ISRCTN10644366 https://doi.org/10.1186/ISRCTN10644366

# Can performing daily breathing exercises before major surgery reduce the risk of developing lung complications after surgery?

**Submission date**
25/11/2019

**Recruitment status**
No longer recruiting

**Registration date**
20/12/2019

**Overall study status**
Completed

**Last Edited**
01/08/2025

**Condition category**
Surgery

[_] Prospectively registered
[X] Protocol
[X] Statistical analysis plan
[X] Results
[_] Individual participant data

## Plain English summary of protocol

Background and study aims
Major operations in the stomach or chest provide life-saving operations for people with cancer or a heart condition. As with all major surgery, there is a chance of developing complications after the operation. The Inspire study is concerned with lung complications, including pneumonia. Lung complications after surgery are common, affecting on average one in ten patients, although it depends on the current health of the person and the type of surgery they are having. Lung complications have a long term effect, and can reduce life expectancy for up to ten years after the operation. Poor health due to lung complications also increases healthcare costs. Consequently, trying to prevent lung complications is important for both patients and the NHS.
The study aims to investigate whether breathing training reduces lung complications in patients who, because of their health or the operation they are having, have a higher than average risk of developing lung complications after surgery. Some studies have shown that training for as little as two weeks before a major operation halves the risk of lung complications. The benefits of this training, however, remain uncertain as previous studies recruited too few patients and many were not done well.

Who can participate?
Adult patients having operations in the chest or stomach under general anaesthesia.

What does the study involve?
The Inspire study is investigating whether a series of daily breathing exercises that aim to improve the strength and endurance of the muscles in the chest can help to reduce the chances of getting a lung complication after surgery. The exercises involve using a hand-held device held up to the mouth, through which the patient will breathe in and out. Training takes approximately 15 minutes twice a day and can be performed at home whilst sitting down.
To try to make sure the groups are the same to start with, each patient is put into a group randomly. Each person taking part will have an equal chance of being in either group. If a patient takes part in the research neither they, nor the surgeon, nor the research team will be able to choose which breathing technique they are given.

Groups 1 & 2: Breathing training with the hand-held device with resistance/difficulty differences: Patients will be taught how to use the device and perform the exercises and instructed to do the exercises twice a day (30 breaths each time, which will take approximately 15 minutes) for a minimum of 2 weeks. If the patients have a longer wait for surgery or their surgery date is rescheduled then they can continue doing the exercises until the day before their operation.
Group 3: Breathing exercises without the hand-held device: Patients will be given an instruction leaflet with a series of deep breathing exercises but will otherwise have no additional breathing training before surgery.

What are the possible benefits and risks of participating?
The researchers cannot promise that the study will help participants, but they anticipate that participants who perform breathing exercises before surgery will have fewer lung complications and recover from surgery more quickly. The results from this study may help improve the management of some complications that could develop after surgery, for other people having operations in the future.
There are no known risks associated with performing breathing exercises. However, if participants have problems operating the breathing device or experience untoward events the local research team will provide contact details on joining the study.
There should also be no risks associated with participating in the information study, as this only involves audio-recording conversations participants have with hospital staff and researchers. Most people find these conversations helpful but some can find it upsetting. If this happens, participants will be able to stop the appointment or interview at any time, without giving a reason.

Where is the study run from?
Bristol Trials Centre at the University of Bristol (UK)

When is the study starting and how long is it expected to run for?
November 2019 to July 2023

Who is funding the study?
National Institute for Health Research (NIHR) Health Technology Assessment (HTA) Programme (UK)

Who is the main contact?
1. Dawn Phillips (public)
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# Contact information

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Public

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Scientific

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# Additional identifiers

**Clinical Trials Information System (CTIS)**
Nil known

**Integrated Research Application System (IRAS)**
250345

**ClinicalTrials.gov (NCT)**
Nil known

**Protocol serial number**
6296, HTA 16/140/07, CPMS 39337, IRAS 250345

# Study information

**Scientific Title**

Effectiveness and cost-effectiveness of INSPIRatory musclE training (IMT) for reducing postoperative pulmonary complications (PPC): a sham-controlled randomised controlled trial (RCT): INSPIRE

## Acronym
INSPIRE

## Study objectives
Inspiratory muscle training (IMT) performed twice per day for a minimum of 2 weeks before an operation reduces the risk of lung complications in patients at high risk of having lung complications.

