

2021

Weak evidence, supplemented with common sense for reduction in postoperative pulmonary complications

Natalie M. Wiseman

Wayne State University, nataliewiseman3@gmail.com

Follow this and additional works at: <https://digitalcommons.wayne.edu/crp>



Part of the [Medical Education Commons](#), [Medical Physiology Commons](#), [Pulmonology Commons](#), and the [Respiratory Tract Diseases Commons](#)

Recommended Citation

WISEMAN NM. Weak evidence, supplemented with common sense for reduction in postoperative pulmonary complications. *Clin. Res. Prac.* May 28 2021;7(1):eP2301. <https://doi.org/10.22237/crp/1622160180>

This Clinical Decision Report is brought to you for free and open access by the Open Access Journals at DigitalCommons@WayneState. It has been accepted for inclusion in *Clinical Research in Practice: The Journal of Team Hippocrates* by an authorized editor of DigitalCommons@WayneState.

Weak evidence, supplemented with common sense for reduction in postoperative pulmonary complications

NATALIE M. WISEMAN, BS, Wayne State University School of Medicine, nwisema@med.wayne.edu

ABSTRACT A clinical decision report appraising:

Kaminski PN, Forgiarini LA, Jr., Andrade CF. Early respiratory therapy reduces postoperative atelectasis in children undergoing lung resection. *Respir Care*. 2013;58(5):805-809. <https://doi.org/10.4187/respcare.01870>

for prevention of postoperative pulmonary complications following thoracic surgery for a patient who is not able to participate in incentive spirometry.

Keywords: *Postoperative pulmonary complications, incentive spirometry*

Clinical-Social Context

Gela Katz [pseudonym] is a 25-year-old woman with Down Syndrome and aspiration pneumonia. Ms. Gela Katz presented from an outside hospital with a right lower lobe pneumonia and right pleural effusion with a pigtail drain placed in the pleural space. At her prior hospital, her drain output slowed and was somewhat restored with tissue plasminogen activator (tPA), with improvement but without resolution of the effusion. She was also started on antibiotics for the pneumonia. She was admitted to our surgical intensive care unit (SICU) with a plan for video-assisted thoracic surgery (VATS) with decortication on the following day. While in the SICU, Ms. Gela Katz seemed comfortable on 2 liters of oxygen by nasal canula with no complaints, agreeable to the medical staff and singing and talking with her parents. Given her existing pneumonia, oxygen saturation of 93%, and upcoming intrathoracic surgery, her ARISCAT risk score was greater than 45, indicating a 42.1% risk of post-operative pulmonary complications.¹ We discussed breathing exercises and an incentive spirometer with her and her mother, her primary caregiver, to reduce her risk, but she had difficulty learning the technique and her mom reported that she would not be interested in doing it after surgery if it is difficult or painful. To manage her risk of postoperative pulmonary complications, we needed to explore other options for encouraging deep breathing and full chest expansion despite post-surgical pain.

Clinical Question

What postoperative interventions can be used to prevent pulmonary complications in patients that have difficulty learning maneuvers such as an incentive spirometer?

NATALIE M. WISEMAN, BS is a fourth year medical student at the Wayne State University School of Medicine and a Senior Editor of this Journal.



ISSN: 2379-4550

<http://digitalcommons.wayne.edu/crp>, © 2021 The Author(s)

Licensed under [Creative Commons Attribution 4.0 International \(CC-BY-4.0\)](https://creativecommons.org/licenses/by/4.0/)

Research Article

Kaminski PN, Forgiarini LA, Jr., Andrade CF. Early respiratory therapy reduces postoperative atelectasis in children undergoing lung resection. *Respir Care.* 2013;58(5):805-809. <https://doi.org/10.4187/respcare.01870>.⁷

