**SUPPLEMENTARY MATERIALS**

**Methods**

 This observational qualitative study considered a cohort of patients attending the Respiratory Unit of the Istituti Clinici Scientifici (ICS) Maugeri of Lumezzane (Bs), Italy. The study was approved by ICS Maugeri IRCCS Ethics Committee (EC 2322; 16 July 2019). All participants were informed and gave their written consent to participate.

**Patients**

Patients aged >18 years with a diagnosis of COPD or severe asthma were eligible for enrolment. COPD and asthma were defined according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria (1) and Global Initiative for Asthma (GINA) guidelines (2). Patients were admitted either to an inpatient program with an average stay of 25 (SD 3) days or an outpatient program attending no less than 22 rehabilitative sessions with 2 or 3 weekly accesses over a 2-month period. Subjects were excluded if any of the following conditions were present: dyspnea at rest with need for acute hospitalization, oncological disease, terminal illness, neuromuscular degenerative diseases, severe orthopedic diseases, subject bedridden or confined to a wheelchair, and altered cognitive status measured by MMSE (3) < to 22.

 **Intervention**

***Development of the interview***

To obtain a questionnaire with face validity based on expert opinion involving a structured process of consensus, we engaged key stakeholders (4 doctors and 4 nurses) from among health staff employed in the rehabilitation field of our Institute. We performed a systematic review of the COPD literature identifying items to use for the questionnaire and prepared a preliminary draft of questions. During the meeting, using a Delphi-like procedure, we asked the experts to rate the accordance of preselected items on a 5-point Likert scale (0 = totally disagree; 1=disagree; 2=sufficiently agree; 3=moderately agree; 4=totally agree). Consensus was considered when more than 75% of the respondents rated each item as totally agree. Finally, the focus group checked that the wording of each question was simple, clear, and comprehensible. The first version of the interview proposed 3 different levels of answers (correct, partially correct, totally incorrect). After discussion, the focus group proposed to limit answers to a dichotomous format (correct or incorrect) on the grounds that patients should be completely able to use their drugs without any interim of uncertainty. The questionnaire assesses the degree of disease/drugs knowledge and skills to use correctly the drugs. To improve routinely real life questionnaire usability, focus group have proposed to limit skills items to 3 not recording device use steps one by one; the focus group proposed to collect all the devices steps/errors (see below) into one critical error regardless of whether the patient presented only one, two or multiple execution errors in the different steps.

The final tool consisted of 8 questions enquiring about: the name of the drug/drugs, dosage prescribed, time of administration during the day, ability to distinguish the drug/s from others, the usefulness, and how to prepare, use and replace the drugs. Five items dealt with knowledge (part A=knowledge) and 3 with correct self-administration of the inhalation drugs (part B=skills) (**Figure 1 in the main text**). The operator scored each item dichotomously, according to the patient's response, as knows/does not know or correct maneuver/incorrect maneuver (**Figure 1 in the main text**). The score for part A (representing the percentage of correct answers for knowledge) and that for part B (representing the percentage of correct maneuvers for skills) were summed to give a final total global ability score (A+B), being 0% the worse and 100% the best value of global ability. In the case where two or more drugs were prescribed, the data for analysis were the average total score of each drug. After discussions, the focus group agreed to include a box containing all the types of devices available on the market in order to facilitate greater interactivity in terms of knowledge; the nurse tutor asked patients to identify their prescribed respiratory drugs within the box.

***Interview***

Before conducting the interviews, all nurse staff participated in briefing session on how to conduct the interview in a standardized way. According to the previous literature (4), an error or incorrect drug use was defined according to the following table list:

**Table list of errors**

|  |  |
| --- | --- |
| **Preparations errors**  | **Delivery errors**  |
| Lack of cartridge or no capsule in device prior to inhalation | Exhaling into the powder device prior to inhalation |
| Opening next blister when taking the capsule | No inhalation through the mouthpiece |
| Not sliding the lever | Powder remaining in the capsule at the end |
| Total dose preparation error | Lack of hand-lung synchronization with smoke emanation |
| Do not remove the lid | Inhalation despite dose counter at zero |
| Does not hold the inhaler upright | Not pressing the button |
| Incorrectly insert the MDI into the camera | Twisting error |
| Do not uncover the inhaler | Loading position error |
| Do not properly load the drug dose | Opening the mouth piece |
| Place the device down after dose preparation (before inhalation) | Performs the pulsation before inhalation |
|  | Interrupts inhalation (freon-cold effect) |
|  | Inhalation is too fast or energetic |
|  | Performs several pulses of the mdi in a single inhalation |
|  | Absence of apnea |
|  | Cough during inhalation |
|  | Blows into the device before inhalation |
|  | Inhalation is not energetic |

Finally, nurse staff had a list with all the possible mistakes patient could miss during his/her interview.

Nurse staff participated in a meeting to reinforce their knowledge and use of all the inhaled devices and prepared an educational booklet with fact sheets on each drug dedicated to nurses and patients.

The score was calculated (T0) during a face to face visit and assigned to a nurse case-manager not involved in the educational program. Patients admitted for a PR program, either as inpatients or outpatients, underwent the interview at the time of admission or at their first/second access.

**Education program**

After assigning the score, and starting from the baseline level of knowledge and skills, two structured tailored educational meetings of 20 minutes each were given by a nurse (different from the case manager) to reinforce the knowledge and the correct use of the inhalation therapy, in such a way as to be able to intervene promptly and effectively if the therapy was not performed correctly. The educational program consisted of reminders and self-management plan. No differences were proposed for inpatient and outpatient while some specific items where tailored according to asthma and COPD diseases. For example, dedicated social support meetings, link to daily habits, and motivational reinforcement were tailored on specific case. The program involved interactive and autonomy-supportive approach groups and smoking patients were given a written document with the quit smoking strategy and individually tailored pharmacotherapy guidance. The decision to further reinforce with a third educational meeting was left to the decision of the case manager.

For those patients with important difficulties in knowledge and execution (first-time users of inhalation therapy or with a change in type of device) demonstration videos were provided for each device; in parallel, simplified fact sheets (with the use of images to demonstrate, brief, easy and clear explanations) were provided to the patient and/or caregiver.

The form for verification of change in knowledge and skills to inhalation therapy was re-administered to the patient on discharge (T1) by the same case-manager.

**Measurements**

The following data were collected: setting of rehabilitation, anthropometrics such as age, sex, definitive diagnosis of COPD based on spirometry, presence of comorbidities with the Cumulative Illness Rating Scale (CIRS) (5) present/past data on FEV1 (% pred.) and forced vital capacity [FVC (% pred.)]; if naïve to PR, educational level (no education or elementary school vs. higher than elementary school), number and type of prescribed inhaled drugs, if the patient was autonomous in general use of prescribed drugs. Patients were defined as autonomous if they had an acceptable level of cognitive status and absence of dysphagia.

**References**

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