## Evidence Search Service Results of your search request

**Cleaning and decontamination of spirometry devices**

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Please acknowledge this work in any resulting paper or presentation as: *Evidence search: Cleaning and decontamination of spirometry devices* Alison McLaren.(27 July 2020). East Surrey Hospital, UK: Surrey and Sussex Library and Knowledge Services.

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* Association for Respiratory Technology & Physiology (ARTP): <https://www.artp.org.uk/>

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## A. National and International Guidance

#### American Journal of Respiratory and Critical Care Medicine

**Standardization of Spirometry 2019 Update An Official American Thoracic Society and European Respiratory SocietyTechnical Statement** (2019)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=324ecb6ae43be3d992178180fc357b91)

... Hygiene and Infection Control: The goal of infection control is to prevent the transmission of infection to patients and staff during pulmonary function testing. The number of documented cases of infection transmission is very small, but the potential is real. Infection can be transmitted by direct contact with surfaces such as mouthpieces, noseclips, handheld spirometers, chair arms, and immediate proximal surfaces of valves or tubing. Indirect transmission occurs by aerosol droplets generated by the patient blowing into the equipment but also expelled into the air of the testing room between maneuvers...

#### Association for Respiratory Technology & Physiology (ARTP)

**Respiratory Function Testing During Endemic COVID-19** (2020)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3debba7df0c099b7c3da1bd3fde27263)

... Ensure the tests are performed with the appropriate lung function filters in situ. There needs to be recognition that, for some tests, this may affect the results; e.g. cardiorespiratory exercise testing....Following the investigation, the equipment and environment needs to be cleaned appropriately and full PPE removed safely. Consideration needs to be given to the role of additional cleaning staff to support this process.

#### European Respiratory Society

**Recommendation from ERS Group 9.1 (Respiratory function technologists /Scientists) Lung function testing during COVID-19 pandemic and beyond** (2020)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8b58d44bd1b06c8e41a8dd6429946134)

Testing and equipment • Test procedures should be limited to Spirometry and Diffusing capacity and other tests should only be introduced when risk has been appropriately evaluated. Lung volumes by whole body plethysmography may also be possible if droplet contamination can be contained and local national guidelines support this. • Test should always be carried out with a high specification disposable in-line bacterial and viral filter in place (We recommend filters with minimum proven efficiency for high expiratory flow of 600 to 700 L/min). Use of disposable combined mouthpieces/sensors is not recommended at this time. The exception would be where an additional filter can be added to the patient circuit and not degrade the measurements. Maximise the use of single use consumables and dispose of the items with care e.g. nose clips, rubber mouthpieces, etc. • Where reusable items are utilised, they should be managed carefully and should be thoroughly cleaned as recommended by local infection control policy.

#### South African Medical Journal

**Guideline for office spirometry in adults, 2012** (2013)

Koegelenberg C.F.N., Swart F., Irusen E.M.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f58acc9f434f955d3601a3d3d543da5d)

Background. Office spirometry remains an integral part of a comprehensive respiratory evaluation and is used to categorise the nature, severity and progression of respiratory diseases and to measure response to treatment. These updated guidelines are aimed at improving the quality, standardisation and usefulness of office spirometry in South Africa. Recommendations. All equipment should have proof of validation regarding resolution and the system's linearity (consistency). Moreover, equipment must be calibrated daily and quality controlled. It is also important to have standard operating procedures in place, including the documentation of ambient conditions and infection control measures. Adequate spirometry relies on a competent operator, accurate equipment, standardised operating procedures, quality control and patient co-operation. The indication for spirometry in a particular patient should be unambiguous and should be documented. Subjects should be appropriately prepared for testing, and patient details must be documented. Forced vital capacity (FVC) manoeuvres (either closed or open circuit) must be performed strictly according to guidelines, and strict quality assurance methods should be in place, including acceptability criteria (for any given effort) and repeatability (between efforts). Testing should continue until at least 3 acceptable curves are produced (with 2 fulfilling repeatability criteria). Other indices are derived from these efforts. Conclusion. Test results must be categorised and graded according to current guidelines, taking into account the indication for the test and the appropriateness of reference values.