Description of Related Literature

The UpToDate article on preventing postoperative pulmonary complications describes risk assessment for common postoperative pulmonary complications, including atelectasis, pneumonia, acute respiratory distress syndrome (ARDS), aspiration, and several others, and discuss preoperative, intraoperative, and postoperative strategies for reducing risk.² Preoperative strategies, like quitting smoking and good management of asthma or COPD with avoidance of triggers, largely don't apply to our patient who doesn't smoke and doesn't have long-standing pulmonary disease. Intraoperative strategies, like reducing the length or invasiveness of surgery or considering neuraxial anesthesia, were already optimized or out of our control for our patient. Therefore, we focused on postoperative strategies, which include lung expansion, early mobilization, pain control, removal of nasogastric (NG) tubes used for stomach decompression, and prevention of venous thromboembolism. Many of these have standard implementation in our hospital, including early mobilization, VTE prophylaxis with low molecular weight heparinoids or subcutaneous heparin, and lung expansion with an incentive spirometer. As our patient was eligible for all our standard interventions except the lung expansion, which she had difficulty with, further options for lung expansion were explored.

PubMed was first searched for human studies containing "postoperative pulmonary complications prevention incentive spirometry" using the best match option, to search for options that incentive spirometry is compared to. This produced a Cochrane review which determined that incentive spirometry is not better than no intervention or deep breathing exercises in patients undergoing upper abdominal surgery.³ A search using just "postoperative pulmonary complications prevention" returned hundreds of options, mainly discussing intraoperative ventilation techniques or preoperative physiotherapy, which were outside of the scope of our question. In addition, most of the thoracic surgeries studied in these papers were lung resections, which differ substantially from the surgery that our patient anticipated. A search using "lung expansion postoperative pulmonary complications" and limited to human clinical trials returned 17 options, which were whittled down to 2 by removing protocols without data, non-relevant procedures, and pre- or intraoperative studies. One of the remaining two studies included a 2015 study randomized 137 patients into 4 groups, control, two kinds of incentive spirometry, and deep breathing exercises, and found that the lung expansion techniques did not affect the rate of postoperative pulmonary complications and the authors therefore did not recommend their use.⁴ The other, a 1984 study, randomized 172 patients into 4 groups, control, deep breathing, incentive spirometry, and intermittent positive pressure breathing, and found that all three lung expansion maneuver groups had lower rates of postoperative pulmonary complications.⁵ However, these results were contradicted by the majority of more recent work.

To attempt to limit the search to maneuvers my patient could be instructed to perform, a search was performed with "pediatric postoperative pulmonary complications" and limited to human clinical trials. This offered 91 results, most of which were about procedures not relevant to my patient. Relevant results included an announcement of a study on high-flow nasal cannula which has not yet published results⁶ and a 2013 Kaminski et al. study on early respiratory therapy. Their early respiratory therapy protocol included "positive expiratory pressure ..., expiratory rib cage compression, coughing, lifting the upper limbs, and ambulation" for 123 patients and was compared to a historical control group of 71 patients who received physiotherapeutic techniques without standardization, and showed a reduction in atelectasis in the experimental group.⁷ Because post-expiratory pressure would be an excellent option for a patient with difficulty learning techniques or performing them as instructed, a final Pubmed search for "pediatric positive expiratory pressure postoperative" was performed, resulting in 4 publications, including the Kaminski et al. study and 3 others which were not determined to be relevant to the patient or question.

There is a paucity of published clinical trials to address this specific question. Given the difficulty in application of these techniques for a patient with difficulty learning the technique or following instructions, the Kaminski et al. study, which included interventions which could be performed with and for her rather than by her, was found to be the most relevant in terms of possibly providing a workable intervention.

The SORT Grade of Recommendation for preventing post-operative respiratory complications in patients unable to use an incentive spirometer is B, based on limited studies.⁸



Critical Appraisal

Kaminski et al. assess early postoperative respiratory therapy for reduction of pulmonary complications in children. Their study design was prospective and retrospective, with a prospective intervention group and a retrospective control group. This represents and Oxford Centre for Evidence-Based Medicine level of evidence of 4.

