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Physiotherapy

Physiotherapy xxx (2016) xxx–xxx

Do COPD patients taught pursed lips breathing (PLB) for dyspnoea management continue to use the technique long-term? A mixed methodological study

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Abstract

Objective To investigate whether COPD patients taught pursed lips breathing (PLB) for dyspnoea management continue to use the technique long-term and, if so, their experience of this.
Design A mixed methodological approach using semi-structured telephone interviews, a focus group and observation of current PLB technique was used. Qualitative analysis was based on grounded theory.
Setting Participants were recruited from the two inner city London (UK) boroughs.
Participants A purposive sample of 13 patients with COPD taught PLB 6 to 24 months previously. 11 participants took part in the telephone interviews; focus group participation and observed PLB was 5/11 and 6/11 respectively.
Main outcome measures A thematic analysis of interviews and focus group; observation of PLB technique.
Results Nine reported on-going use of PLB with 8 reporting definite benefit. Observed technique showed ongoing ability for PLB to reduce RR and increase SpO_2. Four distinct themes emerged from the data: use of PLB when short of breath due to physical activity (8/9), increased confidence and reduced panic (4/9), use as an exercise (3/9), use at night (3/9). Those that had discontinued PLB had done so because it didn't help (2) and they had forgotten/were too busy to continue.
Conclusion This study found 9 of 13 of patients taught PLB continued with long-term use and 8 of 13 reporting definite benefit from PLB. The role of PLB in increasing patients' confidence in their ability to manage their breathlessness and, use at night, were novel findings.
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Keywords: Chronic Obstructive Pulmonary Disease; Dyspnoea; Breathing exercises; Rehabilitation

Introduction

Pursed lips breathing (PLB) is a breathing retraining strategy, adopted spontaneously by some patients, that has been advocated for the treatment of exertional dyspnoea in Chronic Obstructive Pulmonary Disease (COPD) [1,2]. It has been used in clinical practice for over 40 years and is customarily integrated into pulmonary rehabilitation (PR) programmes [3–6]. PLB is carried out by exhaling through partially closed lips *i.e.* through pursed lips as if making the flame of a small candle flicker [7]. Review of the PLB literature [8] identified 11 quantitative studies, 10 short-term studies and one that looked at the effects of PLB over 12 weeks. The aim of this study was to document the subjective experience of people with COPD taught PLB at least 6 months previously. The principle research question was: 'what are the key themes expressed about the use of PLB by these patients.'

Method

Ethical approval was gained to recruit patients taught PLB more than 6 months and less than 24 months previously as part of the randomised controlled study investigating the effects

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http://dx.doi.org/10.1016/j.physio.2016.05.006
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Please cite this article in press as: Roberts SE, et al. Do COPD patients taught pursed lips breathing (PLB) for dyspnoea management continue to use the technique long-term? A mixed methodological study. Physiotherapy (2016), http://dx.doi.org/10.1016/j.physio.2016.05.006

Table 1
PLB teaching protocol.

Standardised protocol used when participants were taught PLB
PLB taught in sitting, at rest, at two home visits 3 to 4 weeks apart
'Imagine a small candle, make the flame flicker but don't blow it out' [7]
Practise PLB every day for 2 minutes as an exercise
Use PLB as a means of delaying the onset of breathlessness when active
Use PLB as a means of regaining control of breathing when breathlessness caused distress

of PLB in stable COPD [9]. This study comprised three components: a semi-structured telephone questionnaire, a focus group and, for those still using PLB, a home visit (HV). The sample was a purposive sample of all the patients who met the characteristics of interest for this study. The characteristics being: diagnosis of COPD; taught PLB according to a standardised protocol (see Table 1) 6 to 24 months previously. The effects of PLB on respiratory rate (RR) and oxygen saturation (SpO_2) were also measured and compared both to spontaneous breathing and to the same measurements made when PLB was first taught. The home diaries kept by the participants when taught PLB, were available to compare with observations made at the HV. The protocol followed for teaching PLB is provided in supplementary information online.

Telephone interview

A short questionnaire was administered to investigate participants' recollection of learning PLB, if they had continued to use PLB or not and why, and when they used or stopped using PLB.