#### Turkish Thoracic Journal

**Turkish thoracic society experts consensus report: Recommendations for pulmonary function tests during and after covid 19 pandemic** (2020)

Gemicioglu B., Borekci S., Dilektasli A.G., Ulubay G., Azap O., Saryal S.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0be5750821abd31f57e6f7633be8159c)

The recommendation of conducting pulmonary function tests (PFTs) from different societies during and after the coronavirus disease (COVID-19) pandemic was rated by the experts of the Turkish Thoracic Society (TTS) and presented as the TTS experts consensus report. Information about the topic has been provided. Globally, as of mid-May 2020, there have been over 4.4 million confirmed cases of COVID-19. There are two main routes of transmission of COVID-19: respiratory droplets and contact transmission. PFTs are non-invasive tests that are commonly performed in routine assessment and follow-up of patients in the pulmonology units. However, PFTs may generate aerosols and require sharing common surfaces. With regard to the high prevalence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the community, PFTs should not be performed routinely in confirmed or suspected patients with COVID-19 during the pandemic. Because of the risk of human-to-human transmission of COVID-19, PFTs should be restricted to a small patient population with selected indications. Triage for COVID-19 should be performed prior to testing. Only essential PFTs such as spirometry, diffusion capacity of the lungs for carbon monoxide (DLCO), arterial blood gas analysis, or pulse oximetry should be performed in the selected cases. Tests should be scheduled to allow sufficient time for donning and doffing of the technical personnel with the full personal protective equipment (PPE) (gown, a filtering respirator mask, goggles or full-face shield, and disposable gloves), ventilation of the room, and application of post-test cleaning and disinfection procedures of the equipment and the testing room. Copyright © 2020 by Turkish Thoracic Society.

## B. Synopses or Summaries

#### Association for Respiratory Technology & Physiology (ARTP)

**COVID19 infection control issues for lung function** (2020)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=c061662745965649475780c6200164ee)

The purpose of this document is to summarise the information, evidence and guidance for infection control relevant to lung function testing services in patients with suspected or confirmed COVID19. It is divided into 4 sections covering the following areas; 1. Information about the virus and the infection risks 2. PPE: masks & filters 3. Environmental considerations and cleaning procedures 4. Current and future considerations for lung function services

## C. Original Research

1. **Amid COVID-19 pandemic: Challenges with access to care for COPD patients**  
   Elbeddini A. Research in social & administrative pharmacy : RSAP 2020;:No page numbers.

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammation in the lungs that causes obstruction in the airway, poor airflow, and irreversible loss of lung function. In clinical practice, comprehensive care for COPD patients includes the diagnosis using spirometry, clinical examination and comprehensive pharmacological and non-pharmacological management. The diagnosis is based on symptoms, dyspnea and lung function impairment and can be mild to very severe. Symptoms are examined using the COPD assessment test (CAT) score, and dyspnea grade are examined using a modified MRC from GOLD guidelines. When mild, the care includes self-management education, smoking cessation, lifestyle modifications, vaccination, and short-acting bronchodilators. Self-management education involves inhaler device training, breathing technique, early recognition of acute exacerbations and writing action plans. As the disease progresses, other care measures are added. These measures include the addition of long-acting inhaler therapies, pulmonary rehabilitation, oral therapies, oxygen and lung transplantation. During the final stages of COPD, patients receive end-of-life care (Bourbeau et al., 2019).1 The novel coronavirus disease (COVID-19) is a viral infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that is spread through respiratory droplets. This infectious disease has led to a pandemic and is affecting the lives of many around the world, including Canadians. During this pandemic, the non-essential health services, including caring for patients with COPD, have been put on hold to reduce the risk of spread. Other implications of this pandemic for COPD patients include the health risk in case of infection. A meta-analysis including studies from January to March 2020 in Wuhan showed that pre-existing COPD worsens the risk of COVID-19 progression and leads to poorer prognostics. The sub-group analysis showed a significantly higher risk of ICU requirements and death in COPD patients who are infected with the SARS-CoV-2 virus. Studies suggest strong efforts to mitigate the risk of infection in this population (Zhao et al., May 2020).2 This makes caring for this population even more critical during the pandemic. Crown Copyright © 2020. Published by Elsevier Inc. All rights reserved.

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1. **CHEST Reviews: Addressing reduced laboratory-based pulmonary function testing during a pandemic**  
   Kouri A. Chest 2020;:No page numbers.

