at different levels of total lung capacity. After each breath, the patient performs a three second breath-hold to allow time for collateral ventilation. Here, the air moves into the lobe distal to the mucus-plugged airways. Following the breath-hold, the patient performs active exhalation through an open glottis to mobilise secretions achieving good expiratory flow without dynamic airway compression. This technique is suitable for sensitive airways such as those with asthma and patients with haemoptysis [23]. There are three phases to the technique [22]:

1. Unsticking the mucus in the smaller airways by breathing at low lung volumes.
2. Collecting the mucus from the middle airways by breathing at low to mid lung volumes.
3. Evacuating the mucus from the central airways by breathing at mid to high lung volumes.

Oscillating PEP devices

These are often used in bronchiectasis where the volume is the main problem along with low to moderate tenacity [23]. There are different oscillation devices with slightly different properties. The two most common devices used by the authors are:

1. Acapella: This is a flow operated oscillating positive pressure device combining the resistive features of positive expiratory pressure (PEP) with a vibratory component to mobilise secretions [22, 25]. It oscillates at frequencies of 13–30 Hz. Oscillations are effective on mucus properties such as viscosity, elasticity and spinnability aids airway clearance. It has a low PEFR/PIFR ratio of only 0.64, and thus, an acapella needs to be combined with forced expiratory techniques to assist mucociliary clearance from larger airways. The use of an Acapella is position independent [22, 23].
2. Aerobika: This device has a wider range of flows compared to acapella. It can be used by either high flow or low flow patient groups, depending on their PEFR. PEP setting pressures can be adjusted to between 10 and 30 cmH20. Oscillation frequency is 10–12 Hz, and like the Acapella, it is also position independent [22, 23].

Positive expiratory pressure (PEEP) based devices

In individuals with long-standing obstructive airways disease, the main bronchi and trachea can become "floppy". This can be detected at bronchoscopy and on expiratory CT scans where marked collapse of the airways can be seen on expiration. This can markedly impair mucus clearance leading to changes in mucus morphology, distal atelectasis and thus recurring infections and exacerbations [26]. To address this, a flow-regulating device such as PEP can be very effective. PEP provides positive pressure throughout expiration. These devices are typically set around 10–20 cmH2O. This pressure splints the airway open allowing more effective mucus mobilisation and clearance. Typically forced expiratory techniques are combined with 12 to 15 repetitions of PEP which also help mobilise secretions [27].

Bilevel positive airway pressure (BIPAP)

Certain patients can develop refractory atelectasis secondary to poor respiratory muscle strength or thick, tenacious sputum. In these individuals, inspiratory positive airway pressure (IPAP) can help expand the lung bases, aid in sputum clearance and reverse atelectasis. This can be combined with assisted coughing techniques [4, 20]. The expiratory positive airway pressure (EPAP) delivered through the BiPAP machine can also help proximal airway collapse and aid mucus clearance. Bi-level support for cough clearance may be used in chronic airway diseases such as COPD, bronchiectasis and neuromuscular disorders [8, 28, 29].

Insufflator/exsufflator devices

These devices are often used in patients with neuromuscular weakness such as those with motor neurone disease (MND). Here, the respiratory muscles have deteriorated to the point where effective cough clearance is temporarily or permanently compromised. They are particularly useful in the setting of acute infection [29]. The device cycles between positive and negative pressure. The device inflates the lung and then abruptly changes to negative pressure. Pressures of $\pm$ 50 cmH2O can be delivered though the mouthpiece. Critically, the patients' families are trained how to use these devices in the home, and they may be life-saving [20].

Assessing neuromuscular disease

Respiratory physiotherapists now have a large input in the management of patients with respiratory muscle weakness, due to neuromuscular disease. These disorders include motor neurone disease, Duchenne muscular dystrophy, spinal muscular atrophy, Parkinson's disease, MS and stroke [30–34].

There are 4 main issues with these patients, which for ease of recall we call the 4 S's (saliva, swallow, sputum, shortness of breath). These issues are managed by the multidisciplinary team of whom the physiotherapist is a key player.