Focus group

All patients who completed the telephone interview were invited to attend a focus groups and focus group questions were generated from analysis of the telephone interviews. Patients were also asked about their initial expectations of PLB and how it compared with subsequent experience, ways in which PLB might be taught, and any negative effects experienced. Finally patients were asked to speculate on how they thought PLB worked.

The telephone interviews and focus group were audio recorded and the focus group was observed by a physiotherapist who acted as scribe to augment the recording. To minimise bias the telephone interviews and focus group were conducted by a physiotherapist not involved in teaching PLB. The audio recordings were transcribed and analysed using a manual process to identify the key themes [10]. This was followed by checking for accuracy and over-representation of themes by the physiotherapist who conducted the interviews and the focus group scribe. At HV to observe PLB focus group participants reviewed the transcript to check accuracy.

Home visit

Observation of current PLB technique was carried out after a minimum 5 minutes rest. RR and SpO_2 were measured using a pulse oximeter (Finger pulse oximeter model 950, Healthdyne Technologies, Brussels) and were recorded for 1 minute of spontaneous breathing and 1 minute of PLB. Observations were compared with those recorded at the time of learning PLB.

Results

At the time of learning PLB, the 13 participants identified for the study had a mean (SD) age of 65 (10.85) years and a mean predicted (SD) FEV_1 of 42.8 (0.18)%. Their COPD had been stable and optimally managed according to NICE guidelines [11]. The median time from learning PLB to the telephone interview was 17 months (range 6 to 23 months). A figurative trajectory of participation in the study is given as supplementary information online (online Figure 1). The response rate for the telephone interviews was 11 of 13 with 5 agreeing to take part in the focus group, and 6 to be observed demonstrating their PLB technique.

Long-term benefit

11 of 13 possible study participants agreed and could be contacted for telephone interview. 9 of 13 participants reported continued use of PLB and 8 of 13 reported long-term benefits; two had not found PLB helpful and had stopped and one was not sure but still used PLB. For those who reported a definite benefit, three emphasised that it helped their breathlessness but not always or not completely. Of those attending the focus group (5) all agreed that the benefits exceeded their initial expectations. For the two who had stopped using PLB little further information was gained; both declined to attend a focus group. Representative quotes for perceived benefit from PLB and recollection of initial thoughts with regard to learning PLB are given as supplementary information online (online Table 1).

A review of the diaries from the time of learning PLB indicated all had tried to use PLB as instructed and 11 had, at the time, found it helpful; neither of those who initially found PLB unhelpful took any part in this follow-up study. At long-term follow up the number who had found PLB un-helpful, were uncertain of any benefit, or were not using it had increased from 3 to 5. Of those still using PLB (9), all at some point said they used it when they were short of breath. This was the first reason mentioned by four. The remaining five gave more specific individual reasons (see Table 2). There was an equal split between using it many times a day, once or twice a day, and a few times a week.

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Table 2
First reasons given for using PLB.

When short of breath [4/9]	Well you know like when I'm out of breath, sometime I do that, and I find it eases it a bit (M11); Recently I've had this bad cough so my breathing, when I'm walking I get out of breath, so I use the pursed lip to try and get me breathing back to normal (F4).
Panic attacks/relaxing thing to do [2/9]	I started getting panic attacks . . . and I found that when this was about to happen if I used the pursed lip way of breathing it would allow me enough time not to hyperventilate (M9); Obviously because I think it helps.. . .it's a moment everyday where you focus on your breathing and it helps . . . it's quite relaxing (F7)
Habit [1/9]	I seem to do it without even thinking about it. It seems to occur naturally, I feel like if I didn't do that I would be hard of breathing, you know (M1).
To recover from coughing [1/9]	Sometimes when I bring up phlegm, I get a bit winded. . .so I immediately start doing the breathing exercises (M12)
Unsure [1/9]	I'll try anything (F13)

Table 3
Themes extracted from telephone interview and focus group transcripts.