To reduce the spread of SARS-CoV-2, many pulmonary function testing (PFT) laboratories have been closed or have significantly reduced their testing capacity. As these mitigation strategies may be necessary for the next 6-18 months to prevent recurrent peaks in disease prevalence, fewer objective measurements of lung function will alter the diagnosis and care of patients with chronic respiratory diseases. PFTs, which include spirometry, lung volumes, and diffusion capacity measurement, are essential to the diagnosis and management of patients with asthma, COPD, and other chronic lung conditions. Both traditional and innovative alternatives to conventional testing must now be explored. These may include peak expiratory flow devices, electronic portable spirometers, portable exhaled nitric oxide measurement, airwave oscillometry devices, as well as novel digital health tools such as smartphone microphone spirometers, and mobile health technologies along integration of machine learning approaches. The adoption of some novel approaches may not merely replace but could improve existing management strategies and alter common diagnostic paradigms. With these options come important technical, privacy, ethical, financial, and medicolegal barriers that must be addressed. However, the COVID-19 pandemic also presents a unique opportunity to augment conventional testing by including innovative and emerging approaches to measuring lung function remotely in patients with respiratory disease. The benefits of such an approach have the potential to enhance respiratory care and empower patient self-management well beyond the current global pandemic. Copyright © 2020. Published by Elsevier Inc.

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1. **Italian pediatric respiratory society recommendations on pediatric pulmonary function testing during COVID-19 pandemic**  
   Bignamini E. et al Italian Journal of Pediatrics 2020;46:68.

Effective prevention and control strategies are mandatory to prevent SARS-CoV-2 infection. Main text The Italian Pediatric Respiratory Society promotes a series of new recommendations that should be followed in pulmonary function testing laboratories during the COVID-19 pandemic. Conclusion Pulmonary function testing should be performed in children with chronic lung disease only if it is needed to guide management and limited to the necessary tests, namely spirometry. When performed, strict infection control measures should be followed due to the potential risk of transmitting SARS-CoV-2.

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1. **Italian pediatric respiratory society recommendations on pediatric pulmonary function testing during COVID-19 pandemic.**  
   Bignamini Italian Journal of Pediatrics 2020;46(1):1-3.

Background: Effective prevention and control strategies are mandatory to prevent SARS-CoV-2 infection. Main text: The Italian Pediatric Respiratory Society promotes a series of new recommendations that should be followed in pulmonary function testing laboratories during the COVID-19 pandemic. Conclusion: Pulmonary function testing should be performed in children with chronic lung disease only if it is needed to guide management and limited to the necessary tests, namely spirometry. When performed, strict infection control measures should be followed due to the potential risk of transmitting SARS-CoV-2.

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[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a84140e974f01c0782bd196304fae1e3)

1. **Lung function testing in the COVID-19 endemic**  
   Hull J.H. The Lancet Respiratory Medicine 2020;8(7):666-667.

... As COVID-19-related hospital admissions subside, many lung function services have started to reconsider how best to operate, within the constraints dictated by a COVID-19 endemic scenario. Central to planning in this phase are the precautions needed to protect lung function staff, and to minimise cross-infection risk, given an ongoing need to test vulnerable patient groups—eg, immunocompromised or individuals with long-term conditions. Clear and definitive guidance is urgently required for all clinicians planning on undertaking lung function testing (LFT)—particularly spirometry, which is performed widely and in a variety of settings. This procedure requires patients to repeatedly undertake forced exhalatory manoeuvres and as such frequently precipitates coughing and the production of sputum. It also requires clinicians and patients to be in close proximity and thus, even with the use of device filters, in a COVID endemic phase, enhanced infection prevention and control is crucia

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[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=efaa6c37b8f893bd26f70b22834f23e5)

1. **Rethinking respiratory function laboratories in the era of coronavirus disease 2019 Considerations for today and the day after**  
   Lombardi C. Annals of allergy asthma and immunology 2020;:-.