1. **(S)aliva**
   The salivary glands produce between 1 and 1.5 L of saliva per day [35]. If the patient cannot swallow their

saliva due to advanced bulbar issues, or there is unilateral facial weakness, severe drooling may ensue. Such changes in physical appearance may be a cause of distress for the patient. Pooling of saliva also poses a risk for aspiration and consequent pneumonia. Due to an inability to clear saliva, angular chelitis can also develop. This can act as a barrier to non-invasive ventilation use and other physiotherapy interventions as it can make wearing a facemask painful [36]. To address this issue, we often consult the respiratory team at our institution who have developed a hierarchy of treatment. They prescribe adjunctive medicines in a stepwise fashion progressing from amitriptyline 10 to 20 mg at night to hyoscine hydrobromide 1.5 mg skin patch changing every 3 days. Parotid gland radiation, aiming to leave one third of gland function, can be used in refractory individuals [37, 38].

2. **(S)wallowing**
   Micro- and macro-aspiration: This is usually the remit of the speech and language therapists and physicians to identify potential aspirators and to apply physical manoeuvres and thickeners for liquids [39]. If they are suffering from repeated lower respiratory tract infections, patients can often be trialled on prophylactic macrolide therapy to good effect. If there is a severe aspiration risk or there is concern about nutritional deficiency, the multidisciplinary team will consider placing a percutaneous feeding tube [38].
3. **(S)putum**
   Sputum clearance: Please see above section. In patients with progressive neuromuscular disorders, resistance training unfortunately does not slow down the progression of their muscular weakness. The exception is Parkinson's disease, where there is evidence that expiratory muscle training can strengthen the expiratory muscles. However, there is no evidence that this reduces the risk of chest infections [30].
4. **(S)hortness of breath**
   Ventilatory failure: The most studied group are patients with MND. Strong indications to start BIPAP include orthopnoea, symptoms of hypercapnia such as early morning headaches, daytime somnolence, a SNIP/MIP < 40 cmH20, or a MEP < 60 cmH20 [36, 38, 40]. Patients with bulbar disease usually have a higher risk of impending ventilatory failure [30, 36]. If an arterial blood gas on room air shows hypercapnia, or an elevated bicarbonate level without hypokalaemia, this would suggest that the patients should consider NIV [38]. Similarly, if overnight transcutaneous CO2 and O2 monitoring shows hypercapnia at any stage or oxygen saturations of < 90% for more than 5 min whilst asleep, NIV should be considered [36, 41].

   In neuromuscular clinics, physiotherapists would often perform these volitional respiratory muscle strength tests—the maximum inspiratory mouth pressures (MIP), maximum sniff pressure (SNIP) maximum expiratory mouth pressures (MEP) and cough peak flow (CPF). These tests are usually performed via an adapted face mask as the patients often cannot get a tight seal on the mouthpiece. These tests are very useful, when combined with symptoms, at predicting when MND patients should commence nocturnal non-invasive ventilation [38]. Recent studies have shown a cough peak flow below 250 L/ min (normal > 350–400 L/min) puts MND patients at risk of impending "cough clearance failure" and subsequent ventilatory failure [42].

At present in the Saolta group, all aspects of neuromuscular assessment take place in secondary care. We feel, as Sláintecare matures, many of the physiotherapy assessments should move into the community which could be a huge bonus for some of these patients with severe mobility issues.

Chronic respiratory failure

Long-term oxygen therapy (LTOT)

Respiratory physiotherapists are involved in the prescription of long-term oxygen therapy (LTOT). As they are trained to take arterial blood gases, they can manage the whole LTOT prescription journey. Oxygen clinics are ideally suited for the community. Portable blood gas analysers would be critical for this linked to secondary care for maintenance and regular calibration. Stopping oxygen therapy where it has been inappropriately prescribed or in patients who improve significantly over time has resulted in massive cost savings to primary care in other institutions [43].

BIPAP

In Ireland, the prescription and initiation of NIV is outside of the usual scope of practice for respiratory physiotherapists. However, to our knowledge, University Hospital Galway (UHG) is the only hospital that has a lead NIV respiratory physiotherapist as recommended in the latest British Thoracic Society NIV audit report (2019) [44, 45]. Our group has written a competency pathway document for the Irish Society of Chartered Physiotherapists (ISCP) to help facilitate more physiotherapists gain competence in acute NIV prescription and initiation.