Physical activity [8/9]	If I do the hoovering, if I make the bed, I find myself doing it more (M1); I can't get out of the car immediately. I will do the breathing and then get out and walk, that's. . .a transition I find quite difficult, from driving to walking (F7)
Using it at night [3/9]	Last night. . .I woke up, and after I finished (coughing) I was, you know breathing heavily, and I sat up in bed took a long deep breath and let it out very slowly, pursed lips (M12); At night time when I'm in bed and I can't get my breath I do the breathing and it's marvellous (F5).
As an exercise [3/9]	If I sit up in the night, watching the telly . . . I wouldn't be out of breath. . ..just as an exercise (M11).
Anxiety, panic attacks and hot flushes [3/9]	It gives me time to concentrate on relaxing and not going off into that place you go to when your panicking (M9).

PLB themes

Four distinct themes emerged from analysis of the data collected by telephone interview (see Table 3). The acute episodes of anxiety and panic reported were predominantly, although not exclusively, related to episodes of breathlessness. These themes were explored further in the focus group and example quotes from both the telephone interviews and the focus group transcript are provided in Table 4. Further clarity was gained from the focus group as to what was meant when they reported PLB was used to help with breathlessness during an activity. Specifically they were asked whether they used PLB during the activity or to help them recover their breath, having stopped to rest. When out and about, all but one agreed that they had to:

> stop for a little while and do it (F2).

For the one person who did use PLB whilst walking she described it thus:

> I do mine often when walking. . .I've got a shopping trolley. . ..you're walking along the street you feel a little bit breathless and I do it (F4).

Additional to these themes, in both the focus group and in some telephone interviews there were times when participants diverted from PLB to talk about their inhalers. Two participants reported reduced use of short-acting beta agonist (SABA) inhalers after learning PLB. One recounted a story of being locked out of her house, where her inhalers were; she used PLB to control the situation to get back to her car to another inhaler:

> you can leave your inhalers behind but you can always do PLB (F7).

Learning PLB

The best place for learning PLB was explored in the focus group. All had first learnt PLB in a one-to one situation but some had subsequently had this re-enforced at pulmonary rehabilitation (PR). One of the group felt the one-to-one situation was important for her:

> I think you take more notice, or I do (F4).

In contrast the majority of the group thought learning it in a group situation could be beneficial:

> Now with me it was going to the class [PR]
>
> that made me conscious of it (M11).

Table 4
Median change in respiratory rate and oxygen saturation from resting breathing to PLB when initially taught and at follow-up 6 to 24 months later.

	Initial teaching ($n=11$)	Long term follow up ($n=6$)
RR (bpm) Median change (range)	−7 (+1 to −13)	−8 (−3 to −16)
SpO_2% median change (range)	+2 (−1 to +4)	+1.5 (0 to +6)

bpm, breaths per minute; RR, respiratory rate; SpO_2%, pulse oximetry oxygen saturation.

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There was general agreement expressed with the idea that more opportunities could be taken to teach PLB:

> if you went to your GP when you were diagnosed, any time, hospital, anywhere, to be given PLB something you could practise. . .it's not as available as it should be (F7).

The idea of being taught PLB in *a normal environment* was also expressed:

> doing it in the gym is not the same, to do it outside properly on a proper incline with a bit of wind coming along I think people would take it more seriously. . ..even on a treadmill might be better. . . you would be doing it (PLB) because you needed it not because you were told to (F4).

PLB technique

At telephone interview some comments were made on the technique of PLB from simple to more detailed descriptions. PLB technique was also explored further in the focus group (see supplementary information in online Table 2). The general emphasis was that the breath out should be longer than the breath in and that upper chest breathing was not helpful. Discussion also indicated that some had combined PLB with diaphragmatic breathing, particularly when performed as an exercise *i.e.* not when breathless. When PLB was observed during a home visit, it was noted that, whilst the focus was on breathing out through pursed lips the depth of inspiration varied considerably between participants; those that used deeper inspiration (about half) demonstrated the greatest reduction in RR. Changes in respiratory rate (RR) and oxygen saturation (SpO_2%) with PLB compared to spontaneous breathing were observed and compared to those recorded when the technique was first taught (see Table 4). This showed comparable reductions in RR and improvement in SpO_2% both in this group over time and compared to the published literature [8] but numbers were not sufficient to test for statistical significance.