... Respiratory function laboratories should be considered highly specialized laboratory units directed by a chief with full responsibility for the safety of health care personnel and quality control. These laboratories should be located in dedicated areas with enough space and ventilation for patients undergoing respiratory function measurements. The use of air purification or ultraviolet and ozone decontamination systems should be applied according to the indications of the hospital or company management staff for rooms where aerosol-generating procedures are performed

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1. **Microbiological evaluation of UV disinfection effectiveness in a specialist cystic fibrosis clinic**  
   O Allen Journal of Cystic Fibrosis 2019;18(4):e37-e39.

The aim of the study was to evaluate the impact of manual cleaning and manual cleaning followed by Ultraviolet-C disinfection on the colony forming units of bacteria retrievable from equipment and surfaces within clinic rooms following a CF outpatient encounter. While UV disinfection has proven to be effective within general healthcare settings, it has not been evaluated in a CF centre. Microbiological sampling was performed following outpatient encounters involving 11 adult patients with CF and chronic infection with P.aeruginosa, MRSA or E. coli ESBL. The results of this study suggest that manual cleaning followed by UV-C disinfection is more effective than manual cleaning alone at reducing environmental contamination within a CF clinic and that UV-C disinfection is likely to reduce the risk of fomite transmission in the CF outpatient setting

1. **Comparison of handheld to conventional spirometry in pediatric cystic fibrosis**  
   Avdimiretz N. American Journal of Respiratory and Critical Care Medicine 2018;197:No page numbers.

RATIONALE: Advantages of handheld devices over desktop spirometers include improved portability, ease of cleaning, and use at home. In cystic fibrosis (CF), replacing traditional spirometry with handheld spirometry in the ambulatory setting would negate requiring isolation in the pulmonary function lab. The CF Foundation does recommend contact precautions and segregation measures, even in ambulatory settings. Therefore, the utilization of handheld spirometers may aid in infection control and patient flow. However, because such handheld spirometers were initially less accurate than conventional devices, there is still a sense that newer generation devices are inaccurate; although adult studies show otherwise. We conducted a pilot study to examine the accuracy of a typical handheld spirometer versus a conventional device in pediatric CF patients. METHOD(S): Spirometric data from 12 pediatric CF patients aged <18 years were obtained in the ambulatory setting using the Micro Loop Spirometer © (CareFusion, USA) and compared to same-day data obtained via desktop spirometry. Indices included FEV1, FVC, FEV1/FVC, FEF25-75%, and peak expiratory flow (PEF). Similar coaching techniques were used and ATS standards were adhered to. Correlation coefficients were calculated with 95% confidence intervals to determine the strength of relationship between data sets. Bland-Altman plots were generated, plotting differences between the techniques against averages of them, to determine agreement between the techniques. RESULT(S): Ages ranged from 7-17 years. Linear relationships were obtained between the two devices for all indices: r=0.99, 0.96, 0.95, 0.99, 0.96 for FEV1, FVC, FEV1/FVC, FEF25-75%, and PEF respectively (p<0.0001 for all). Bland-Altman plots for all indices demonstrated scatter across averaged values. However, mean differences between the data using both techniques (handheld - conventional) +/- limits of agreement (defined as +/-2 SD) were: -0.08 +/- 0.26 L for FEV1 (p<0.05), -0.07 +/- 0.25 L for FVC (p=0.09), -0.09 +/- 0.42 L for FEF25-75% (p=0.19), and -0.58 +/- 1.32 L for PEF (p<0.05). CONCLUSION(S): Measurements obtained using the handheld spirometer correlate well in a linear fashion with data obtained via conventional desktop spirometry. However, because agreement limits are wide (>=250 mL) and differences between the two devices are significant for FEV1 and PEF, bias (mean differences) between the techniques are not insignificant. We found no consistent trend in bias across volumes. This suggests that handheld versus conventional spirometers may not always be used interchangeably in the pediatric CF population. Larger studies are needed with the goal of potentially improving patient flow and infection control in the ambulatory setting.

1. **Effect of early family meetings and patient education in adults with cystic fibrosis: A quality improvement initiative**  
   Khan M.Z. Pediatric Pulmonology 2017;52:420.