This study included 127 consecutive lung resection patients with an average age of 6.9 years old from Santo Antonio Children's hospital in Porto Alegre, Brazil, excluding any patients who had received multiple surgeries. Four patients were excluded due to incomplete information on their physiotherapeutic intervention. The remaining 23 patients were divided into a control (retrospective) group with no prescribed therapy who followed their physiotherapist's decisions, and an intervention (prospective) group who followed a strict physiotherapeutic protocol. This protocol began 4 hours after surgery and included 3 sessions per day until the time of discharge. Each session was 30 minutes and included four cycles of 10 breaths with a mask with positive expiratory pressure of 10 cm H₂O and active expiration, expiratory rib cage compression, manually assisted coughing, elevation of upper limbs, and ambulation. This was performed by 5 physiotherapists who were trained to perform the maneuvers in a standardized way and used their own judgement to determine the length of manual rib cage compression and assisted coughing, aiming for a perception that secretions were cleared. In patients who could not remove secretions, nasopharyngeal aspiration was used.

Outcome measures included postoperative pulmonary complications (including prolonged air leak, pneumothorax, atelectasis, and consolidation on chest x-ray), postoperative bronchoscopy, timing of chest tube removal, and duration of hospital stay. Chest x-rays were examined by blinded radiologists. Prolonged air leak was defined as air leak still present at 7 days. Need for bronchoscopy was determined based on clinical and radiological worsening at 3 days, including copious secretions, persistent atelectasis, consolidation, or diffuse rhonchi. Chest tubes were removed when drainage was under 3 mL/kg/day, x-ray showed complete expansion, and no air leaks were detected. Discharge occurred at least 1 day after chest tube removal, absence of fever, and lung expansion on chest x-ray. In their study, atelectasis was significantly more common in the control group, with 11 cases (15.5%) as compared to 4 (7.7%, $p=0.1$; number needed to treat (NNT) = 13), with no difference in pneumothorax ($p=0.89$) or prolonged air leak ($p=0.68$). They report a difference in grouped "other" pulmonary complications, including chylothorax, empyema, subcutaneous emphysema, pleural effusion, or pulmonary necrosis, with 12 cases in the control group and 1 in the early physiotherapy group ($p=0.01$), but they do not describe which complications each had. They also report no difference in the timing of chest tube removal (2.71 ± 2.15 days vs 3.28 ± 2.65 days) or length of hospital stay (9.9 ± 9.1 days vs 8.48 ± 5.21 days), but do not give p values.

This study has several weaknesses worth noting. First, the control group physiotherapy is not described. Their goal in using the physiotherapists' standard system is to compare to a standard of care, but it is difficult to understand what that standard of care is and how it might compare to the standard of care performed in any other hospital. Next, they have a surplus of outcome variables, increasing their chances of false positive results due to a large number of statistical tests. They don't define any as primary or secondary, either. The outcomes are also mostly unblinded, as they are coming from the medical records, with the exception of the radiographical outcomes, which were judged blind. This fails to protect against bias. Additionally, the authors do not sufficiently describe dividing the 123 patients into two groups, so it is unclear how this was done. They provide p-values for gender, age, preoperative diagnoses, and type of resection to demonstrate that the groups are not different, but the lack of randomization is a drawback. Finally, there is a lack of detail in the description of the outcome variables, missing p values on some and not specifying which complications on others. Additionally, there are some issues with fit between this paper and my particular patient, who had a VATS decortication rather than a resection, and who is not a pediatric patient and therefore dissimilar from the patients in this study in terms of musculature and bony or cartilage flexibility. However, a perfect fit was not available to include, and the interventions available to a pediatric population were more relevant to my patient than those in the adult studies.