Negative effects

Only one participant reported a negative effect (F7). At telephone interview, she felt that it possibly encouraged her to focus too much on her breathing. She repeated this idea at the focus group but the other group members did not agree.

Perceived mechanism of effect

In drawing the focus group to a close, participants were asked to speculate on the mechanism of PLB effect. The participants found this difficult to answer and either reported how it made them feel or were unable to comment. Three mentioned that it gave them more confidence to manage their breathlessness:

> I feel better, I feel more confident, I don't panic so much. . .It helps you, obviously when you are out of breath, it brings you confidence in yourself (F2)

Two found it more difficult to say:

> If I'm out of breath and I do the pursed lip breathing it helps me. . .that's it (M11).

Discussion

Main findings

In this mixed-methods study of the perceived impact of PLB on breathlessness 8 of 13 study participants reported long-term benefit; this assumed a 'worst-case scenario' *i.e.* that those that could not be contacted or declined contact had found PLB unhelpful and had not continued to use the technique. Of those who did participate in the study 8 of 11 reported definite benefit. Use of PLB as a tool for managing breathlessness was associated with physical activity and improved confidence in their ability to cope with breathlessness. Participants reported no significant adverse effects.

Strengths and limitations

The main limitation of this study was that only one focus group was held. Small numbers are acceptable for qualitative studies because of the richness of data generated but, optimally, a focus group study should consist of repeated groups until no new information is gained. Repeated group meetings balance out any idiosyncrasies from an individual session ([12]; p. 36) and reduce the risk of including outlier experiences. However one-to-one interviews carried out prior to the focus group helped to minimise bias from group members giving socially desirable responses; in the telephone interviews three participants expressed the opinion that PLB did not work all the time however only one repeated this in the focus group with the other two failing to endorse the opinion. A further limitation was the lack of information from those who did not find PLB helpful. Different reasons for discontinuation of its use may be speculated. One reason might be a difference in lung volume response to PLB *i.e.* the finding [13,14] that PLB results in a decrease in end-expiratory lung volumes and a reported decrease in breathlessness in some patients with COPD but the reverse in others. Another reason may relate to issues of self-efficacy associated with a person's beliefs regarding the taking on of new ideas that might benefit their health [15]. Further qualitative studies may give insight into different illness and health behaviours which may have an influence on uptake of PLB ([16]; p. 34–5).

Interpretation of findings in relation to previously published works

To our knowledge, there are currently no published studies of long-term benefits from PLB. However four categories

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of dyspnoea management strategies (DMS) used by people with severe COPD have been reported [17]: changing activity, relaxation, inhaled medication, and altered breathing pattern. PLB was identified as the 11th most effective DMS and the author reported concern over this relatively low ranking given that PLB is taught routinely for dyspnoea management. An alternative interpretation might view the four categories as reflecting different but essential components of a comprehensive COPD dyspnoea self-management programme in which each individual interventions provides only small reductions in dyspnoea but, added together, they produce clinically meaningful change [1]. In our study three patients commented that PLB does not always help, particularly when the breathlessness is experienced in more extreme circumstances. This mirrors the DMS study observation [17] that patients rated PLB as 55% effective in relieving breathlessness.

From focus group discussion and observation at home visits, it was evident that adaptations to the original technique had occurred. The combining of PLB with diaphragmatic breathing demonstrated by one patient has been described in the literature [18]. This technique may have been spontaneously adopted by the patient or learned at PR. Despite the variations in techniques equivalent changes in RR and SpO_2 to those seen when the technique was first taught were observed and the various techniques were subjectively assessed as falling within what might be termed PLB. It should be noted that the demonstrations given by patients at the home visits were of PLB 'as an exercise' at rest. The actual practice of PLB during acute breathlessness was not observed and may have been different.