Introduction: CF is a rare disease with a median survival of 40.7 years. Although the life expectancy of individuals with CF continues to increase, the complexity of care places a burden on this population. Since patient-provider interactions are most frequent during hospital admissions, outpatient care is of utmost importance in the management of CF. Under this realization, we conducted a preliminary investigation using home-based intervention to improve the quality of CF care. Method(s): Our program combined family meetings, illustrative patient education delivered electronically via iPads, and hand-held spirometer exercises. In our study, twenty-five adult patients mean age of twenty-seven and one-half years were enrolled. Participants were asked to complete surveys during clinic visits regarding the perceived educational value of their treatment program, family support, and support from their CF center. Family members were invited to the initial meeting for educational reinforcement. Two surveys were completed after our intervention using a Likert scale from 0-10. We compared the scores of the pre-intervention survey with post-intervention surveys 1 and 2 with one-way analysis. Result(s): Of the twenty-five participants who enrolled in our study, mean score of family support improved from 9.66 to 9.67 (p=0.976). The mean scores further increased in patient education in various categories including understanding PFT numbers from 9.44 to 9.75 (p=0.541), drug treatments from 9.42 to 9.833 (p-value= 0.019) and infection control from 7.92 to 9.14 (p= 0.026). Conclusion(s): Our evaluation of this "stage-one" trial underscores the exciting potential for home-based interventions in the treatment of CF. We determined that a home-based educational program and regular spirometer use could increase patients' lung function and perceived value of their health care as well as advocate family support at home. This study showed that further measures must be taken to ensure that patients are remaining in contact with their providers and educational, psychosocial, and physical benefits are continuing to accumulate.

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1. **Incentive Spirometry for Pediatrics.**  
   Anon. RT: The Journal for Respiratory Care Practitioners 2017;30(7):24-25.

The article discusses the use of incentive spirometers for bronchial hygiene therapy. Topics include how the devices increase lung capacity and improve patient's ability to breathe, the objectives of incentive spirometry, and several incentive spirometry options offered by Smiths Medical, Teleflex, and Dr Burton Healthcare Products.

1. **Practice Safe Spirometry.**  
   O'BRIEN RT: The Journal for Respiratory Care Practitioners 2016;29(4):10-12.

The article discusses the risks associated with using spirometers for pulmonary function testing. Topics discussed include use of forced expiratory volume (FEV) parameters as recommended by National Lung Health Education Program, priority of healthcare professionals to protect patients from cross contamination, and restricting testing of patients by staff having respiratory infections.

1. **Infection control in the pulmonary function test laboratory**  
   Rasam S. Lung India 2015;32(4):359-366.

Pulmonary function testing plays a crucial role in the diagnostic evaluation of patients with lung diseases. Cases of cross infection acquired from the pulmonary function laboratory, although rare, have been reported from various countries. It is therefore imperative to identify the risks and potential organisms implicated in cross infections in a pulmonary function test (PFT) laboratory and implement better and more effective infection control procedures, which will help in preventing cross infections. The infrastructure, the daily patient flow, and the prevalent disinfection techniques used in a PFT laboratory, all play a significant role in transmission of infections. Simple measures to tackle the cross infection potential in a PFT laboratory can help reduce this risk to a bare minimum. Use of specialized techniques and equipment can also be of much use in a set up that has a high turnover of patients. This review aims at creating awareness about the possible pathogens and situations commonly encountered in a PFT laboratory. We have attempted to suggest some relevant and useful infection control measures with regard to disinfection, sterilization, and patient planning and segregation to help minimize the risk of cross infections in a PFT laboratory. The review also highlights the lacuna in the current scenario of PFT laboratories in India and the need to develop newer and better methods of infection control, which will be more user-friendly and cost effective. Further studies to study the possible pathogens in a PFT laboratory and evaluate the prevalent infection control strategies will be needed to enable us to draw more precious conclusions, which can lead to more relevant, contextual recommendations for cross infections control in PFT lab in India.

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[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=561cee8b3ab82f8bb50e710c73adbbde)

1. **Developing a spirometry protocol for children and young people.**  
   Mighten Nursing Children & Young People 2014;26(1):22-25.

The practicalities of obtaining technically acceptable spirometry results with children and young people demand a protocol that follows national guidance and is adjusted to local conditions. Although there is guidance for adults, to date there has been no equivalent for children and young people. The procedural structure should be developed to include consistent standards and values, acknowledgement of contraindications, competence of the testing procedure among clinicians, and constant recalibration and cleaning of equipment. Only if these requirements are met can the results be valid.