## Ethics approval required
Old ethics approval format

## Ethics approval(s)
Approved 16/05/2019, London - Bloomsbury Research Ethics Committee (Health Research Authority, Skipton House, 80 London Road, London, SE1 6LH; +44 (0)207 104 8063; nrescommittee.london-bloomsbury@nhs.net), ref: 19/LO/0546

## Study design
Pragmatic parallel three-group multi-center interventional randomized controlled trial (with an internal pilot)

## Primary study design
Interventional

## Study type(s)
Treatment

## Health condition(s) or problem(s) studied
Patients undergoing major surgery who are at high risk of developing lung complications after surgery

## Interventions
Current intervention as of 05/10/2020:
INSPIRE is a pragmatic parallel, 3 group multi-center RCT (with an internal pilot) with high-resistance IMT, low-resistance IMT and usual care interventions. During the internal pilot we will also conduct a study within a trial (SWAT).

The pilot study will check whether participants need more than one session of training to be able to use the breathing device correctly and whether a device with a manual or automatic setting improves breathing function. If it is found that the additional virtual training session and /or the manual or automatic device improves device use and/or breathing function we may incorporate these into Phase 2 of the study.

The main study consists of patients being recruited in a 2:1:1 ratio whilst the SWAT consists of a further randomisation in a 2x2 factorial design to one of four group allocations.

Patients will receive appropriate training and advice regarding breathing exercises and may be asked to train for a minimum of 2 weeks before their planned operation.

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Previous intervention:
INSPIRE is a pragmatic parallel, 3 group multi-center RCT (with an internal pilot) with high resistance IMT, low resistance IMT and usual care interventions. During the internal pilot we will also conduct a study within a trial (SWAT).

The pilot study will check whether participants need more than one session of training to be able to use the breathing device correctly. There will be two groups as follows:
Group A: Extra one-off hospital visit one week after being randomised to Group 1 to receive further training on using the breathing device. Group B: No additional hospital visits or training. Results will be analysed at the end of the pilot study, and if it is found that the additional training improves device use we may include the extra training in the larger study.

The main study consists of patients being recruited in a 2:1:1 ratio into one of the following three groups:
1. High resistance inspiratory muscle training (IMT) training at 50% of their maximal inspiratory pressure (MIP)
2. Low resistance IMT (control) training at 10% of their MIP
3. Usual care arm (patients will be given a breathing exercise leaflet)
The random allocation will be stratified by hospital site and specialty.

During Phase 1 of the study patients randomised to the high resistance IMT arm will be included in a study within a trial (SWAT) and will be further randomised in a 2x2 factorial design to one of the following four groups:
1. Automatic load adjustment and an additional hospital visit
2. Automatic load adjustment and no additional hospital visit
3. Manual load adjustment and an additional hospital visit
4. Manual load adjustment and no additional hospital visit

Patients will receive appropriate training on how to use the device and on how to perform breathing exercises and will be asked to train for a minimum of 2 weeks but no longer than 8 weeks before their planned operation.

## Intervention Type
Behavioural

## Primary outcome(s)
Incidence of any post-pulmonary complication (PPC) occurring in-hospital (before discharge) or hospital readmission for a PPC within 30 days from surgery in each of the three care groups. We will use the composite outcome proposed by the European Society of Anaesthesiology and the European Society of Intensive Care Medicine as a consensus definition for PPC. This includes respiratory failure, respiratory infection, atelectasis, pleural effusion, pneumothorax, aspiration pneumonitis and bronchospasm; there are specified diagnostic criteria for each component.

## Key secondary outcome(s))
Measured using patient notes unless stated otherwise:
1. Incidence of each of the seven individual components of the composite primary outcome