Two themes emerged from the interviews that were unexpected: the use of PLB at night and an association in the participants' discussions between use of PLB and use of SABA inhalers. Use of PLB to manage nocturnal symptoms was not suggested to participants when taught PLB although disturbed sleep is an issue reported to affect quality of life for people with COPD [19,20]. Although the participants in this study did not specifically refer to use of PLB to reduce panic and anxiety associated with their night time breathlessness, a previous qualitative study investigating COPD patients perspective on sleep [20] identified nocturnal anxiety and fear of breathlessness as a key themes. The second unexpected theme was the introduction by participants into the discussion comments on their use of SABA inhalers and how this had, for some, reduced since learning PLB. It can be hypothesised that this may have been due to their improved sense of confidence in their ability to cope with their breathlessness by using PLB. It is also interesting to note that one of the proposed mechanism for PLB [13,14,23,24] is a reduction in dynamic hyperinflation. This has been proven as a mechanism by which use of SABA inhalers results in reduced breathlessness [21,22] and raises the possibility of an underlying mechanistic association for PLB reducing the use of SABA inhalers and warrants further study.

Implications for future research

In line with good practice, replication of this study is needed in order to confirm or refute the findings, in particular of the focus group of which only one was held. This study also raised the interesting distinction between the sensation of dyspnoea experienced and the degree of dyspnoea, and this again warrants further study. When asked how they thought PLB worked participants either found this difficult to answer or emphatically related it to an improvement in their confidence in their ability to cope with breathlessness. This suggests that PLB may impact on the sense of control over breathlessness and is essentially a new finding. This was proposed as a mechanism of action for PLB 20 years ago [25] but not further explored in the published literature. It could be hypothesised that the role of PLB in improving self-efficacy with respect to managing breathlessness is only as a distraction technique however it may relate to the reported shortened recovery time from exercise induced breathlessness [26] and the developing body of evidence suggests its role in reducing dynamic hyperinflation [13,14,23,24].

Conclusions

In this study demonstrated 8 of 13 patients with stable COPD who were taught PLB continue to use the technique with perceived long-term benefit. This observation is consistent with short term studies in which up to 63% of COPD patients reported benefit [8]. While the association between benefits from PLB and exercise have been previously reported the effects on reducing fear and anxiety associated with breathlessness and, use at night, are novel findings and need further study.

Acknowledgements

Leon Poltawski, Research Assistant, School of Health & Social Work, University of Hertfordshire; collaborated on interview schedules, conducted telephone interviews and focus group, provided review of write up of qualitative interviews as part of validation.

Ethical approval: Ethical approval for the study was obtained from the Brent Medical Ethics Committee. Reference number 09/H0717/63.

Funding: Funding for taxi fares to attend the focus group was supplied by a donation from PJ Maitland who had no role in the study design, the collection, analysis and interpretation of data; in writing of the manuscript; or in the decision to submit the manuscript for publication.

Conflict of interest: None.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.physio.2016.05.006.