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1. **Overcoming barriers to infection control in patients with CF**  
   Gross J. Pediatric Pulmonology 2014;49:199-200.

Cystic fibrosis (CF) is a genetic life-shortening disease characterized by chronic airway infection and inflammation leading to bronchiectasis and eventually respiratory failure. There is increased morbidity and mortality associated with acquisition of a variety of pathogens including methicillin-resistant Staphylococcus aureus (MRSA), epidemic strains of Pseudomonas aeruginosa and genomovars of Burkholderia cepacia. Therefore, it has become imperative to limit transmission of bacteria between patients with CF. The new CF infection control guidelines have been designed to limit direct and indirect contact between providers and patients as well as contact between CF patients in the clinic and hospital settings. Access to a copy of the guidelines has a beneficial effect on adherence to the recommendations. Consequently, it is important to disseminate infection control guidelines to your care team, patients, families and all other health care workers that may come in contact with a patient with CF, including ancillary support services such as radiology and the laboratory (1,2). The new guidelines present significant organizational, financial and logistical challenges for CF centers. Our center recently made changes consistent with the new guidelines. In order to accomplish these changes, it is important for centers to have comprehensive written inpatient and outpatient infection control policies. After the previous guidelines were published, one review demonstrated that socializing among CF patients was discouraged in only 80% of inpatient policies and 55% of outpatient policies (3). In our center's experience, there were multiple barriers to overcome. There are three main barriers to adherence to guidelines: knowledge (lack of awareness or familiarity); attitudes (lack of agreement, self-efficacy, outcome expectancy or the inertia of previous practice); and behavior (external barriers) (4). These barriers are similarly found in CF centers related to infection control (1). Imagine, today is CF clinic day. The day begins with cleaning of all the CF clinic rooms. All horizontal surfaces and equipment including keyboards, computers, otoscopes, and plastic models are wiped down with antibacterial solution. Once completed, the door is shut and a sign is hung noting the room has been cleaned. Portable carts loaded with masks, gowns, gloves, sputum cups and swabs are placed outside of every clinic room. It is 9am and the clinic day is about to begin. A patient with CF enters the main doors of the hospital, where she obtains a mask and is reminded to perform hand hygiene. Hand hygiene is a critical component for patient and family education since it is established that during clinic visits, patients' hands can become recontaminated and hand hygiene has been shown to be effective (5). She walks directly to the CF clinic lobby and presents a laminated "fast pass" card, written documentation that she has CF, to the receptionist in the clinic waiting room. In a study of inpatients, only 61% discouraged socialization between patients, so it is important that the patient and family, in addition to the health care team, be well educated about infection control policies and procedures (1). The CF nurse is paged and quickly arrives, stopping briefly to measure the patient's height and weight, then escorts the patient to a CF clinic room. While the patient is waiting in the clinic room, the nurse performs hand hygiene, then dons gown and gloves and obtains vital signs with clean portable instruments. The respiratory therapist (RT) performs hand hygiene, dons a gown and gloves, enters the room, and obtains spirometry with a portable spirometer, then collects a sputum sample. Additionally, the RT reviews the importance of and techniques to clean the nebulizer at home, a vital component of infection control, that is often a barrier, due to lack of familiarity or agreement. In a survey, only 23% of respondents provided this education to more than 75% of their patients (1). Written protocols for home cleaning that are provided for families are of great importance (2). The influential role the RT plays in infection control has been well outlined (6). Today is an annual CF clinic visit, so the nurse reviews the history, inquires about new concerns and collects multiple tubes of blood for laboratory evaluation. The blood and sputum samples are hand delivered to the lab by a technologist. The clinical microbiology lab should receive a copy of the most recent guidelines in order to follow the recommendations for specimen processing. After the prior set of guidelines was published, only 79% of CF centers had written lab protocols (2). In addition to labs, an annual chest radiograph is required, so the nurse calls radiology to inform the radiology front desk that a patient with CF will be arriving shortly. The patient dons a mask, walks directly to radiology, presents her "fast pass" and is directly escorted to an imaging suite where radiology techs perform hand hygiene and don gown and gloves before obtaining the chest radiograph. Once imaging is completed, the gown and gloves are discarded in the radiology suite and the suite is cleaned as the patient returns to her dedicated room in the CF clinic for the remainder of her multidisciplinary evaluation. Once the visit is completed, environmental services is called to perform appropriate disinfection of the room to prepare the room for afternoon use. This story is an image of ideal goals for management of a single patient in the midst of a busy CF clinic day. Challenges to attaining this level of coordination involve support from hospital administration, local clinic administration, nursing, respiratory therapy, the laboratory, radiology, preventative medicine, and environmental services as well as other divisions and departments within the hospital. Real world solutions to overcoming the barriers to implementing these dramatic changes vary depending on individual clinic and hospital resources. In our experience, the most significant challenge was appropriate allocation of limited resources and space to accommodate the new guidelines. There are economic advantages to contact precaution and infection control practices evidenced in the literature (7). With concerted coordinated effort, these goals can be reached to decrease risk of acquisition of a new pathogen in the clinic and hospital setting and ultimately optimize care of the patient with CF.