The Grade of Evidence for aggressive post-operative respiratory therapy to prevent lung complications is 2, based on limited, poor quality study.⁸

Clinical Application

I discussed the purposes behind the lung expansion maneuvers and the risks of atelectasis and pneumonia with Gela's mother. Given the paucity of high-quality data regarding prevention of postoperative pulmonary complications, and given many studies and reviews that dispute the effectiveness of incentive spirometry, we ultimately did not feel strong concern over Gela's inability to perform the incentive spirometer maneuver. The low



level of evidence and weaknesses of the paper critically appraised were considered, and we decided not to deviate from the normal pulmonary physiotherapy that is provided several times per day in the ICU. She returned from the operating room with three chest tubes, two of which were removed within one week before she was transferred out of the ICU, and the last of which was removed the next day. She was discharged home without postoperative complications.

New Knowledge Related to Clinical Decision Science

Doctors are often confronted with clinical situations where there is no clear research evidence to guide treatment. These situations require creativity and common sense, which this clinical decision report highlights. I discussed the purposes behind the lung expansion maneuvers and the risks of atelectasis and pneumonia with Gela's mother, along with the lack of well-researched options for patients like Gela. Gela's mother was a resource about activities that Gela might be able to participate in. Together, we found a Cincinnati Children's resource on a "bubble PEP," a device for home use which uses a column of water with dish soap to create a positive expiratory pressure when a patient blows through a straw into the bottom of the column.⁹ This creates bubbles, which may be more engaging and more like a game, and therefore more motivating to perform. Gela's mother also suggested recorders or party whistles, which could perform a similar function in providing resistance, though at an unknown level. We also discussed the benefits of exercise which makes her breath deeply, especially because she is mostly sedentary. These are all reasonable home interventions that may help her respiratory function.

Conflict Of Interest Statement

The author declares no conflicts of interest.

References

1. Canet J, Gallart L, Gomar C, et al. Prediction of postoperative pulmonary complications in a population-based surgical cohort. *Anesthesiology*. 2010;113(6):1338-1350. <https://doi.org/10.1097/aln.0b013e3181fc6e0a>
2. Smetana GW. Strategies to reduce postoperative pulmonary complications in adults. In: Post T, ed. *UpToDate*. UpToDate, Waltham, MA. (Accessed December 17, 2019): UpToDate; 2018.
3. do Nascimento Junior P, Modolo NS, Andrade S, Guimaraes MM, Braz LG, El Dib R. Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. *Cochrane Database Syst Rev*. 2014(2):CD006058. <https://doi.org/10.1002/14651858.cd006058.pub3>
4. Lunardi AC, Paisani DM, Silva C, Cano DP, Tanaka C, Carvalho CRF. Comparison of lung expansion techniques on thoracoabdominal mechanics and incidence of pulmonary complications after upper abdominal surgery: a randomized and controlled trial. *Chest*. 2015;148(4):1003-1010. <https://doi.org/10.1378/chest.14-2696>
5. Celli BR, Rodriguez KS, Snider GL. A controlled trial of intermittent positive pressure breathing, incentive spirometry, and deep breathing exercises in preventing pulmonary complications after abdominal surgery. *Am Rev Respir Dis*. 1984 Jul;130(1):12-5. <https://doi.org/10.1164/arrd.1984.130.1.12>
6. Charlesworth M, Glossop AJ. Strategies for the prevention of postoperative pulmonary complications. *Anaesthesia*. 2018;73(8):923-927. <https://doi.org/10.1111/anae.14288>
7. Kaminski PN, Forgiarini LA, Jr., Andrade CF. Early respiratory therapy reduces postoperative atelectasis in children undergoing lung resection. *Respir Care*. 2013;58(5):805-809. <https://doi.org/10.4187/respcare.01870>
8. Ebell MH, Siwek J, Weiss BD, et al. Strength of Recommendation Taxonomy (SORT): A patient-centered approach to grading evidence in the medical literature. *Journal of the American Board of Family Practice*. 2004;17(1):59-67. <https://doi.org/10.3122/jabfm.17.1.59>
9. Bubble PEP (Positive Expiratory Pressure). <https://www.cincinnatichildrens.org/health/b/Bubble-PEP>. Accessed December 14, 2019.