References

[1] American Thoracic Society. Dyspnea. Mechanisms, assessment, and management: a consensus statement. American Thoracic Society. Am J Respir Crit Care Med 1999;159(January (1)):321–40.
[2] Marciniuk DD, Goodridge D, Hernandez P, Rocker G, Balter M, Bailey P, *et al.* Canadian Thoracic Society COPD Committee Dyspnea Expert Working Group. Managing dyspnea in patients with advanced chronic obstructive pulmonary disease: a Canadian Thoracic Society clinical practice guideline. Can Respir J 2011;18(March–April (2)):69–78.
[3] British Thoracic Society. Pulmonary rehabilitation. Thorax 2001;56(November (11)):827–34.
[4] Chartered Society of Physiotherapy. The effectiveness of pulmonary rehabilitation: evidence and implications for physiotherapists. London: CSP; 2003, March.
[5] Nici L, Donner C, Wouters E, Zuwallack R, Ambrosino N, Bourbeau J, *et al.* American Thoracic Society/European Respiratory Society statement on pulmonary rehabilitation. Am J Respir Crit Care Med 2006;173(June (12)):1390–413.
[6] van der Schans CP, de Jong W, Kort E, Wijkstra PJ, Koëter GH, Postma DS, *et al.* Mouth pressures during pursed lip breathing. Physiother Theory Pract 1995;11:29–34.
[7] Nield MA, Soo Hoo GW, Roper JM, Santiago S. Efficacy of pursed-lips breathing: a breathing pattern retraining strategy for dyspnea reduction. J Cardiopulm Rehabil Prev 2007;27(July–August (4)):237–44.
[8] Roberts SE, Stern M, Schreuder FM, Watson T. The use of pursed lips breathing in stable COPD: a systematic review of the evidence. Phys Ther Rev 2009;14(4):240–6.
[9] Roberts SE (Unpublished PhD thesis) The effectiveness of pursed lips breathing in the management of breathlessness in stable chronic obstructive pulmonary disease. University of Hertfordshire; 2010.
[10] Pope C, Mays N. Critical reflections on the rise of qualitative research. BMJ 2009;339(7723):737–9 [Clinical research ed.].
[11] National Institute for Health and Clinical Excellence. Chronic obstructive pulmonary disease. National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. Thorax 2004;59(February (Suppl. 1)):1–232.
[12] Krueger RA. Focus Groups: a practical guide for applied research. 2nd ed. Thousand Oaks: SAGE Publications; 1994.
[13] Bianchi R, Gigliotti F, Romagnoli I, Romagnoli I, Lanini B, Castellani C, *et al.* Patterns of chest wall kinematics during volitional pursed-lip breathing in COPD at rest. Resp Med 2007;101(July (7)):1412–8.
[14] Cabral LF, D'Elia TC, Marins Dde S, Zin WA, Guimarães FS. Pursed lip breathing improves exercise tolerance in COPD: a randomized crossover study. Eur J Phys Rehabil Med 2015;51(February (1)):79–88.
[15] Stuifbergen AK, Seraphine A, Roberts G. An explanatory model of health promotion and quality of life in chronic disabling conditions. Nurs Res 2000;49(May–June (3)):122–9.
[16] Bowling A. Research methods in health: investigating health and health services. Buckingham: Open University Press; 1997.
[17] Thomas LA. Effective dyspnea management strategies identified by elders with end-stage chronic obstructive pulmonary disease. Appl Nurs Res 2009;22(May (2)):79–85.
[18] Petty TL, Guthrie A. The effects of augmented breathing maneuvers on ventilation in severe chronic airway obstruction. Resp Care 1971;16(3):104–11.
[19] van Manen JG, Bindels PJ, Dekker EW, Ijzermans CJ, Bottema BJAM, van de Zee JS, *et al.* Added value of co-morbidity in predicting health-related quality of life in COPD patients. Resp Med 2001;95(June (6)):496–504.
[20] Shackell BS, Jones RC, Harding G, Pearse S, Campbell J. 'Am I going to see the next morning?' A qualitative study of patients' perspectives of sleep in COPD. Prim Care Respir J 2007;16(December (6)):378–83.
[21] Boni E, Corda L, Franchini D, Chiroli P, Damiani GP, Pini L, *et al.* Volume effect and exertional dyspnoea after bronchodilator in patients with COPD with and without expiratory flow limitation at rest. Thorax 2002;57(June (6)):528–32.
[22] O'Donnell DE, Lam M, Webb KA. Measurement of symptoms, lung hyperinflation, and endurance during exercise in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1998;158(November (5 (Pt 1))):1557–65.
[23] Ingram Jr RH, Schilder DP. Effect of pursed lips expiration on the pulmonary pressure-flow relationship in obstructive lung disease. Am Rev Respir Dis 1967;96(September (3)):381–8.
[24] Spahija JA, Grassino A. Effects of pursed-lips breathing and expiratory resistive loading in healthy subjects. J Appl Physiol 1996;80(May (5)):1772–84.
[25] Breslin EH. The pattern of respiratory muscle recruitment during pursed-lip breathing. Chest 1992;101(January (1)):75–8.
[26] Garrod R, Dallimore K, Cook J, Davies V, Quade K. An evaluation of the acute impact of pursed lips breathing on walking distance in nonspontaneous pursed lips breathing chronic obstructive pulmonary disease patients. Chron Respir Dis 2005;2(2):67–72.

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