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1. **Spirometry 1: outlining pre-test preparation.**  
   Loveridge Practice Nursing 2013;24(4):169-173.

... Cleaning and infection control is another requirement of pre-test preparation. Although cases of cross-infection are rare from lung function testing (Rutala et al. 1991; Burgos et al, 1996), this is no reason not to clean or sterilize equipment. One-way disposable, valved mouthpieces (Figure 1) should be used (Levy et al 2009) and nose clips for the relaxed VC should be single-patient use...

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1. **Microbiological contamination of spirometers: An exploratory study in general practice**  
   Hancock K.L. Australian Family Physician 2012;41(1):63-65.

Background: Spirometry is an important tool when diagnosing chronic respiratory conditions in general practice. However, the equipment may harbour pathogenic micro-organisms and cross-transmission of aerolised pathogens could occur if hygiene measures are insufficient. Method(s): We assessed microbiological contamination in 16 spirometers from a convenience sample of South Australian general practices. Result(s): We found potentially relevant microbiological contamination in three spirometers: two Pseudomonas spp.; one coagulase negative Staphylococcus sp. and one Alcaligenes sp. Although the three practices concerned all reported to have a written spirometer cleaning protocol in place, the frequency of spirometer disinfection did not match the manufacturers' recommendations. Discussion(s): Despite the small size of our study sample, we found potentially relevant microbiological contamination in 3 out of 16 spirometers from metropolitan general practices. The potential hazard of spirometers as reservoirs of microorganisms stresses the need for stricter attention to hygiene measures for spirometer maintenance in general practices.

1. **Risk of bacterial cross infection associated with inspiration through flow-based spirometers**  
   Bracci M. American Journal of Infection Control 2011;39(1):50-55.

Background: Bacterial contamination of spirometers has been documented in water-sealed devices, mouthpieces, and connection tubes. Little information is available about bacterial contamination of flow-based apparatuses such as turbine-type spirometers and pneumotachographs. Inspiration through contaminated equipment is a potential source of cross infection. To investigate bacteria mobilization (ie, bacteria detachment and aerosolization from the instrument) during routine spirometric testing, 2 types of flow-based spirometers were used. Bacteria mobilization during artificial inspiration through in-line filters or cardboard mouthpieces was evaluated. Method(s): Nine hundred workers undergoing periodic spirometric testing were enrolled at the occupational physician office in 30 sessions of 30 subjects each. The participants were asked to perform a forced vital capacity test in a turbine-type spirometer and in an unheated pneumotachograph fitted with disposable in-line filters or cardboard mouthpieces. To evaluate bacterial mobilization, an artificial inspiration was performed and bacterial growth determined. The bacterial growth analysis was assessed after the first and the thirtieth spirometric tests of each session without disinfecting the instruments between tests. In addition, instrument bacterial contamination was evaluated. Result(s): No significant bacterial mobilization and instrument contamination were found in spirometric tests executed with in-line filters. Conversely, a significant bacterial mobilization and instrument contamination were observed in tests performed with cardboard mouthpieces. Differences between the 2 spirometers were not significant. Conclusion(s): In-line filters may effectively reduce the risk of bacterial cross infection. Inspiration through flow-based spirometers fitted with disposable cardboard mouthpieces is completely safe when combined with spirometer disinfection/sterilization between subjects. © 2011 by the Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved.