(defined using the European Society of Anaesthesiology and the European Society of Intensive Care Medicine) during the study period:
1.1. Respiratory infection (patient notes & chest x ray)
1.2. Respiratory failure
1.3. Pleural effusion (patient notes & chest x ray)
1.4. Atelectasis (patient notes & chest x ray/chest ct)
1.5. Pneumothorax (patient notes & chest x ray)
1.6. Bronchospasm
1.7. Aspiration pneumonitis (patient notes & chest x ray)
2. The requirement for postoperative ventilation (invasive ventilation; non-invasive ventilation ( including continuous positive airway pressure (CPAP) and/or pressure support (BIPAP)); or Optiflow (high flow nasal oxygen therapy)). For non-invasive ventilation and high flow nasal oxygen therapy the researchers will distinguish prophylactic use from use to treat a pulmonary complication
3. Length of ICU stay
4. Length of hospital stay (including readmissions)
5. Antibiotic prescription given during hospital stay
6. Bronchodilator prescription given during hospital stay
7. Quality of life measured using HRQoL questionnaires at baseline and day of surgery, 3 months & 6 months. A combination of the following questionnaires will be issued across the 4 timepoints: EQ-5D-DL; SF-12; Connor Davidson Resilience; Duke Activity Status Index; Hospital Anxiety And Depression Scale; Self-efficacy; Surgical Regret
8. Maximal inspiratory pressure (MIP) measured using POWERbreathe device that calculates residual volume at baseline and randomisation, additional training visit (for those patients randomised to an extra visit) and day of surgery
9. Spirometry (forced expiratory volume, FEV1 and forced vital capacity, FVC) measured using a spirometer at baseline, randomisation and day of surgery
10. Training load measured using POWERbreathe device and patient diary at baseline and day of surgery
11. Mortality
12. Resource use collected from patient notes & patient questionnaires at 3 and 6 months
13. Other complications of surgery documented using the Clavien-Dindo classification and the Comprehensive Classification Index

### Completion date
31/07/2023

# Eligibility

### Key inclusion criteria
1. Aged ≥18 years
2. Elective major cardiac, thoracic and abdominal surgery (oesophageal, gastric, hepatobiliary, colorectal, gynaecological, urological, or open aortic aneurysm repair) under general anaesthesia, including both open and laparoscopic surgery
3. ARISCAT score ≥26
4. At least 14 days until planned operation date
5. Able to give informed consent

### Participant type(s)
Patient

### Healthy volunteers allowed
No

### Age group
Adult

### Lower age limit
18 years

### Sex
All

### Total final enrolment
337

### Key exclusion criteria
1. Emergency surgery
2. Unable to participate in the intervention (e.g. have cognitive impairment)
3. Lack capacity to consent
4. Recent cardiac, thoracic or open abdominal surgery (in previous 2 months)
5. Prisoners
6. Patients with a history of spontaneous pneumothorax (if a patient has had a traumatic pneumothorax and are fully recovered, then they can be included)
7. Eardrum perforation within 6 weeks
8. Phrenic nerve palsy

### Date of first enrolment
02/12/2019

### Date of final enrolment
30/10/2021

## Locations

### Countries of recruitment
United Kingdom

England

### Study participating centre
**University Hospital Southampton NHS Foundation Trust**
Southampton General Hospital
Southampton
United Kingdom
SO16 6YD

### Study participating centre

**Royal Surrey County Hospital**
Egerton Road
Guildford
United Kingdom
GU2 7XX

**Study participating centre**
**Sheffield Teaching Hospitals NHS Foundation Trust**
Royal Hallamshire Hospital
Glossop Rd
Sheffield
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S10 2JF

**Study participating centre**
**Hull University Teaching Hospitals NHS Trust**
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HU3 2JZ

**Study participating centre**
**Royal Marsden Hospital**
203 Fulham Rd
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SW3 6JJ

**Study participating centre**
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**Study participating centre**

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**Study participating centre**
**University Hospitals Bristol and Weston NHS Foundation Trust**
Marlborough Street
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# Sponsor information

**Organisation**
University Hospitals Bristol and Weston NHS Foundation Trust

# Funder(s)

**Funder type**
Government

**Funder Name**
Health Technology Assessment Programme

**Alternative Name(s)**
NIHR Health Technology Assessment Programme, Health Technology Assessment (HTA), HTA

**Funding Body Type**
Government organisation

**Funding Body Subtype**
National government

**Location**
United Kingdom

# Results and Publications

## Individual participant data (IPD) sharing plan

The data sharing plans for the current study are unknown and will be made available at a later date.

## IPD sharing plan summary

Data sharing statement to be made available at a later date

## Study outputs

| Output type | Details | Date created | Date added | Peer reviewed? | Patient-facing? |
|---|---|---|---|---|---|
| Basic results | | | 01/08/2025 | No | No |
| HRA research summary | | | 28/06/2023 | No | No |
| Participant information sheet | Participant information sheet | 11/11/2025 | 11/11/2025 | No | Yes |
| Protocol file | version v3.0 | 13/08/2020 | 05/10/2020 | No | No |
| Statistical Analysis Plan | version 1.0 | 15/08/2024 | 01/08/2025 | No | No |
| Study website | Study website | 11/11/2025 | 11/11/2025 | No | Yes |