The ISCP are lobbying the government to introduce a new clinical grade "Advanced Practice Physio (APP)". In respiratory medicine specifically that new legislation would enable

respiratory physiotherapists to order chest x-rays and prescribe medications and NIV. There are a high number of patients on domiciliary BIPAP (for indications see Table 2), and these patients should be reviewed regularly for compliance purposes, efficacy, interface issues and to check recent downloads [38, 40, 46–48].

High flow nasal oxygen (HFNO)

Respiratory physiotherapists often employ high flow nasal oxygen and acute NIV in acutely unwell respiratory patients. The use of HFNO in type I respiratory failure has increased exponentially in Ireland in the last 7 years [49]. The air/O2 mixture is heated to 37° and 100% humidified so it can be given through the nose which has the advantages of tolerability, communication and the ability to eat and drink without desaturating [50, 51]. The high flow rate (up to 60L/min) is postulated to achieve low-level PEEP which may help recruit alveoli. The humidification can also assist greatly in airway clearance [50–52].

A number of patients are also now prescribed HFNO in the community. Importantly, the respiratory physiotherapists are very comfortable with this technology from using it in secondary care. Potential indications for HFNO in the community include patients who need a higher flow of oxygen, who cannot tolerate face masks/nasal cannulae, and those who require it for sputum clearance [52–56].

Ambulatory O2 assessment

This usually takes the form of 6-min walk tests (6MWT). In these tests, the patients O2 saturation is measured at baseline, during the test itself and afterwards until the saturations come back to the pre-test level if they fell during exercise. The patient usually shuttles between two markers, 30 m apart, and critically, the patient is instructed to walk at their own pace. The total distance the patient walks in 6 min is recorded. The test is used to gauge aerobic fitness in patients, as a comparator pre- and post-pulmonary rehabilitation, and in the routine follow-up of patients with pulmonary hypertension and idiopathic pulmonary fibrosis [57].

There are two indications for ambulatory O2. (1) If patients are mobile as part of getting their 16 h a day of LTOT, they will wear O2 to get out of the house and when they are walking [58]. Here, oxygen is usually delivered from a cylinder, and an assessment for increased O2 needs on mobilisation should be undertaken prior to prescription [43, 59]. (2) The other type is where the patient is not in respiratory failure at rest but desaturates significantly when they walk [59]. According to the ATS 2002 guidelines, patients should only do two 6MWTs per assessments 30 min apart to reduce the learning effect [43, 57].

However, we feel these patients should undergo 3×6MWTs. The first is a test without O2 to see what distance they can walk and what symptoms they have, if any. The second test would be a placebo test with a cylinder of air that weighs the same as the O2 cylinder. Finally, the third test is with O2 set at 2–4 L per minute usually to keep their oxygen saturation over 90% during the test. The patient should be assessed for any improvement with O2 in their symptoms and secondly for any significant improvement with O2 in their 6MWT distance. An improvement in O2 saturation alone is not enough to prescribe ambulatory O2. The minimal clinical important difference in walking distance in COPD is ≥ 26 m. For other respiratory diseases, the clinically important difference is not well established [60]. We believe this method may circumvent the placebo effect of O2; however, this has yet to be proven in rigorous studies.

Physiotherapists have a key role in education, in the assessment of compliance, and in the choice of oxygen devices such as concentrators, potable concentrators, cylinders, portable cylinders, liquid oxygen and transporters [43]. In the future, the vast majority of these ambulatory oxygen assessments could be carried out in the community.