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1. **A cleaning and calibration method for the SpiroPro portable spirometer's pneumotachometer tube in a remote field study.**  
   Division of Pulmonary and Critical Care Department of Medicine School of Medicine The Johns Hopkins University 1830 Monument Street Fifth Floor Baltimore MD 21205. wcheckl1@jhmi.edu. Respiratory Care 2010;55(4):443-452.

BACKGROUND: We developed a systematic method of cleaning and calibration-checking for the pneumotachometer tube of the SpiroPro portable spirometer; this method maximized spirometry accuracy in a population-based study in a remote area of Nepal. METHODS: We tested 10 factory-calibrated pneumotachometer tubes. Each use consisted of a full set of spirometry maneuvers, per the American Thoracic Society (ATS) spirometry criteria. RESULTS: The pneumotachometers remained accurate, per the ATS criteria, for 5-9 disinfections, but began to drift toward inaccuracy after the first disinfection. All the pneumotachometers had become inaccurate, per the ATS criteria, after 10 disinfections. CONCLUSIONS: In a remote field setting the SpiroPro pneumotachometer tube can be cleaned and reused 5-9 times before it becomes inaccurate per the ATS criteria. Rigorous rinsing in distilled water and repeated calibration checks, at various flows up to 12 L/s, are essential for precise and accurate spirometry with the SpiroPro. Reusing the SpiroPro pneumotachometer in a remote setting may impose measurement bias. Single use of SpiroPro pneumotachometers, albeit more costly, will provide better data.

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| --- | --- | --- | --- |
| 1. | EMBASE | exp SPIROMETRY/ | 40497 |
| 2. | EMBASE | exp SPIROMETER/ | 3950 |
| 3. | EMBASE | (spiromet\*).ti,ab | 38774 |
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| 5. | EMBASE | exp CORONAVIRUS/ | 14204 |
| 6. | EMBASE | ("2019-nCoV" OR "SARS-CoV" OR "MERS-CoV" OR "Severe Acute Respiratory Syndrome" OR "Middle East Respiratory Syndrome").ti,ab | 10556 |
| 7. | EMBASE | exp "CORONAVIRUS INFECTION"/ | 13333 |
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| 9. | EMBASE | ("infection control").ti,ab | 27408 |
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| 12. | EMBASE | (decontaminat\*).ti,ab | 15281 |
| 13. | EMBASE | (disinfect\*).ti,ab | 33926 |
| 14. | EMBASE | (1 OR 2 OR 3) | 52037 |
| 15. | EMBASE | (4 OR 5 OR 6 OR 7) | 56419 |
| 16. | EMBASE | (8 OR 9) | 114014 |
| 17. | EMBASE | (14 AND 15) | 53 |
| 18. | EMBASE | (14 AND 16) | 71 |
| 19. | EMBASE | 18 [DT 2010-2020] [English language] | 46 |
| 20. | EMBASE | (10 AND 14) | 114 |
| 21. | EMBASE | (11 AND 14) | 279 |
| 22. | EMBASE | (12 AND 14) | 6 |
| 23. | EMBASE | (13 AND 14) | 53 |
| 24. | EMBASE | 20 [DT 2010-2020] [English language] | 57 |
| 25. | EMBASE | 21 [DT 2010-2020] [English language] | 196 |
| 26. | CINAHL | exp SPIROMETRY/ | 6138 |
| 27. | CINAHL | (spiromet\*).ti,ab | 5671 |
| 28. | CINAHL | (coronavirus OR covid-19).ti,ab | 11131 |
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| 30. | CINAHL | ("2019-nCoV" OR "SARS-CoV" OR "MERS-CoV" OR "Severe Acute Respiratory Syndrome" OR "Middle East Respiratory Syndrome").ti,ab | 2510 |
| 31. | CINAHL | exp "INFECTION CONTROL"/ | 72610 |
| 32. | CINAHL | ("infection control").ti,ab | 11272 |
| 33. | CINAHL | (hygiene).ti,ab | 18897 |
| 34. | CINAHL | (clean\*).ti,ab | 18256 |
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| 41. | CINAHL | (37 AND 39) | 56 |
| 42. | CINAHL | (33 OR 34 OR 35 OR 36) | 41019 |
| 43. | CINAHL | (37 AND 42) | 58 |
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**Date of request:** 23rd July, 2020  
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