Table 2 Indications for domiciliary BIPAP

Cause	Comment
Severe restriction	Kyphoscoliosis, post-tuberculosis surgery
Neuromuscular weakness	Muscular dystrophy, MND and other rare neuromuscular diseases
Obesity hyperventilation syndrome	
Severe obstructive sleep apnoea	May require BIPAP initially due to acidotic hypercapnia, but many convert to CPAP later when PaCO2 is better controlled
COPD	• ≥ 2 acute hospital admissions with acidotic type II respiratory failure requiring BIPAP • ≥ 1 acute hospital admission with acidotic type II respiratory failure requiring intubation and ventilation • Symptomatic hypercapnia • On commencing LTOT, symptomatic $\pm$ acidotic hypercapnia
Cystic fibrosis and bronchiectasis	Due to severe airflow obstruction

Dysfunctional breathing

Dysfunctional breathing refers to an often chronic change in breathing pattern that leads to a perception of breathlessness and other symptoms. An organic cause must be ruled out prior to making the diagnosis. Many have comorbid diseases such as asthma which can make this difficult. Dysfunctional breathing has been referred to by many names, but recently, the term "breathing pattern disorder" (BPD) has been gaining traction [62].

The three main types of dysfunctional breathing or BPD treated by respiratory physiotherapists are:

1. *Hyperventilation syndrome*. The Nijmegen questionnaire has been validated in this group of patients. A score of > 23 out of 64 is positive [61]. Arterial blood gases are also very useful and may show metabolic alkalosis, hyperoxia and hypocapnia [62]. Symptoms may include palpitations, feelings of acute panic, paraesthesia in the hands and around the lips and carpopedal spasm due to a decrease in serum ionised calcium [62]. Treatment is comprised of breathing relaxation techniques such as the Papworth method which emphasises diaphragmatic breathing combined with slow nasal breathing to normalise their tidal volumes. Other techniques employed include the Bradcliff and the Buteyko methods. Nasal breathing also helps engage the diaphragm by acting as a proximal resistance to inspiration and treating underlying anxiety disorders [62–65].
2. *Deep sighing breathing*. This is a very common disorder as well. Patients frequently feel breathless at rest and have air hunger. The "sighs" are the witnessed frequent deep breaths that the patient takes [62]. There is often exercise discordance where their maximum exercise capacity is well maintained. Only one-third of these patients have a positive Nijmegen questionnaire [66]. Often, they have a pre-existing airway disease like asthma or COPD. Chronic stimulation of the laryngopharynx can also cause it such as post-nasal drip or acid reflux [67]. There is also an association with anxiety, depression and post-traumatic stress disorder [67–69]. Treatment involves the Papworth method described above [62]. Treating underlying conditions such as airways disease, GORD and PND may also help. In our experience, 90% of patients are significantly improved after two physiotherapy sessions. Psychological counselling in these patients is sometimes also critical [70].
3. *Vocal cord dysfunction* (VCD) is the most challenging of the dysfunctional breathing disorders to treat. There is often severe underlying psychological morbidity [71]. In a recent study in VCD, 17% of women under the age of 35 had been sexually assaulted [68]. Speech and language therapists often play a big role in these patients. Strategies include asking the patient during attacks of VCD to push their tongue into the roof of their mouth and exhale hard against their tongue which helps abduct their vocal cords [72, 73]. The respiratory physiotherapist can also emphasise a relaxed breathing technique stimulating the parasympathetic nervous system [74]. Another strategy is to inhale Heliox (21% O2 and 79% He) because of its low density [75, 76]. The present authors have not found this strategy to be helpful in several patients. Psychological counselling and psychiatric referral are often indicated in these patients [76, 77].

BPD is a complex, multidimensional disorder that has serious effects on patients' quality of life. The modern respiratory physiotherapist has a key role in recognising, assessing and treating BPD. After establishing the diagnosis, the ongoing management of dysfunctional breathing, particularly hyperventilation syndrome and deep sighing breathing, would be very amenable to the community setting.

Conclusion

With the establishment of Slaintecare, more specialist care will be provided in local community hubs. There is a huge "buy in" for this, both in the community and the acute hospitals. Patients will benefit from local and more accessible specialist care. Hospitals will benefit by reducing the pressure on an over stretched hospital system. This will be through freeing up hospital based clinic slots and by hopefully preventing hospital admissions and presentations. The modern respiratory physiotherapist with their expertise in areas such as sputum clearance, oxygen/NIV, and management of complex breathing disorders will be key in the provision of this local specialist care.

Declarations

Ethics approval Not applicable.

Conflict of interest The authors declare no competing interests.

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